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Exposure Factors Handbook: 2011 Edition






Office of Research and Development, Washington, DC 20460
National Center for Environmental Assessment

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EXPOSURE FACTORS HANDBOOK: 2011 EDITION

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FOREWORD

The U.S. Environmental Protection Agency (U.S. EPA), Office of Research and Development (ORD), National Center for Environmental Assessment's (NCEA) mission is to provide guidance and risk assessments aimed at protecting human health and the environment. To accomplish this mission, NCEA works to develop and improve the models, databases, tools, assumptions, and extrapolations used in risk assessments. NCEA established the Exposure Factors Program to develop tools and databases that improve the scientific basis of exposure and risk assessment by (1) identifying exposure factors needs in consultation with clients, and exploring ways for filling data gaps; (2) compiling existing data on exposure factors needed for assessing exposures/risks; and (3) assisting clients in the use of exposure factors data. The *Exposure Factors Handbook and* the *Child-Specific Exposure Factors Handbook,* as well as other companion documents such as *Example Exposure Scenarios,* are products of the Exposure Factors Program.

The *Exposure Factors Handbook* provides information on various physiological and behavioral factors commonly used in assessing exposure to environmental chemicals. The handbook was first published in 1989 and was updated in 1997. Since then, new data have become available. This updated edition incorporates data available since 1997 up to July 2011. It also reflects the revisions made to the *Child-Specific Exposure Factors Handbook*, which was updated and published in 2008. This edition of the handbook supersedes the information presented in the 2008 *Child-Specific Exposure Factors Handbook.* Each chapter in the 2011 edition of the *Exposure Factors Handbook* presents recommended values for the exposure factors covered in the chapter as well as a discussion of the underlying data used in developing the recommendations. These recommended values are based solely on NCEA's interpretations of the available data. In many situations, different values may be appropriate to use in consideration of policy, precedent, or other factors.

David Bussard
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The National Center for Environmental Assessment (NCEA), Office of Research and Development was responsible for the preparation of this handbook. Jacqueline Moya served as the Work Assignment Manager for the current updated edition, providing overall direction and technical assistance, and is a contributing author. The current draft was prepared by Westat Inc. under contract with the U.S. EPA (contract number GS-23F-8144H). Earlier drafts of this report were prepared by Versar, Inc.

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EXECUTIVE SUMMARY

Some of the steps for performing an exposure assessment are (1) identifying the source of the environmental contamination and the media that transports the contaminant; (2) determining the contaminant concentration; (3) determining the exposure scenarios, and pathways and routes of exposure; (4) determining the exposure factors related to human behaviors that define time, frequency, and duration of exposure; and (5) identifying the exposed population. Exposure factors are factors related to human behavior and characteristics that help determine an individual's exposure to an agent. This *Exposure Factors Handbook* has been prepared to provide information and recommendations on various factors used in assessing exposure to both adults and children. The purpose of the *Exposure Factors Handbook* is to (1) summarize data on human behaviors and characteristics that affect exposure to environmental contaminants, and (2) recommend values to use for these factors. This handbook provides nonchemical-specific data on the following exposure factors:

- Ingestion of water and other selected liquids (see Chapter 3),
- Non-dietary ingestion factors (see Chapter 4),
- Ingestion of soil and dust (see Chapter 5),
- Inhalation rates (see Chapter 6),
- Dermal factors (see Chapter 7),
- Body weight (see Chapter 8),
- Intake of fruits and vegetables (see Chapter 9),
- Intake of fish and shellfish (see Chapter 10),
- Intake of meat, dairy products, and fats (see Chapter 11),
- Intake of grain products (see Chapter 12),
- Intake of home-produced food (see Chapter 13),
- Total food intake (see Chapter 14),
- Human milk intake (see Chapter 15),
- Activity factors (see Chapter 16),
- Consumer products (see Chapter 17),
- Lifetime (see Chapter 18), and
- Building characteristics (see Chapter 19).

The handbook was first published in 1989 and was revised in 1997 (U.S. EPA, 1989, 1997). Recognizing that exposures among infants, toddlers, adolescents, and teenagers can vary significantly, the U.S. EPA published the *Child-Specific Exposure Factors Handbook* in 2002 (U.S. EPA, 2002) and its revision in 2008 (U.S. EPA, 2008). The 2008 revision of the *Child-Specific Exposure Factors Handbook* as well as this 2011 edition of the

Exposure Factors Handbook reflect the age categories recommended in the U.S. EPA *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). This 2011 edition of the *Exposure Factors Handbook* also incorporates new factors and data provided in the 2008 *Child-Specific Exposure Factors Handbook* (and other relevant information published through July 2011. The information presented in this 2011 edition of the *Exposure Factors Handbook* supersedes the 2008 *Child-Specific Exposure Factors Handbook.*

The data presented in this handbook have been compiled from various sources, including government reports and information presented in the scientific literature. The data presented are the result of analyses by the individual study authors. However, in some cases, the U.S. EPA conducted additional analysis of published primary data to present results in a way that will be useful to exposure assessors and/or in a manner that is consistent with the recommended age groups. Studies presented in this handbook were chosen because they were seen as useful and appropriate for estimating exposure factors based on the following considerations: (1) soundness (adequacy of approach and minimal or defined bias); (2) applicability and utility (focus on the exposure factor of interest, representativeness of the population, currency of the information, and adequacy of the data collection period); (3) clarity and completeness (accessibility, reproducibility, and quality assurance); (4) variability and uncertainty (variability in the population and uncertainty in the results); and (5) evaluation and review (level of peer review and number and agreement of studies). Generally, studies were designated as "key" or "relevant" studies. Key studies were considered the most up-to-date and scientifically sound for deriving recommendations; while relevant studies provided applicable or pertinent data, but not necessarily the most important for a variety of reasons (e.g., data were outdated, limitations in study design). The recommended values for exposure factors are based on the results of key studies. The U.S. EPA also assigned confidence ratings of *low, medium, or high* to each recommended value based on the evaluation elements described above. These ratings are not intended to represent uncertainty analyses; rather, they represent the U.S. EPA's judgment on the quality of the underlying data used to derive the recommendations.

Key recommendations from the handbook are summarized in Table ES-1. Additional recommendations and detailed supporting information for these recommendations can be found in the individual chapters of this handbook. In providing recommendations for the various exposure factors, an attempt was made to present percentile values that are consistent with the exposure estimators defined in the *Guidelines for Exposure Assessment* (U.S. EPA, 1992) (i.e., mean and upper percentile). However, this was not always possible because the data available were limited for some factors, or the authors of the study did not provide such information. As used throughout this handbook, the term "upper percentile" is intended to represent values in the upper tail (i.e., between 90^{th} and 99.9^{th} percentile) of the distribution of values for a particular exposure factor. The 95^{th} percentile was used throughout the handbook to represent the upper tail because it is the middle of the range between 90^{th} and 99^{th} percentile. Other percentiles are presented, where available, in the tables at the end of each chapter. It should be noted that users of the handbook may use the exposure metric that is most appropriate for their particular situation.

The recommendations provided in this handbook are not legally binding on any U.S. EPA program and should be interpreted as suggestions that program offices or individual exposure/risk assessors can consider and modify as needed based on their own evaluation of a given risk assessment situation. In certain cases, different values may be appropriate in consideration of policy, precedent, strategy, or other factors (e.g., more up-to-date data of better quality or more representative of the population of concern).

REFERENCES FOR THE EXECUTIVE SUMMARY

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Table ES-1. Summary of Exposure Factor Recommendations

Chapter 3	PER CAPITA INGESTION OF DRINKING WATER				CONSUMERS-ONLY INGESTION OF DRINKING WATER			
	Mean		95th Percentile		Mean		95th Percentile	
	mL/day	mL/kg-day	mL/day	mL/kg-day	mL/day	mL/kg-day	mL/day	mL/kg-day
Children								
Birth to 1 month	184	52	839[a]	232[a]	470[a]	137[a]	858[a]	238[a]
1 to <3 months	227[a]	48	896[a]	205[a]	552	119	1,053[a]	285[a]
3 to <6 months	362[a]	52	1,056	159	556	80	1,171[a]	173[a]
6 to <12 months	360	41	1,055	126	467	53	1,147	129
1 to <2 years	271	23	837	71	308	27	893	75
2 to <3 years	317	23	877	60	356	26	912	62
3 to <6 years	327	18	959	51	382	21	999	52
6 to <11 years	414	14	1,316	43	511	17	1,404	47
11 to <16 years	520	10	1,821	32	637	12	1,976	35
16 to <18 years	573	9	1,783	28	702	10	1,883	30
18 to <21 years	681	9	2,368	35	816	11	2,818	36
Adults								
>21 years	1,043	13	2,958	40	1,227	16	3,092	42
>65 years	1,046	14	2,730	40	1,288	18	2,960	43
Pregnant women	819[a]	13[a]	2,503[a]	43[a]	872[a]	14[a]	2,589[a]	43[a]
Lactating women	1,379[a]	21[a]	3,434[a]	55[a]	1,665[a]	26[a]	3,588[a]	55[a]

[a] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Chapter 3	INGESTION OF WATER WHILE SWIMMING			
	Mean		Upper Percentile	
	mL/event[a]	mL/hour	mL/event	mL/hour
Children	37	49	90[b]	120[b]
Adults	16	21	53[c]	71[c]

[a] Participants swam for 45 minutes.
[b] 97th percentile
[c] Based on maximum value.

Chapter 4	MOUTHING FREQUENCY AND DURATION							
	Hand-to-Mouth				Object-to-Mouth			
	Indoor Frequency		Outdoor Frequency		Indoor Frequency		Outdoor Frequency	
	Mean contacts/ hour	95th Percentile contacts/ hour	Mean contacts/ hour	95th Percentile contacts/hour	Mean contacts/ hour	95th Percentile contacts/ hour	Mean contacts/ hour	95th Percentile contacts/ hour
Birth to 1 month	-	-	-	-	-	-	-	-
1 to <3 months	-	-	-	-	-	-	-	-
3 to <6 months	28	65	-	-	11	32	-	-
6 to <12 months	19	52	15	47	20	38	-	-
1 to <2 years	20	63	14	42	14	34	8.8	21
2 to <3 years	13	37	5	20	9.9	24	8.1	40
3 to <6 years	15	54	9	36	10	39	8.3	30
6 to <11 years	7	21	3	12	1.1	3.2	1.9	9.1
11 to <16 years	-	-	-	-	-	-	-	-
16 to <21 years	-	-	-	-	-	-	-	-

	Object-to-Mouth Duration	
	Mean minute/hour	95th Percentile minute/hour
Birth to 1 month	-	-
1 to <3 months	-	-
3 to <6 months	11	26
6 to <12 months	9	19
1 to <2 years	7	22
2 to <3 years	10	11
3 to <6 years	-	-
6 to <11 years	-	-
11 to <16 years	-	-
16 to <21 years	-	-

-	No data.

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Chapter 5 — SOIL AND DUST INGESTION

	Soil				Dust		Soil + Dust	
	General Population Central Tendency mg/day	High End						
		General Population Upper Percentile mg/day	Soil-Pica mg/day	Geophagy mg/day	Central Tendency mg/day	General Population Upper Percentile mg/day	General Population Central Tendency mg/day	General Population Upper Percentile mg/day
6 weeks to <1 year	30	-	-	-	30	-	60	-
1 to <6 years	50	-	1,000	50,000	60	-	100	-
3 to <6 years	-	200	-	-	-	100	-	200
6 to <21 years	50	-	1,000	50,000	60	-	100	-
Adult	20	-	-	50,000	30	-	50	-

\- No data.

Chapter 6 — INHALATION

	Long-Term Inhalation Rates	
	Mean m³/day	95th Percentile m³/day
Birth to 1 month	3.6	7.1
1 to <3 months	3.5	5.8
3 to <6 months	4.1	6.1
6 to <12 months	5.4	8.0
1 to <2 years	5.4	9.2
Birth to <1year	8.0	12.8
2 to <3 years	8.9	13.7
3 to <6 years	10.1	13.8
6 to <11 years	12.0	16.6
11 to <16 years	15.2	21.9
16 to <21 years	16.3	24.6
21 to <31 years	15.7	21.3
31 to <41 years	16.0	21.4
41 to <51 years	16.0	21.2
51 to <61 years	15.7	21.3
61 to <71 years	14.2	18.1
71 to <81 years	12.9	16.6
≥81 years	12.2	15.7

	Short-Term Inhalation Rates, by Activity Level									
	Sleep or Nap		Sedentary/Passive		Light Intensity		Moderate Intensity		High Intensity	
	Mean m³/minute	95th m³/minute	Mean m³/minute	95th m³/minute	Mean m³/minute	95th m³/minute	Mean m³/minute	95th m³/minute	Mean m³/minute	95th m³/minute
Birth to <1year	3.0E–03	4.6E–03	3.1E–03	4.7E–03	7.6E–03	1.1E–02	1.4E–02	2.2E–02	2.6E–02	4.1E–02
1 to <2 years	4.5E–03	6.4E–03	4.7E–03	6.5E–03	1.2E–02	1.6E–02	2.1E–02	2.9E–02	3.8E–02	5.2E–02
2 to <3 years	4.6E–03	6.4E–03	4.8E–03	6.5E–03	1.2E–02	1.6E–02	2.1E–02	2.9E–02	3.9E–02	5.3E–02
3 to <6 years	4.3E–03	5.8E–03	4.5E–03	5.8E–03	1.1E–02	1.4E–02	2.1E–02	2.7E–02	3.7E–02	4.8E–02
6 to <11 years	4.5E–03	6.3E–03	4.8E–03	6.4E–03	1.1E–02	1.5E–02	2.2E–02	2.9E–02	4.2E–02	5.9E–02
11 to <16 years	5.0E–03	7.4E–03	5.4E–03	7.5E–03	1.3E–02	1.7E–02	2.5E–02	3.4E–02	4.9E–02	7.0E–02
16 to <21 years	4.9E–03	7.1E–03	5.3E–03	7.2E–03	1.2E–02	1.6E–02	2.6E–02	3.7E–02	4.9E–02	7.3E–02
21 to <31 years	4.3E–03	6.5E–03	4.2E–03	6.5E–03	1.2E–02	1.6E–02	2.6E–02	3.8E–02	5.0E–02	7.6E–02
31 to <41 years	4.6E–03	6.6E–03	4.3E–03	6.6E–03	1.2E–02	1.6E–02	2.7E–02	3.7E–02	4.9E–02	7.2E–02
41 to <51 years	5.0E–03	7.1E–03	4.8E–03	7.0E–03	1.3E–02	1.6E–02	2.8E–02	3.9E–02	5.2E–02	7.6E–02
51 to <61 years	5.2E–03	7.5E–03	5.0E–03	7.3E–03	1.3E–02	1.7E–02	2.9E–02	4.0E–02	5.3E–02	7.8E–02
61 to <71 years	5.2E–03	7.2E–03	4.9E–03	7.3E–03	1.2E–02	1.6E–02	2.6E–02	3.4E–02	4.7E–02	6.6E–02
71 to <81 years	5.3E–03	7.2E–03	5.0E–03	7.2E–03	1.2E–02	1.5E–02	2.5E–02	3.2E–02	4.7E–02	6.5E–02
≥81 years	5.2E–03	7.0E–03	4.9E–03	7.0E–03	1.2E–02	1.5E–02	2.5E–02	3.1E–02	4.8E–02	6.8E–02

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Chapter 7 — SURFACE AREA

Total Surface Area

	Mean m²	95th Percentile m²
Birth to 1 month	0.29	0.34
1 to <3 months	0.33	0.38
3 to <6 months	0.38	0.44
6 to <12 months	0.45	0.51
1 to <2 years	0.53	0.61
2 to <3 years	0.61	0.70
3 to <6 years	0.76	0.95
6 to <11 years	1.08	1.48
11 to <16 years	1.59	2.06
16 to <21 years	1.84	2.33
Adult Males		
21 to <30 years	2.05	2.52
30 to <40 years	2.10	2.50
40 to <50 years	2.15	2.56
50 to <60 years	2.11	2.55
60 to <70 years	2.08	2.46
70 to <80 years	2.05	2.45
≥80 years	1.92	2.22
Adult Females		
21 to <30 years	1.81	2.25
30 to <40 years	1.85	2.31
40 to <50 years	1.88	2.36
50 to <60 years	1.89	2.38
60 to <70 years	1.88	2.34
70 to <80 years	1.77	2.13
≥80 years	1.69	1.98

Percent Surface Area of Body Parts

	Head	Trunk	Arms	Hands	Legs	Feet
	Mean Percent of Total Surface Area					
Birth to 1 month	18.2	35.7	13.7	5.3	20.6	6.5
1 to <3 months	18.2	35.7	13.7	5.3	20.6	6.5
3 to <6 months	18.2	35.7	13.7	5.3	20.6	6.5
6 to <12 months	18.2	35.7	13.7	5.3	20.6	6.5
1 to <2 years	16.5	35.5	13.0	5.7	23.1	6.3
2 to <3 years	8.4	41.0	14.4	4.7	25.3	6.3
3 to <6 years	8.0	41.2	14.0	4.9	25.7	6.4
6 to <11 years	6.1	39.6	14.0	4.7	28.8	6.8
11 to <16 years	4.6	39.6	14.3	4.5	30.4	6.6
16 to <21 years	4.1	41.2	14.6	4.5	29.5	6.1
Adult Males ≥21	6.6	40.1	15.2	5.2	33.1	6.7
Adult Females ≥21	6.2	35.4	12.8	4.8	32.3	6.6

Surface Area of Body Parts

	Head		Trunk		Arms		Hands		Legs		Feet	
	Mean m²	95th m²	Mean m²	95th m²	Mean m²	95th m²	Mean m²	95th m²	Mean m²	95th m²	Mean m²	95th m²
Birth to 1 month	0.053	0.062	0.104	0.121	0.040	0.047	0.015	0.018	0.060	0.070	0.019	0.022
1 to <3 months	0.060	0.069	0.118	0.136	0.045	0.052	0.017	0.020	0.068	0.078	0.021	0.025
3 to <6 months	0.069	0.080	0.136	0.157	0.052	0.060	0.020	0.023	0.078	0.091	0.025	0.029
6 to <12 months	0.082	0.093	0.161	0.182	0.062	0.070	0.024	0.027	0.093	0.105	0.029	0.033
1 to <2 years	0.087	0.101	0.188	0.217	0.069	0.079	0.030	0.035	0.122	0.141	0.033	0.038
2 to <3 years	0.051	0.059	0.250	0.287	0.088	0.101	0.028	0.033	0.154	0.177	0.038	0.044
3 to <6 years	0.060	0.076	0.313	0.391	0.106	0.133	0.037	0.046	0.195	0.244	0.049	0.061
6 to <11 years	0.066	0.090	0.428	0.586	0.151	0.207	0.051	0.070	0.311	0.426	0.073	0.100
11 to <16 years	0.073	0.095	0.630	0.816	0.227	0.295	0.072	0.093	0.483	0.626	0.105	0.136
16 to <21 years	0.076	0.096	0.759	0.961	0.269	0.340	0.083	0.105	0.543	0.687	0.112	0.142
Adult Males ≥21	0.136	0.154	0.827	1.10	0.314	0.399	0.107	0.131	0.682	0.847	0.137	0.161
Adult Females ≥21	0.114	0.121	0.654	0.850	0.237	0.266	0.089	0.106	0.598	0.764	0.122	0.146

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Chapter 7 **MEAN SOLID ADEHERENCE TO SKIN (mg/cm²)**

	Face	Arms	Hands	Legs	Feet
Children					
Residential (indoors)[a]	-	0.0041	0.0011	0.0035	0.010
Daycare (indoors and outdoors)[b]	-	0.024	0.099	0.020	0.071
Outdoor sports[c]	0.012	0.011	0.11	0.031	-
Indoor sports[d]	-	0.0019	0.0063	0.0020	0.0022
Activities with soil[e]	0.054	0.046	0.17	0.051	0.20
Playing in mud[f]	-	11	47	23	15
Playing in sediment[g]	0.040	0.17	0.49	0.70	21
Adults					
Outdoor sports[i]	0.0314	0.0872	0.1336	0.1223	-
Activities with soil[h]	0.0240	0.0379	0.1595	0.0189	0.1393
Construction activities[j]	0.0982	0.1859	0.2763	0.0660	-

[a] Based on weighted average of geometric mean soil loadings for 2 groups of children (ages 3 to 13 years; *N* = 10) playing indoors.
[b] Based on weighted average of geometric mean soil loadings for 4 groups of daycare children (ages 1 to 6.5 years; *N* = 21) playing both indoors and outdoors.
[c] Based on geometric mean soil loadings of 8 children (ages 13 to 15 years) playing soccer.
[d] Based on geometric mean soil loadings of 6 children (ages ≥8 years) and 1 adult engaging in Tae Kwon Do.
[e] Based on weighted average of geometric mean soil loadings for gardeners and archeologists (ages 16 to 35 years).
[f] Based on weighted average of geometric mean soil loadings of 2 groups of children (age 9 to 14 years; *N* = 12) playing in mud.
[g] Based on geometric mean soil loadings of 9 children (ages 7 to 12 years) playing in tidal flats.
[h] Based on weighted average of geometric mean soil loadings of 3 groups of adults(ages 23 to 33 years) playing rugby and 2 groups of adults (ages 24 to 34) playing soccer.
[i] Based on weighted average of geometric mean soil loadings for 69 gardeners, farmers, groundskeepers, landscapers, and archeologists (ages 16 to 64 years) for faces, arms and hands; 65 gardeners, farmers, groundskeepers, and archeologists (ages 16 to 64 years) for legs; and 36 gardeners, groundskeepers, and archeologists (ages 16 to 62) for feet.
[j] Based on weighted average of geometric mean soil loadings for 27 construction workers, utility workers and equipment operators (ages 21 to 54) for faces, arms, and hands; and based on geometric mean soil loadings for 8 construction workers (ages 21 to 30 years) for legs.
\- No data.

Chapter 8 **BODY WEIGHT**

	Mean Kg
Birth to 1 month	4.8
1 to <3 months	5.9
3 to <6 months	7.4
6 to <12 months	9.2
1 to <2 years	11.4
2 to <3 years	13.8
3 to <6 years	18.6
6 to <11 years	31.8
11 to <16 years	56.8
16 to <21 years	71.6
Adults	80.0

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Chapter 9 **FRUIT AND VEGETABLE INTAKE**

	Per Capita		Consumers-Only	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
Total Fruits				
Birth to 1 year	6.2	23.0[a]	10.1	25.8[a]
1 to <2 years	7.8	21.3[a]	8.1	21.4[a]
2 to <3 years	7.8	21.3[a]	8.1	21.4[a]
3 to <6 years	4.6	14.9	4.7	15.1
6 to <11 years	2.3	8.7	2.5	9.2
11 to <16 years	0.9	3.5	1.1	3.8
16 to <21 years	0.9	3.5	1.1	3.8
21 to <50 years	0.9	3.7	1.1	3.8
≥50 years	1.4	4.4	1.5	4.6
Total Vegetables				
Birth to 1 year	5.0	16.2[a]	6.8	18.1[a]
1 to <2 years	6.7	15.6[a]	6.7	15.6[a]
2 to <3 years	6.7	15.6[a]	6.7	15.6[a]
3 to <6 years	5.4	13.4	5.4	13.4
6 to <11 years	3.7	10.4	3.7	10.4
11 to <16 years	2.3	5.5	2.3	5.5
16 to <21 years	2.3	5.5	2.3	5.5
21 to <50 years	2.5	5.9	2.5	5.9
≥50 years	2.6	6.1	2.6	6.1

[a] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Chapter 10 **FISH INTAKE**

	Per Capita		Consumers-Only	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
General Population—Finfish				
All	0.16	1.1	0.73	2.2
Birth to 1 year	0.03	0.0[a]	1.3	2.9[a]
1 to <2 years	0.22	1.2[a]	1.6	4.9[a]
2 to <3 years	0.22	1.2[a]	1.6	4.9[a]
3 to <6 years	0.19	1.4	1.3	3.6[a]
6 to <11 years	0.16	1.1	1.1	2.9[a]
11 to <16 years	0.10	0.7	0.66	1.7
16 to <21 years	0.10	0.7	0.66	1.7
21 to <50 years	0.15	1.0	0.65	2.1
Females 13 to 49 years	0.14	0.9	0.62	1.8
≥50 years	0.20	1.2	0.68	2.0
General Population—Shellfish				
All	0.06	0.4	0.57	1.9
Birth to 1 year	0.00	0.0[a]	0.42	2.3[a]
1 to <2 years	0.04	0.0[a]	0.94	3.5[a]
2 to <3 years	0.04	0.0[a]	0.94	3.5[a]
3 to <6 years	0.05	0.0	1.0	2.9[a]
6 to <11 years	0.05	0.2	0.72	2.0[a]
11 to <16 years	0.03	0.0	0.61	1.9
16 to <21years	0.03	0.0	0.61	1.9
21 to <50 years	0.08	0.5	0.63	2.2
Females 13 to 49 years	0.06	0.3	0.53	1.8
≥50 years	0.05	0.4	0.41	1.2

Table ES-1. Summary of Exposure Factor Recommendations (continued)

General Population—Total Finfish and Shellfish				
All	0.22	1.3	0.78	2.4
Birth to 1 year	0.04	0.0[a]	1.2	2.9[a]
1 to <2 years	0.26	1.6[a]	1.5	5.9[a]
2 to <3 years	0.26	1.6[a]	1.5	5.9[a]
3 to <6 years	0.24	1.6[a]	1.3	3.6[a]
6 to <11 years	0.21	1.4	0.99	2.7[a]
11 to <16 years	0.13	1.0	0.69	1.8
16 to <21 years	0.13	1.0	0.69	1.8
21 to <50 years	0.23	1.3	0.76	2.5
Females 13 to 49 years	0.19	1.2	0.68	1.9
≥50 years	0.25	1.4	0.71	2.1

[a] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

	Mean g/day	95th Percentile g/day
Recreational Population—Marine Fish—Atlantic		
3 to <6 years	2.5	8.8
6 to <11 years	2.5	8.6
11 to <16 years	3.4	13
16 to <18 years	2.8	6.6
>18 years	5.6	18
Recreational Population—Marine Fish—Gulf		
3 to <6 years	3.2	13
6 to <11 years	3.3	12
11 to <16 years	4.4	18
16 to <18 years	3.5	9.5
>18 years	7.2	26
Recreational Population—Marine Fish—Pacific		
3 to <6 years	0.9	3.3
6 to <11 years	0.9	3.2
11 to <16 years	1.2	4.8
16 to <18 years	1.0	2.5
>18 years	2.0	6.8

Recreational Population—Freshwater Fish—See Chapter 10

Native American Population—See Chapter 10

Other Populations—See Chapter 10

Chapter 11 MEATS, DAIRY PRODUCTS, AND FAT INTAKE

	Per Capita		Consumers-Only	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
Total Meats				
Birth to 1 year	1.2	5.4[a]	2.7	8.1[a]
1 to <2 years	4.0	10.0[a]	4.1	10.1[a]
2 to <3 years	4.0	10.0[a]	4.1	10.1[a]
3 to <6 years	3.9	8.5	3.9	8.6
6 to <11 years	2.8	6.4	2.8	6.4
11 to <16 years	2.0	4.7	2.0	4.7
16 to <21 years	2.0	4.7	2.0	4.7
21 to <50 years	1.8	4.1	1.8	4.1
≥50 years	1.4	3.1	1.4	3.1
Total Dairy Products				
Birth to 1 year	10.1	43.2[a]	11.7	44.7[a]
1 to <2 years	43.2	94.7[a]	43.2	94.7[a]
2 to <3 years	43.2	94.7[a]	43.2	94.7[a]
3 to <6 years	24.0	51.1	24.0	51.1
6 to <11 years	12.9	31.8	12.9	31.8
11 to <16 years	5.5	16.4	5.5	16.4
16 to <21 years	5.5	16.4	5.5	16.4
21 to <50 years	3.5	10.3	3.5	10.3
≥50 years	3.3	9.6	3.3	9.6

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Total Fats				
Birth to 1 month	5.2	16	7.8	16
1 to <3 months	4.5	12	6.0	12
3 to <6 months	4.1	8.2	4.4	8.3
6 to <12 months	3.7	7.0	3.7	7.0
1 to <2 years	4.0	7.1	4.0	7.1
2 to <3 years	3.6	6.4	3.6	6.4
3 to <6 years	3.4	5.8	3.4	5.8
6 to <11 years	2.6	4.2	2.6	4.2
11 to <16 years	1.6	3.0	1.6	3.0
16 to <21 years	1.3	2.7	1.3	2.7
21 to <31 years	1.2	2.3	1.2	2.3
31 to <41 years	1.1	2.1	1.1	2.1
41 to <51 years	1.0	1.9	1.0	1.9
51 to <61 years	0.9	1.7	0.9	1.7
61 to <71 years	0.9	1.7	0.9	1.7
71 to <81 years	0.8	1.5	0.8	1.5
≥81 years	0.9	1.5	0.9	1.5

[a] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Chapter 12 **GRAINS INTAKE**

	Per Capita		Consumers-Only	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
Birth to 1 year	3.1	9.5[a]	4.1	10.3[a]
1 to <2 years	6.4	12.4[a]	6.4	12.4[a]
2 to <3 years	6.4	12.4[a]	6.4	12.4[a]
3 to <6 years	6.2	11.1	6.2	11.1
6 to <11 years	4.4	8.2	4.4	8.2
11 to <16 years	2.4	5.0	2.4	5.0
16 to <21 years	2.4	5.0	2.4	5.0
21 to <50 years	2.2	4.6	2.2	4.6
≥50 years	1.7	3.5	1.7	3.5

[a] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Chapter 13 **HOME-PRODUCED FOOD INTAKE**

	Mean g/kg-day	95th Percentile g/kg-day
Consumer-Only Home-Produced Fruits, Unadjusted[a]		
1 to 2 years	8.7	60.6
3 to 5 years	4.1	8.9
6 to 11 years	3.6	15.8
12 to 19 years	1.9	8.3
20 to 39 years	2.0	6.8
40 to 69 years	2.7	13.0
≥70 years	2.3	8.7
Consumer-Only Home-Produced Vegetables, Unadjusted[a]		
1 to 2 years	5.2	19.6
3 to 5 years	2.5	7.7
6 to 11 years	2.0	6.2
12 to 19 years	1.5	6.0
20 to 39 years	1.5	4.9
40 to 69 years	2.1	6.9
≥70 years	2.5	8.2
Consumer-Only Home-Produced Meats, Unadjusted[a]		
1 to 2 years	3.7	10.0
3 to 5 years	3.6	9.1
6 to 11 years	3.7	14.0
12 to 19 years	1.7	4.3
20 to 39 years	1.8	6.2
40 to 69 years	1.7	5.2
≥70 years	1.4	3.5

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Consumer-Only Home-Caught Fish, Unadjusted[a]		
1 to 2 years	-	-
3 to 5 years	-	-
6 to 11 years	2.8	7.1
12 to 19 years	1.5	4.7
20 to 39 years	1.9	4.5
40 to 69 years	1.8	4.4
≥70 years	1.2	3.7

Per Capita for Populations that Garden or (Farm)

	Home-Produced Fruits[b]		Home-Produced Vegetables[b]	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
1 to <2 years	1.0 (1.4)	4.8 (9.1)	1.3 (2.7)	7.1 (14)
2 to <3 years	1.0 (1.4)	4.8 (9.1)	1.3 (2.7)	7.1 (14)
3 to <6 years	0.78 (1.0)	3.6 (6.8)	1.1 (2.3)	6.1 (12)
6 to <11 years	0.40 (0.52)	1.9 (3.5)	0.80 (1.6)	4.2 (8.1)
11 to <16 years	0.13 (0.17)	0.62 (1.2)	0.56 (1.1)	3.0 (5.7)
16 to <21 years	0.13 (0.17)	0.62 (1.2)	0.56 (1.1)	3.0 (5.7)
21 to <50 years	0.15 (0.20)	0.70 (1.3)	0.56 (1.1)	3.0 (5.7)
50+ years	0.24 (0.31)	1.1 (2.1)	0.60 (1.2)	3.2 (6.1)

Per Capita for Populations that Farm or (Raise Animals)

	Home-Produced Meats[b]		Home-Produced Dairy	
	Mean g/kg-day	95th Percentile g/kg-day	Mean g/kg-day	95th Percentile g/kg-day
1 to <2 years	1.4 (1.4)	5.8 (6.0)	11 (13)	76 (92)
2 to <3 years	1.4 (1.4)	5.8 (6.0)	11 (13)	76 (92)
3 to <6 years	1.4 (1.4)	5.8 (6.0)	6.7 (8.3)	48 (58)
6 to <11 years	1.0 (1.0)	4.1 (4.2)	3.9 (4.8)	28 (34)
11 to <16 years	0.71 (0.73)	3.0 (3.1)	1.6 (2.0)	12 (14)
16 to <21 years	0.71 (0.73)	3.0 (3.1)	1.6 (2.0)	12 (14)
21 to <50 years	0.65 (0.66)	2.7 (2.8)	0.95 (1.2)	6.9 (8.3)
50+ years	0.51 (0.52)	2.1 (2.2)	0.92 (1.1)	6.7 (8.0)

[a] Not adjusted to account for preparation and post cooking losses.
[b] Adjusted for preparation and post cooking losses.
\- No data.

Chapter 14 TOTAL PER CAPITA FOOD INTAKE

	Mean g/kg-day	95th Percentile g/kg-day
Birth to 1 year	91	208[a]
1 to <3 years	113	185[a]
3 to <6 years	79	137
6 to <11 years	47	92
11 to <16 years	28	56
16 to <21 years	28	56
21 to <50 years	29	63
≥50 years	29	59

[a] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Chapter 15 HUMAN MILK AND LIPID INTAKE

	Mean		Upper Percentile	
	mL/day	mL/kg-day	mL/day	mL/kg-day
	Human Milk Intake			
Birth to 1 month	510	150	950	220
1 to <3 months	690	140	980	190
3 to <6 months	770	110	1,000	150
6 to <12 months	620	83	1,000	130
	Lipid Intake			
Birth to 1 month	20	6.0	38	8.7
1 to <3 months	27	5.5	40	8.0
3 to <6 months	30	4.2	42	6.1
6 to <12 months	25	3.3	42	5.2

Table ES-1. Summary of Exposure Factor Recommendations (continued)

Chapter 16	**ACTIVITY FACTORS**					
	Time Indoors (total) minutes/day		Time Outdoors (total) minutes/day		Time Indoors (at residence) minutes/day	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Birth to <1 month	1,440	-	0	-	-	-
1 to <3 months	1,432	-	8	-	-	-
3 to <6 months	1,414	-	26	-	-	-
6 to <12 months	1,301	-	139	-	-	-
Birth to <1 year	-	-	-	-	1,108	1,440
1 to <2 years	1,353	-	36	-	1,065	1,440
2 to <3 years	1,316	-	76	-	979	1,296
3 to <6 years	1,278	-	107	-	957	1,355
6 to <11 years	1,244	-	132	-	893	1,275
11 to <16 years	1,260	-	100	-	889	1,315
16 to <21 years	1,248	-	102	-	833	1,288
18 to <64 years	1,159	-	281	-	948	1,428
>64 years	1,142	-	298	-	1,175	1,440
	Showering minutes/day		Bathing minutes/day		Bathing/Showering minutes/day	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Birth to <1year	15	-	19	30	-	-
1 to <2 years	20	-	23	32	-	-
2 to <3 years	22	44	23	45	-	-
3 to <6 years	17	34	24	60	-	-
6 to <11 years	18	41	24	46	-	-
11 to <16 years	18	40	25	43	-	-
16 to <21 years	20	45	33	60	-	-
18 to <64 years	-	-	-	-	17	-
>64 years	-	-	-	-	17	-
	Playing on Sand/Gravel minutes/day		Playing on Grass minutes/day		Playing on Dirt minutes/day	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
Birth to <1 year	18	-	52	-	33	-
1 to <2 years	43	121	68	121	56	121
2 to <3 years	53	121	62	121	47	121
3 to <6 years	60	121	79	121	63	121
6 to <11 years	67	121	73	121	63	121
11 to <16 years	67	121	75	121	49	120
16 to <21 years	83	-	60	-	30	-
18 to <64 years	0 (median)	121	60 (median)	121	0 (median)	120
>64 years	0 (median)	-	121 (median)	-	0 (median)	-

	Swimming minutes/month	
	Mean	95th Percentile
Birth to <1 year	96	-
1 to <2 years	105	-
2 to <3 years	116	181
3 to <6 years	137	181
6 to <11 years	151	181
11 to <16 years	139	181
16 to <21 years	145	181
18 to <64 years	45(median)	181
>64 years	40(median)	181

Table ES-1. Summary of Exposure Factor Recommendations (continued)

	Occupational Mobility	
	Median Tenure (years) Men	Median Tenure (years) Women
All ages, ≥16 years	7.9	5.4
16 to 24 years	2.0	1.9
25 to 29 years	4.6	4.1
30 to 34 years	7.6	6.0
35 to 39 years	10.4	7.0
40 to 44 years	13.8	8.0
45 to 49 years	17.5	10.0
50 to 54 years	20.0	10.8
55 to 59 years	21.9	12.4
60 to 64 years	23.9	14.5
65 to 69 years	26.9	15.6
≥70 years	30.5	18.8

	Population Mobility			
	Residential Occupancy Period (years)		Current Residence Time (years)	
	Mean	95th Percentile	Mean	95th Percentile
All	12	33	13	46

\- No data.

Chapter 17	CONSUMER PRODUCTS - See Chapter 17

Chapter 18	LIFE EXPECTANCY
	Years
Total	78
Males	75
Females	80

Chapter 19	BUILDING CHARACTERISTICS	
	Residential Buildings	
	Mean	10th Percentile
Volume of Residence (m^3)	492	154
Air Exchange Rate (air changes/hour)	0.45	0.18
	Non-Residential Buildings	
	Mean (Standard Deviation)	10th Percentile
Volume of Non-residential Buildings (m^3)		408
Vacant	4,789	510
Office	5,036	2,039
Laboratory	24,681	1,019
Non-refrigerated warehouse	9,298	476
Food sales	1,889	816
Public order and safety	5,253	680
Outpatient healthcare	3,537	1,133
Refrigerated warehouse	19,716	612
Religious worship	3,443	595
Public assembly	4,839	527
Education	8,694	442
Food service	1,889	17,330
Inpatient healthcare	82,034	1,546
Nursing	15,522	527
Lodging	11,559	1,359
Strip shopping mall	7,891	35,679
Enclosed mall	287,978	510
Retail other than mall	3,310	459
Service	2,213	425
Other	5,236	527
All Buildings	5,575	
Air Exchange Rate (air changes/hour)	1.5 (0.87) Range 0.3–4.1	0.60

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ACRONYMS AND ABBREVIATIONS

AAP	=	American Academy of Pediatrics
ACH	=	Air Changes per Hour
ADAFs	=	Age Dependent Adjustment Factors
ADD	=	Average Daily Dose
AF	=	Adherence Factor
AHS	=	American Housing Survey
AIR	=	Acid Insoluble Residue
API	=	Asian and Pacific Islander
ASHRAE	=	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASTM	=	American Society for Testing and Materials
ARS	=	Agricultural Research Service
ASCII	=	American Standard Code for Information Interchange
ATD	=	Arizona Test Dust
ATSDR	=	Agency for Toxic Substances and Disease Registry
ATUS	=	American Time Use Survey
BI	=	Bootstrap Interval
BMD	=	Benchmark Dose
BMI	=	Body Mass Index
BMR	=	Basal Metabolic Rate
BTM	=	Best Tracer Method
BW	=	Body Weight
C	=	Concentration
CATI	=	Computer-Assisted Telephone Interviewing
CDC	=	Centers for Disease Control and Prevention
CDFA	=	California Department of Food and Drugs
CDS	=	Child Development Supplement
CHAD	=	Consolidated Human Activity Database
CI	=	Confidence Interval
cm^2	=	Square Centimeter
cm^3	=	Cubic Centimeter
CNRC	=	Children’s Nutrition Research Center
CRITFC	=	Columbia River Inter-Tribal Fish Commission
CSFII	=	Continuing Survey of Food Intake by Individuals
CT	=	Central Tendency
CTFA	=	Cosmetic, Toiletry, and Fragrance Association
CV	=	Coefficient of Variation
DAF	=	Dosimetry Adjustment Factor
DARLING	=	Davis Area Research on Lactation, Infant Nutrition and Growth
DHHS	=	Department of Health and Human Services
DIR	=	Daily Inhalation Rate
DIY	=	Do-It-Yourself
DK	=	Respondent Replied “Don’t Know”
DLW	=	Doubly Labeled Water
DOE	=	Department of Energy
DONALD	=	Dortmund Nutritional and Anthropometric Longitudinally Designed
E or EE	=	Energy Expenditure
EBF	=	Exclusively Breastfed
ECG	=	Energy Cost of Growth
ED	=	Exposure Duration

ACRONYMS AND ABBREVIATIONS (continued)

EFAST	=	Exposure and Fate Assessment Screening Tool
EI	=	Energy Intake
EPA	=	Environmental Protection Agency
ERV	=	Energy Recovery Ventilator
EVR	=	Equivalent Ventilation Rate
F	=	Fahrenheit
f_B	=	Breathing Frequency
FCID	=	Food Commodity Intake Database
FITS	=	Feeding Infant and Toddler Study
F/S	=	Food/Soil
g	=	Gram
GAF	=	General Assessment Factor
GM	=	Geometric Mean
GSD	=	Geometric Standard Deviation
H	=	Oxygen Uptake Factor
HEC	=	Human Equivalent Exposure Concentrations
HR	=	Heart Rate
HRV	=	Heat Recovery Ventilator
USHUD	=	United States Department of Housing and Urban Development
I	=	Tabulated Intake Rate
I_A	=	Adjusted Intake Rate
I-BEAM	=	Indoor Air Quality Building and Assessment Model
ICRP	=	International Commission on Radiological Protection
IEUBK	=	Integrated Exposure and Uptake Biokinetic Model
IFS	=	Iowa Fluoride Study
IOM	=	Institute of Medicine
IPCS	=	International Programme on Chemical Safety
IR	=	Intake Rate/Inhalation Rate
IRIS	=	Integrated Risk Information System
IUR	=	Inhalation Unit Risk
Kcal	=	Kilocalories
KJ	=	Kilo Joules
K-S	=	Kolmogorov-Smirnov
kg	=	Kilogram
L	=	Liter
L_1	=	Cooking or Preparation Loss
L_2	=	Post-cooking Loss
LADD	=	Lifetime Average Daily Dose
LCL	=	Lower Confidence Limit
LTM	=	Limiting Tracer Method
m^2	=	Square Meter
m^3	=	Cubic Meter
MCCEM	=	Multi-Chamber Concentration and Exposure Model
MEC	=	Mobile Examination Center
mg	=	Milligram
MJ	=	Mega Joules
mL	=	Milliliter
METS	=	Metabolic Equivalents of Work
MOA	=	Mode of Action
MSA	=	Metropolitan Statistical Area
MVPA	=	Moderate-to-Vigorous Physical Activity

N = Number of Subjects or Respondents

ACRONYMS AND ABBREVIATIONS (continued)

N_c	=	Weighted Number of Individuals Consuming Homegrown Food Item
N_T	=	Weighted Total Number of Individuals Surveyed
NAS	=	National Academy of Sciences
NCEA	=	National Center for Environmental Assessment
NCHS	=	National Center for Health Statistics
NERL	=	National Exposure Research Laboratory
NFCS	=	Nationwide Food Consumption Survey
NHANES	=	National Health and Nutrition Examination Survey
NHAPS	=	National Human Activity Pattern Survey
NHES	=	National Health Examination Survey
NIS	=	National Immunization Survey
NLO	=	Non-Linear Optimization
NMFS	=	National Marine Fisheries Service
NOAEL	=	No-Observed-Adverse-Effect-Level
NOPES	=	Non-Occupational Pesticide Exposure Study
NR	=	Not Reported
NRC	=	National Research Council
NS	=	No Statistical Difference
OPP	=	Office of Pesticide Programs
ORD	=	Office of Research and Development
PBPK	=	Physiologically-Based Pharmacokinetic
PC	=	Percent Consuming
PDIR	=	Physiological Daily Inhalation Rate
PFT	=	Perfluorocarbon Tracer
PSID	=	Panel Study of Income Dynamics
PTEAM	=	Particle Total Exposure Assessment Methodology
RAGS	=	Risk Assessment Guidance for Superfund
RDD	=	Random Digit Dial
RECS	=	Residential Energy Conservation Survey
RfD	=	Reference Dose
RfC	=	Reference Concentration
ROP	=	Residential Occupancy Period
RTF	=	Ready to Feed
SA	=	Surface Area
SA/BW	=	Surface Area to Body Weight Ratio
SAS	=	Statistical Analysis Software
SCS	=	Soil Contact Survey
SD	=	Standard Deviation
SDA	=	Soaps and Detergent Association
SE	=	Standard Error
SEM	=	Standard Error of the Mean
SES	=	Socioeconomic Status
SHEDS	=	Stochastic Human Exposure and Dose Simulation Model
SMBRP	=	Santa Monica Bay Restoration Project
SMRB	=	Simmons Market Research Bureau
SOCAL	=	Southern California
SPS	=	Statistical Processing System
t	=	Exposure Time
TDEE	=	Total Daily Energy Expenditure
TRF	=	Tuna Research Foundation

ACRONYMS AND ABBREVIATIONS (continued)

UCL	=	Upper Confidence Limit
USDA	=	United States Department of Agriculture
USDL	=	United States Department of Labor
VE	=	Volume of Air Breathed per Day
VO_2	=	Oxygen Consumption Rate
VOC	=	Volatile Organic Compounds
VQ	=	Ventilatory Equivalent
VR	=	Ventilation Rate
VT	=	Tidal Volume
WHO	=	World Health Organization
WIC	=	USDA’s Women, Infants, and Children Program

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1. INTRODUCTION

1.1. BACKGROUND AND PURPOSE

Some of the steps for performing an exposure assessment are (1) identifying the source of the environmental contamination and the media that transports the contaminant; (2) determining the contaminant concentration; (3) determining the exposure scenarios, and pathways and routes of exposure; (4) determining the exposure factors related to human behaviors that define time, frequency, and duration of exposure; and (5) identifying the exposed population. Exposure factors are factors related to human behavior and characteristics that help determine an individual's exposure to an agent. The National Academy of Sciences (NAS) report on *Risk Assessment in the Federal Government: Managing the Process* and subsequent publication of the U.S. Environmental Protection Agency's (EPA) exposure guidelines in 1986 identified the need for summarizing exposure factors data necessary for characterizing some of the steps outlined above (NAS, 1983; U.S. EPA, 1986a). Around the same time, the U.S. EPA published a report entitled *Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessment* to support the 1986 exposure guidelines and to promote consistency in U.S. EPA's exposure assessment activities (U.S. EPA, 1985). The exposure assessment field continued to evolve and so did the need for more comprehensive data on exposure factors. The *Exposure Factors Handbook* was first published in 1989 and updated in 1997 in response to this need (U.S. EPA, 1989a, 1997a). This current edition is the update of the 1997 handbook (U.S. EPA, 1997a), and it incorporates data from the *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2008a) that was published in September 2008. The information presented in this handbook supersedes the *Child-Specific Exposure Factors Handbook* published in 2008 (U.S. EPA, 2008a).

> Exposure factors are factors related to human behavior and characteristics that help determine an individual's exposure to an agent.

> Purpose:
> (1) summarize data on human behavioral and physiological characteristics
> (2) provide exposure/risk assessors with recommended values for these factors

The purpose of the *Exposure Factors Handbook* is to (1) summarize data on human behavioral and physiological characteristics that affect exposure to environmental contaminants, and (2) provide exposure/risk assessors with recommended values for these factors that can be used to assess exposure among both adults and children.

1.2. INTENDED AUDIENCE

The *Exposure Factors Handbook* is intended for use by exposure and risk assessors both within and outside the U.S. EPA as a reference tool and primary source of exposure factor information. It may be used by scientists, economists, and other interested parties as a source of data and/or U.S. EPA recommendations on numeric estimates for behavioral and physiological characteristics needed to estimate exposure to environmental agents.

1.3. SCOPE

This handbook incorporates the changes in risk assessment practices that were first presented in the U.S. EPA's Cancer Guidelines, regarding the need to consider life stages rather than subpopulations (U.S. EPA, 2005a, b). A life stage "refers to a distinguishable time frame in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth" (U.S. EPA, 2005c). The handbook emphasizes a major recommendation in U.S. EPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b) to sum exposures and risks across life stages rather than relying on the use of a lifetime average adult exposure to calculate risk. This handbook also uses updated information to incorporate any new exposure factors data/research that have become available since it was last revised in 1997 and is consistent with the U.S. EPA's new set of standardized childhood age groups (U.S. EPA, 2005c), which are recommended for use in exposure assessments. Available data through July 2011 are included in the handbook.

The recommendations presented in this handbook are not legally binding on any U.S. EPA program and should be interpreted as suggestions that program offices or individual exposure assessors can consider and modify as needed. The recommendations provided in this handbook do not supersede standards or guidance established by U.S. EPA program offices, states, or other risk assessment organizations outside the Agency (e.g., World Health Organization, National Research Council). Many of these factors are best quantified on a site- or situation-specific basis. The decision as to whether to use site-specific or national values for an assessment may depend on the quality of the competing data sets as well as on the purpose of the specific assessment. The handbook has strived to include full discussions of the issues that assessors should consider in deciding how to use these data and recommendations.

This document does not include chemical-specific data or information on physiological parameters that may be needed for exposure assessments involving physiologically based pharmacokinetic (PBPK) modeling. Information on the application of PBPK models and supporting data are found in U.S. EPA (2006a, b).

1.4. UPDATES TO PREVIOUS VERSIONS OF THE HANDBOOK

All chapters have been revised to include published literature up to July 2011. Some of the main revisions are highlighted below:

- Added food and water intake data obtained from the National Health and Nutrition Examination Survey (NHANES) 2003–2006;
- Added fat intake data and total food intake data;
- Added new chapter on non-dietary factors;
- Updated soil ingestion rates for children and adults;
- Updated data on dermal exposure and added information on other factors such as film thickness of liquids to skin, transfer of residue, and skin thickness;
- Updated fish intake rates for the general population using data obtained from NHANES 2003–2006;
- Updated body-weight data with National Health and Nutrition Examination Survey 1999–2006;
- Added body-weight data for pregnant/lactating women and fetal weight;
- Updated children's factors with new recommended age groupings (U.S. EPA, 2005c);
- Updated life expectancy data with U.S. Census Bureau data 2006;
- Updated data on human milk ingestion and prevalence of breast-feeding; and
- Expanded residential characteristics chapter to include data from commercial buildings.

1.5. SELECTION OF STUDIES FOR THE HANDBOOK AND DATA PRESENTATION

Many scientific studies were reviewed for possible inclusion in this handbook. Although systematic literature searches were initially conducted for every chapter, much of the literature was identified through supplementary targeted searches and from personal communications with researchers in the various fields. Information in this handbook has been summarized from studies documented in the scientific literature and other publicly available sources. As such, this handbook is a compilation of data from a variety of different sources. Most of the data presented in this handbook are derived from studies that target (1) the general population (e.g., Center for Disease Control and Prevention [CDC] NHANES) or (2) a sample population from a specific area or group (e.g., fish consumption among Native American children). With very few exceptions, the data presented are the analyses of the individual study authors. Since the studies included in this handbook varied in terms of their objectives, design, scope, presentation of results, etc., the level of detail, statistics, and terminology may vary from study to study and from factor to factor. For example, some authors used geometric means to present their results, while others used arithmetic means or distributions. Authors have sometimes used different terms to describe the same racial/ethnic populations. Within the constraint of presenting the original material as accurately as possible, the U.S. EPA has made an effort to present discussions and results in a consistent manner and using consistent terminology. The strengths and limitations of each study are discussed to provide the reader with a better understanding of the uncertainties associated with the values derived from the study.

If it is necessary to characterize a population that is not directly covered by the data in this handbook, the risk or exposure assessor may need to evaluate whether these data may be used as suitable substitutes for the population of interest or whether there is a need to seek additional population-specific data. If information is needed for identifying and enumerating populations who may be at risk for greater contaminant exposures or who exhibit a heightened sensitivity to particular chemicals, refer to *Socio-demographic Data Used for Identifying Potentially Highly Exposed Populations* (U.S. EPA, 1999).

Studies were chosen that were seen as useful and appropriate for estimating exposure factors for both adults and children. In conjunction with the *Guidance* *on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c), this handbook adopted the age group notation “X to <Y” (e.g., the age group 3 to <6 years is meant to span a 3-year time interval from a child’s 3rd birthday up until the day before his or her 6th birthday). Every attempt was made to present the data for the recommended age groups. In cases where age group categories from the study authors did not match exactly with the U.S. EPA recommended age groups, the recommendations were matched as closely as possible. In some cases, data were limited, and age groups were lumped into bigger age categories to obtain adequate sample size. It is also recognized that dose-response data may not be available for many of the recommended age groupings. However, a standard set of age groups can assist in data collection efforts and provide focus for future research to better assess all significant variations in life stage (U.S. EPA, 2005c). To this date, no specific guidance is available with regard to age groupings for presenting adult data. Therefore, adult data (i.e., >21 years old) are presented using the age groups defined by the authors of the individual studies. No attempt was made to reanalyze the data using a consistent set of age groups. Therefore, in cases where data were analyzed by the U.S. EPA, age categories were defined as finely as possible based on adequacy of sample size. It is recognized that adults’ activity patterns will vary with many factors including age, especially in the older adult population.

Certain studies described in this handbook are designated as “key,” that is, the most up-to-date and scientifically sound for deriving recommendations for exposure factors. The recommended values for all exposure factors are based on the results of the key studies (see Section 1.6). Other studies are designated "relevant," meaning applicable or pertinent, but not necessarily the most important. As new data or analyses are published, “key” studies may be moved to the “relevant” category in future revisions because they are replaced by more up-to-date data or an analysis of improved quality. Studies may be classified as “relevant” for one or more of the following reasons: (1) they provide supporting data (e.g., older studies on food intake that may be useful for trend analysis); (2) they provide information related to the factor of interest (e.g., data on prevalence of breast-feeding); (3) the study design or approach makes the data less applicable to the population of interest (e.g., studies with small sample size, studies not conducted in the United States).

It is important to note that studies were evaluated based on their ability to represent the population for which the study was designed. The users of the handbook will need to evaluate the studies’ applicability to their population of interest.

1.5.1. General Assessment Factors

The Agency recognizes the need to evaluate the quality and relevance of scientific and technical information used in support of Agency actions (U.S. EPA, 2002, 2003a, 2006c). When evaluating scientific and technical information, the U.S. EPA’s Science Policy Council recommends using five General Assessment Factors (GAFs): (1) soundness, (2) applicability and utility, (3) clarity and completeness, (4) uncertainty and variability, and (5) evaluation and review (U.S. EPA, 2003a). These GAFs were adapted and expanded to include specific considerations deemed to be important during evaluation of exposure factors data and were used to judge the quality of the underlying data used to derive recommendations.

1.5.2. Selection Criteria

The confidence ratings for the various exposure factor recommendations, and selection of the key studies that form the basis for these recommendations, were based on specific criteria within each of the five GAFs, as follows:

1) ***Soundness:*** *Scientific and technical procedures, measures, methods, or models employed to generate the information are reasonable for, and consistent with, the intended application.* The soundness of the experimental procedures or approaches in the study designs of the available studies was evaluated according to the following:
   a) **<u>Adequacy of the Study Approach Used</u>:** In general, more confidence was placed on experimental procedures or approaches that more likely or closely captured the desired measurement. Direct exposure data collection techniques, such as direct observation, personal monitoring devices, or other known methods were preferred where available. If studies utilizing direct measurement were not available, studies were selected that relied on validated indirect measurement methods such as surrogate measures (such as heart rate for inhalation rate), and use of questionnaires.

If questionnaires or surveys were used, proper design and procedures include an adequate sample size for the population under consideration, a response rate large enough to avoid biases, and avoidance of bias in the design of the instrument and interpretation of the results. More confidence was placed in exposure factors that relied on studies that gave appropriate consideration to these study design issues. Studies were also deemed preferable if based on primary data, but studies based on secondary sources were also included where they offered an original analysis. In general, higher confidence was placed on exposure factors based on primary data.

b) **Minimal (or Defined) Bias in Study Design:** Studies were sought that were designed with minimal bias, or at least if biases were suspected to be present, the direction of the bias (i.e., an overestimate or underestimate of the parameter) was either stated or apparent from the study design. More confidence was placed on exposure factors based on studies that minimized bias.

2) ***Applicability and Utility:*** *The information is relevant for the Agency's intended use. The applicability and utility of the available studies were evaluated based on the following criteria:*

a) **Focus on Exposure Factor of Interest:** Studies were preferred that directly addressed the exposure factor of interest or addressed related factors that have significance for the factor under consideration. As an example of the latter case, a selected study contained useful ancillary information concerning fat content in fish, although it did not directly address fish consumption.

b) **Representativeness of the Population:** More confidence was placed in studies that addressed the U.S. population. Data from populations outside the United States were sometimes included if behavioral patterns or other characteristics of exposure were similar. Studies seeking to characterize a particular region or demographic characteristic were selected, if appropriately representative of that population. In cases where data were limited, studies with limitations in this area were included, and limitations were noted in the handbook. Higher confidence ratings were given to exposure factors where the available data were representative of the population of interest. The risk or exposure assessor may need to evaluate whether these data may be used as suitable substitutes for their population of interest or whether there is a need to seek additional population-specific data.

c) **Currency of Information:** More confidence was placed in studies that were sufficiently recent to represent current exposure conditions. This is an important consideration for those factors that change with time. Older data were evaluated and considered in instances where the variability of the exposure factor over time was determined to be insignificant or unimportant. In some cases, recent data were very limited. Therefore, the data provided in these instances were the only available data. Limitations on the age of the data were noted. Recent studies are more likely to use state-of-the-art methodologies that reflect advances in the exposure assessment field. Consequently, exposure factor recommendations based on current data were given higher confidence ratings than those based on older data, except in cases where the age of the data would not affect the recommended values.

d) **Adequacy of Data Collection Period:** Because most users of the handbook are primarily addressing chronic exposures, studies were sought that utilized the most appropriate techniques for collecting data to characterize long-term behavior. Higher confidence ratings were given to exposure factor recommendations that were based on an adequate data collection period.

3) ***Clarity and Completeness:*** *The degree of clarity and completeness with which the data, assumptions, methods, quality assurance, sponsoring organizations and analyses employed to generate the information is documented.* Clarity and completeness were evaluated based on the following criteria:

a) **Accessibility:** Studies that the user could access in their entirety, if needed, were preferred.

b) **Reproducibility:** Studies that contained sufficient information so that methods could be reproduced, or could be evaluated, based on the details of the author's work, were preferred.

c) **Quality Assurance:** Studies with documented quality assurance/quality control measures were preferred. Higher confidence ratings were given to exposure factors that were based on studies where appropriate quality assurance/quality control measures were used.

4) ***Variability and Uncertainty:*** *The variability and uncertainty (quantitative and qualitative) in the information or the procedures, measures, methods, or models are evaluated and characterized.* Variability arises from true heterogeneity across people, places, or time and can affect the precision of exposure estimates and the degree to which they can be generalized. The types of variability include spatial, temporal, and inter-individual. Uncertainty represents a lack of knowledge about factors affecting exposure or risk and can lead to inaccurate or biased estimates of exposure. Increasingly probabilistic methods are being utilized to analyze variability and uncertainty independently as well as simultaneously. It is sometimes challenging to distinguish between variability and parameter uncertainty in this context as both can involve the distributions of a random variable. The types of uncertainty include scenario, parameter, and model. More information on variability and uncertainty is provided in Chapter 2 of this handbook. The uncertainty and variability associated with the studies were evaluated based on the following criteria:

a) **Variability in the Population:** Studies were sought that characterized any variability within populations. The variability associated with the recommended exposure factors is described in Section 1.6. Higher confidence ratings were given to exposure factors that were based on studies where variability was well characterized.

b) **Uncertainty:** Studies were sought with minimal uncertainty in the data, which was judged by evaluating all the considerations listed above. Studies were preferred that identified uncertainties, such as those due to possible measurement error. Higher confidence ratings were given to exposure factors based on studies where uncertainty had been minimized.

5) ***Evaluation and Review:*** *The information or the procedures, measures, methods, or models are independently verified, validated, and peer reviewed.* Relevant factors that were considered included:

a) **Peer Review:** Studies selected were those from the peer-reviewed literature and final government reports. Unpublished and internal or interim reports were avoided, where possible. but were used in some cases to supplement information in published literature or government reports.

b) **Number and Agreement of Studies:** Higher confidence was placed on recommendations where data were available from more than one key study, and there was good agreement between studies.

1.6. APPROACH USED TO DEVELOP RECOMMENDATIONS FOR EXPOSURE FACTORS

As discussed above, the U.S. EPA first reviewed the literature pertaining to a factor and determined key studies. These key studies were used to derive recommendations for the values of each factor. The recommended values were derived solely from the U.S. EPA's interpretation of the available data. Different values may be appropriate for the user in consideration of policy, precedent, strategy, or other factors such as site-specific information. The U.S. EPA's procedure for developing recommendations was as follows:

1) ***Study Review and Evaluation:*** Key studies were evaluated in terms of both quality and relevance to specific populations (general U.S. population, age groups, sex, etc.). Section 1.5 describes the criteria for assessing the quality of studies.

2) ***Selection of One versus Multiple Key Studies:*** If only one study was classified as key for a particular factor, the mean value from that study was selected as the recommended central value for that population. If multiple key studies with reasonably equal quality, relevance, and study design information were available, a weighted mean (if appropriate, considering sample size and other statistical factors) of the studies was chosen as the recommended

mean value. Recommendations for upper percentiles, when multiple studies were available, were calculated as the mid-point of the range of upper percentile values of the studies for each age group where data were available. It is recognized that the mid-point of the range of upper percentiles may not provide the best estimate, but in the absence of raw data, more sophisticated analysis could not be performed.

3) ***Assessing Variability:*** The variability of the factor across the population is discussed. For recommended values, as well as for each of the studies on which the recommendations are based, variability was characterized in one or more of three ways: (1) as a table with various percentiles or ranges of values; (2) as analytical distributions with specified parameters; and/or (3) as a qualitative discussion. Analyses to fit standard or parametric distributions (e.g., normal, lognormal) to the exposure data have not been performed by the authors of this handbook, but have been reproduced as they were found in the literature. Recommendations on the use of these distributions were made where appropriate based on the adequacy of the supporting data. Table 1-1 presents the list of exposure factors and the way in which variability in the population has been characterized throughout this handbook (i.e., average, median, upper percentiles, multiple percentiles).

In providing recommendations for the various exposure factors, an attempt was made to present percentile values that are consistent with the exposure estimators defined in *Guidelines for Exposure Assessment* (U.S. EPA, 1992a) (i.e., mean, 50^{th}, 90^{th}, 95^{th}, 98^{th}, and 99.9^{th} percentiles). However, this was not always possible, because the data available were limited for some factors, or the authors of the study did not provide such information. It is important to note, however, that these percentiles were discussed in the guidelines within the context of risk descriptors and not individual exposure factors. For example, the guidelines state that the assessor may derive a high-end estimate of exposure by using maximum or near maximum values for one or more sensitive exposure factors, leaving others at their mean value. The term "upper percentile" is used throughout this handbook, and it is intended to represent values in the upper tail (i.e., between 90^{th} and 99.9^{th} percentiles) of the distribution of values for a particular exposure factor. Tables providing summaries of recommendations at the beginning of each chapter generally present a mean and an upper percentile value. The 95^{th} percentile was used as the upper percentile in these tables, if available, because it is the middle of the range between the 90^{th} and 99.9^{th} percentiles. Other percentiles are presented, where available, in the tables at the end of the chapters. Users of the handbook should employ the exposure metric that is most appropriate for their particular situation.

4) ***Assessing Uncertainty:*** Uncertainties are discussed in terms of data limitations, the range of circumstances over which the estimates were (or were not) applicable, possible biases in the values themselves, a statement about parameter uncertainties (measurement error, sampling error), and model or scenario uncertainties if models or scenarios were used to derive the recommended value. A more detailed discussion of variability and uncertainty for exposure factors is presented in Chapter 2 of this handbook.

5) ***Assigning Confidence Ratings:*** Finally, the U.S. EPA assigned a confidence rating of *low, medium,* or *high* to each recommended value in each chapter. This qualitative rating is not intended to represent an uncertainty analysis; rather, it represents the U.S. EPA's judgment on the quality of the underlying data used to derive the recommendation. This judgment was made using the GAFs described in Section 1.5. Table 1-2 provides an adaptation of the GAFs, as they pertain to the confidence ratings for the exposure factor recommendations. Clearly, there is a continuum from *low to high*, and judgment was used to assign a rating to each factor. It is important to note that these confidence ratings are based on the strengths and limitations of the underlying data and not on how these data may be used in a particular exposure assessment.

The study elements listed in Table 1-2 do not have the same weight when arriving at the overall confidence rating for the various exposure factors. The relative weight of each of these elements for the various factors was subjective and based on the professional judgment of the authors of this handbook.

Also, the relative weights depend on the exposure factor of interest. For example, the adequacy of the data collection period may be more important when determining usual intake of foods in a population, but it is not as important for factors where long-term variability may be small, such as tap water intake. In the case of tap water intake, the currency of the data was a critical element in determining the final rating. In general, most studies ranked high with regard to "level of peer review," "accessibility," "focus on the factor of interest," and "data pertinent to the United States" because the U.S. EPA specifically sought studies for the handbook that met these criteria.

The confidence rating is also a reflection of the ease at which the exposure factor of interest could be measured. This is taken into consideration under the *soundness* criterion. For example, soil ingestion by children can be estimated by measuring, in feces, the levels of certain elements found in soil. Body weight, however, can be measured directly, and it is, therefore, a more reliable measurement than estimation of soil ingestion. The fact that soil ingestion is more difficult to measure than body weight is reflected in the overall confidence rating given to both of these factors. In general, the better the methodology used to measure the exposure factor, the higher the confidence in the value.

Some exposure factors recommendations may have different confidence ratings depending on the population of interest. For example a lower confidence rating may be noted for some age groups for which sample sizes are small. As another example, a lower confidence rating was assigned to the recommendations as they would apply to long-term chronic exposures versus acute exposures because of the short-term nature of the data collection period. To the extent possible, these caveats were noted in the confidence rating tables.

6) ***Recommendation Tables:*** The U.S. EPA developed a table at the beginning of each chapter that summarizes the recommended values for the relevant factor. Table ES-1 of the Executive Summary of this handbook summarizes the principal exposure factors addressed in this handbook and provides the confidence ratings for each exposure factor.

1.7. SUGGESTED REFERENCES FOR USE IN CONJUNCTION WITH THIS HANDBOOK

Many of the issues related to characterizing exposure from selected exposure pathways have been addressed in a number of existing U.S. EPA documents. Some of these provide guidance while others demonstrate various aspects of the exposure process. These include, but are not limited to, the following references listed in chronological order:

- *Methods for Assessing Exposure to Chemical Substances, Volumes 1–13* (U.S. EPA, 1983–1989);
- *Standard Scenarios for Estimating Exposure to Chemical Substances During Use of Consumer Products* (U.S. EPA, 1986b);
- *Selection Criteria for Mathematical Models Used in Exposure Assessments: Surface Water Models* (U.S. EPA, 1987);
- *Selection Criteria for Mathematical Models Used in Exposure Assessments: Groundwater Models* (U.S. EPA, 1988);
- *Risk Assessment Guidance for Superfund, Volume I, Part A, Human Health Evaluation Manual* (U.S. EPA, 1989b);
- *Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions* (U.S. EPA, 1990);
- *Risk Assessment Guidance for Superfund, Volume I, Part B, Development of Preliminary Remediation Goals* (U.S. EPA, 1991a);
- *Risk Assessment Guidance for Superfund, Volume I, Part C, Risk Evaluation of Remedial Alternatives* (U.S. EPA, 1991b);
- *Guidelines for Exposure Assessment* (U.S. EPA, 1992a);
- *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992b);
- *Soil Screening Guidance* (U.S. EPA, 1996a);
- *Series 875 Occupational and Residential Exposure Test Guidelines—Final Guidelines —Group A—Application Exposure Monitoring Test Guidelines* (U.S. EPA, 1996b);
- *Series 875 Occupational and Residential Exposure Test Guidelines—Group B—Post Application Exposure Monitoring Test Guidelines* (U.S. EPA, 1996c);

- *Policy for Use of Probabilistic Analysis in Risk Assessment at the U.S. Environmental Protection Agency* (U.S. EPA, 1997b);
- *Guiding Principles for Monte Carlo Analysis* (U.S. EPA, 1997c);
- *Sociodemographic Data for Identifying Potentially Highly Exposed Populations* (U.S. EPA, 1999);
- *Options for Developing Parametric Probability Distributions for Exposure Factors* (U.S. EPA, 2000a);
- *Risk Assessment Guidance for Superfund, Volume I, Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments* (U.S. EPA, 2001a);
- *Risk Assessment Guidance for Superfund Volume III, Part A, Process for Conducting Probabilistic Risk Assessments* (U.S. EPA, 2001b);
- *Framework for Cumulative Risk Assessment* (U.S. EPA, 2003b);
- *Example Exposure Scenarios* (U.S. EPA, 2003c);
- *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds National Academy Sciences Review Draft* (U.S. EPA, 2003d);
- *Risk Assessment Guidance for Superfund, Volume I, Part E, Supplemental Guidance for Dermal Risk Assessment* (U.S. EPA, 2004);
- *Cancer Guidelines for Carcinogen Risk Assessment* (U.S. EPA, 2005a);
- *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b);
- *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c);
- *Protocol for Human Health Risk Assessment Hazardous Waste Combustion Facilities* (U.S. EPA, 2005d);
- *Aging and Toxic Response: Issues Relevant to Risk Assessment* (U.S. EPA, 2005e);
- *A Framework for Assessing Health Risk of Environmental Exposures to Children* (U.S. EPA, 2006d);
- *Dermal Exposure Assessment: A Summary of EPA Approaches* (U.S. EPA, 2007a);
- *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2008a);
- *Concepts, Methods, and Data Sources For Cumulative Health Risk Assessment of Multiple Chemicals, Exposures and Effects: A Resource Document* (U.S. EPA, 2008b);
- *Physiological Parameters Database for Older Adults (Beta 1.1)* (U.S. EPA, 2008c);
- *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Part F, Supplemental Guidance for Inhalation Risk Assessment* (U.S. EPA, 2009a);
- *Draft Technical Guidelines Standard Operating Procedures for Residential Pesticide Exposure Assessment* (U.S. EPA, 2009b);
- *Stochastic Human Exposure and Dose Simulation (SHEDS)-Multimedia. Details of SHEDS-Multimedia Version 3: ORD/NERL's Model to Estimate Aggregate and Cumulative Exposures to Chemicals* (U.S. EPA, 2009c); and
- *Recommended Use of Body Weight$^{3/4}$ (BW$^{3/4}$) as the Default Method in Derivation of the Oral Reference Dose (RfD)* (U.S. EPA, 2011).

These documents may serve as valuable information resources to assist in the assessment of exposure. Refer to them for more detailed discussion.

1.8. THE USE OF AGE GROUPINGS WHEN ASSESSING EXPOSURE

When this handbook was published in 1997, no specific guidance existed with regard to which age groupings should be used when assessing children's exposure. Age groupings varied from case to case and among Program Offices within the U.S. EPA. They depended on availability of data and were often based on professional judgment. More recently, the U.S. EPA has established a consistent set of age groupings and published guidance on this topic (U.S. EPA, 2005c). This revision of the handbook attempts to present data in a manner consistent with the U.S. EPA's recommended set of age groupings for children. The presentation of data for these fine age categories does not necessarily mean that every age category needs to be the subject of a particular assessment. It will depend on the objectives of the assessment and communications with toxicologists to identify the critical windows of susceptibility.

The development of standardized age bins for children was the subject of discussion in a 2000 workshop sponsored by the U.S. EPA Risk Assessment Forum. The workshop was titled *Issues Associated with Considering Developmental Changes* *in Behavior and Anatomy When Assessing Exposure to Children* (U.S. EPA, 2000b). The purpose of this workshop was to gain insight and input into factors that need to be considered when developing standardized age bins and to identify future research necessary to accomplish these goals.

Based upon consideration of the findings of the technical workshop, as well as analysis of available data, U.S. EPA developed guidance that established a set of recommended age groups for development of exposure factors for children entitled *Guidance for Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c). This revision of the handbook for individuals <21 years of age presents exposure factors data in a manner consistent with U.S. EPA's recommended set of childhood age groupings. The recommended age groups (U.S. EPA, 2005c) are as follows:

Birth to <1 month
1 to <3 months
3 to <6 months
6 to <12 months
1 to <2 years
2 to <3 years
3 to <6 years
6 to <11 years
11 to <16 years
16 to <21 years

1.9. CONSIDERING LIFE STAGE WHEN CALCULATING EXPOSURE AND RISK

In recent years, there has been an increased concern regarding the potential impact of environmental exposures to children and other susceptible populations such as older adults and pregnant/lactating women. As a result, the U.S. EPA and others have developed policy and guidance and undertaken research to better incorporate life stage data into human health risk assessment (Brown et al., 2008). The *Child-Specific Exposure Factors Handbook* was published in 2008 to address the need to characterize children's exposures at various life stages (U.S. EPA, 2008a). Children are of special concern because (1) they consume more of certain foods and water per unit of body weight than adults; (2) they have a higher ratio of body surface area to volume than adults; and (3) they experience important, rapid changes in behavior and physiology that may lead to differences in exposure (Moya et al., 2004). Many studies have shown that young children can be exposed to various contaminants, including pesticides, during normal oral exploration of their environment (i.e., hand-to-mouth behavior) and by touching floors, surfaces, and objects such as toys (Eskenazi et al., 1999; Gurunathan et al., 1998; Lewis et al., 1999; Nishioka et al., 1999; Garry, 2004). Dust and tracked-in soil accumulate in carpets, where young children spend a significant amount of time (Lewis et al., 1999). Children living in agricultural areas may experience higher exposures to pesticides than do other children (Curwin et al., 2007). They may play in nearby fields or be exposed via consumption of contaminated human milk from their farmworker mothers (Eskenazi et al., 1999).

In terms of risk, children may also differ from adults in their vulnerability to environmental pollutants because of toxicodynamic differences (e.g., when exposures occur during periods of enhanced susceptibility) and/or toxicokinetic differences (i.e., differences in absorption, metabolism, and excretion) (U.S. EPA, 2000b). The immaturity of metabolic enzyme systems and clearance mechanisms in young children can result in longer half-lives of environmental contaminants (Ginsberg et al., 2002; Clewell et al., 2004). The cellular immaturity of children and the ongoing growth processes account for elevated risk (AAP, 1997). Toxic chemicals in the environment can cause neurodevelopmental disabilities, and the developing brain can be particularly sensitive to environmental contaminants. For example, elevated blood lead levels and prenatal exposures to even relatively low levels of lead can result in behavior disorders and reductions of intellectual function in children (Landrigan et al., 2005). Exposure to high levels of methylmercury can result in developmental disabilities (e.g., intellectual deficiency, speech disorders, and sensory disturbances) among children (Myers et al., 2000). Other authors have described the importance of exposure timing (i.e., pre-conceptional, prenatal, and postnatal) and how it affects the outcomes observed (Selevan et al., 2000). Exposures during these critical windows of development and age-specific behaviors and physiological factors can lead to differences in response (Makri et al., 2004). Fetal exposures can occur from the mobilization of chemicals of maternal body burden and transfer of those chemicals across the placenta (Makri et al., 2004). Absorption through the gastrointestinal tract is more efficient in neonates and infants, making ingestion exposures a significant route of exposure during the first year of age (Makri et al., 2004).

It has also been suggested that higher levels of exposure to indoor air pollution and allergens among inner-city children compared to non-inner-city children may explain the difference in asthma levels between these two groups (Breysee et al., 2005). With respect to contaminants that are carcinogenic via a mutagenic mode of action (MOA), the U.S. EPA has found that childhood is a particularly sensitive period of development in which cancer potencies per year of exposure can be an order of magnitude higher than during adulthood (U.S. EPA, 2005b).

A framework for considering life stages in human health risk assessments was developed by the U.S. EPA in the report entitled *A Framework for Assessing Health Risks of Environmental Exposures to Children* (U.S. EPA, 2006d). Life stages are defined as "temporal stages (or intervals) of life that have distinct anatomical, physiological, behavioral, and/or functional characteristics that contribute to potential differences in environmental exposures" (Brown et al., 2008). One way to understand the differential exposures among life stages is to study the data using age binning or age groups as it is the recommendation for childhood exposures. Although the framework discusses the importance of incorporating life stages in the evaluation of risks to children, the approach can also be applied to other life stages that may have their own unique susceptibilities. For example, older individuals may experience differential exposures and risks to environmental contaminants due to biological changes that occur during aging, disease status, drug interactions, different exposure patterns, and activities. More information on the toxicokinetic and toxicodynamic impact of environmental agents in older adults can be found in U.S. EPA's document entitled *Aging and Toxic Response: Issues Relevant to Risk Assessmen*t (U.S. EPA, 2005e). The need to better characterize differential exposures of the older adult population to environmental agents was recognized at the U.S. EPA's workshop on the development of exposure factors for the aging (U.S. EPA, 2007b). A panel of experts in the fields of gerontology, physiology, exposure assessment, risk assessment, and behavioral science discussed existing data, data gaps, and current relevant research on the behavior and physiology of older adults, as well as practical considerations of the utility of developing an exposure factors handbook for the aging (U.S. EPA, 2007b). Pregnant and lactating women may also be a life stage of concern due to physiological changes during pregnancy and lactation. For example, lead is mobilized from the maternal skeleton during pregnancy and the postpartum period, increasing the chances for fetal lead exposure (Gulson et al., 2004).

The U.S. EPA encourages the consideration of all life stages and endpoints to ensure that vulnerabilities during specific time periods are taken into account (Brown et al., 2008). Although the importance of assessing risks from environmental exposures to all susceptible populations is recognized, most of the guidance developed thus far relates to children. Furthermore, it is recognized that there is a lack of dose-response data to evaluate differential responses at various life stages (e.g., age groups, pregnant/lactating mothers, older populations). A key component of U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005c) involves the need to sum age-specific exposures across time when assessing long-term exposure, as well as integrating these age-specific exposures with age-specific differences in toxic potency in those cases where information exists to describe such differences: an example is carcinogens that act via a mutagenic mode of action (*Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* – [U.S. EPA, 2005b]). When assessing chronic risks (i.e., exposures greater than 10% of human lifespan), rather than assuming a constant level of exposure for 70 years (usually consistent with an adult level of exposure), the Agency is now recommending that assessors calculate chronic exposures by summing time-weighted exposures that occur at each life stage; this handbook provides data arrayed by childhood age in order to follow this new guidance (U.S. EPA, 2005b). This approach is expected to increase the accuracy of risk assessments, because it will take into account life stage differences in exposure. Depending on whether body-weight-adjusted childhood exposures are either smaller or larger compared to those for adults, calculated risks could either decrease or increase when compared with the historical approach of assuming a lifetime of a constant adult level of exposure.

The *Supplemental Guidance* report also recommended that in those cases where age-related differences in toxicity were also found to occur, differences in both toxicity and exposure would need to be integrated across all relevant age intervals (U.S. EPA, 2005b). This guidance describes such a case for carcinogens that act via a mutagenic mode of action, where age dependent adjustments factors (ADAFs) of 10× and 3× are recommended for children ages birth to <2 years, and 2 to <16 years, respectively, when there is exposure during those years, and available data are insufficient to derive chemical-specific adjustment factors.

Table 1-3, along with Chapter 6 of the *Supplemental Guidance* (U.S. EPA, 2005b) report, have been developed to help the reader understand how to use the new sets of exposure and potency age groupings when calculating risk through the integration of life stage specific changes in exposure and potency for mutagenic carcinogens.

Thus, Table 1-3 presents Lifetime Cancer Risk (for a population with average life expectancy of 70 years) = ∑ (Exposure × Duration/70 years × Potency × ADAF) summed across all the age groups. This is a departure from the way cancer risks have historically been calculated based upon the premise that risk is proportional to the daily average of the long-term adult dose.

1.10. FUNDAMENTAL PRINCIPLES OF EXPOSURE ASSESSMENT

An exposure assessment is the "process of estimating or measuring the magnitude, frequency, and duration of exposure to an agent, along with the number and characteristics of the population exposed" (Zartarian et al., 2007). The definition of exposure as used by the International Program on Chemical Safety (IPCS, 2001) is the "contact of an organism with a chemical or physical agent, quantified as the amount of chemical available at the exchange boundaries of the organism and available for absorption." The term "agent" refers to a chemical, biological, or physical entity that contacts a target. The "target" refers to any physical, biological, or ecological object exposed to an agent. In the case of human exposures, the contact occurs with the visible exterior of a person (i.e., target) such as the skin, and openings such as the mouth, nostrils, and lesions. The process by which an agent crosses an outer exposure surface of a target without passing an absorption barrier (i.e., through ingestion or inhalation) is called an intake. The resulting dose is the intake dose. The intake dose is sometimes referred to in the literature as the administered dose or potential dose.

The terms "exposure" and "dose" are very closely related and, therefore, are often confused (Zartarian et al., 2007). Dose is the amount of agent that enters a target in a specified period of time after crossing a contact boundary. An exposure does not necessarily leads to a dose. However, there can be no dose without a corresponding exposure (Zartarian et al., 2007). Figure 1-1 illustrates the relationship between exposure and dose.

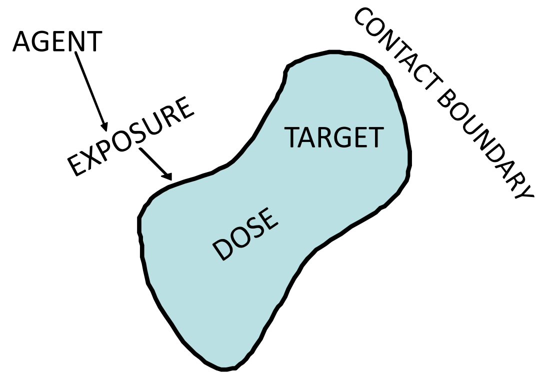

Figure 1-1. Conceptual Drawing of Exposure and Dose Relationship (Zartarian et al., 2007).

In other words, the process of an agent entering the body can be described in two steps: contact (exposure) followed by entry (crossing the boundary). In the context of environmental risk assessment, risk to an individual or population can be represented as a continuum from the source through exposure to dose to effect as shown in Figure 1-2 (U.S. EPA, 2003e; IPCS, 2006; Ott, 2007). The process begins with a chemical or agent released from a source into the environment. Once in the environment, the agent can be transformed and transported through the environment via air, water, soil, dust, and diet (i.e., exposure pathway). Fate and transport mechanisms result in various chemical concentrations with which individuals may come in contact. Individuals encounter the agent either through inhalation, ingestion, or skin/eye contact (i.e., exposure route). The individual's activity patterns as well as the concentration of the agent will determine the magnitude, frequency, and duration of the exposure. The exposure becomes an absorbed dose when the agent crosses an absorption barrier (e.g., skin, lungs, gut). Other terms used in the literature to refer to absorbed dose include internal dose, bioavailable dose, delivered dose, applied dose, active dose, and biologically effective dose (Zartarian et al., 2007). When an agent or its metabolites interact with a target tissue, it becomes a target tissue dose, which may lead to an adverse health outcome. The text under the boxes in Figure 1-2 indicates the specific information that may be needed to characterize each box.

This approach has been used historically in exposure assessments and exposure modeling. It is usually referred to as source-to-dose approach. In recent years, person-oriented approaches and models have gained popularity. This approach is aimed at accounting for cumulative and aggregate exposures to individuals (Georgopoulos, 2008; Price et al., 2003a). The person-oriented approach can also take advantage of information about the individual's susceptibility to environmental factors (e.g., genetic differences) (Georgopoulos, 2008).

There are three approaches to calculate exposures: (1) the point-of-contact approach, (2) the scenario evaluation approach, and (3) the dose reconstruction approach (U.S EPA, 1992a). The data presented in this handbook are generally useful for evaluating exposures using the scenario approach. There are advantages and disadvantages associated with each approach. Although it is not the purpose of this handbook to provide guidance on how to conduct an exposure assessment, a brief description of the approaches is provided below.

The point-of-contact approach, or direct approach, involves measurements of chemical concentrations at the point where exposure occurs (i.e., at the interface between the person and the environment). This chemical concentration is coupled with information on the length of contact with each chemical to calculate exposure. The scenario evaluation approach, or the indirect approach, utilizes data on chemical concentration, frequency, and duration of exposure as well as information on the behaviors and characteristics of the exposed life stage. The third approach, dose reconstruction, allows exposure to be estimated from dose, which can be reconstructed through the measurement of biomarkers of exposure. A biomarker of exposure is a chemical, its metabolite, or the product of an interaction between a chemical and some target molecule or cell that is measured in a compartment in an organism (NAS, 2006). Biomonitoring is becoming a tool for identifying, controlling, and preventing human exposures to environmental chemicals (NAS, 2006). For example, blood lead concentrations and the associated health effects were used by the U.S. EPA in its efforts to reduce exposure to lead in gasoline. The Centers for Disease Control and Prevention conducts biomonitoring studies to help identify chemicals that are both present in the environment and in human tissues (NAS, 2006). Biomonitoring studies also assist public health officials in studying distributions of exposure in a population and how they change overtime. Biomonitoring data can be converted to exposure using pharmacokinetic modeling (NAS, 2006). Although biomonitoring can be a powerful tool, interpretation of the data is difficult. Unlike the other two approaches, biomonitoring provides information on internal doses integrated across environmental pathways and media. Interpretation of these data requires knowledge and understanding of how the chemicals are absorbed, excreted, and metabolized in the biological system, as well as the properties of the chemicals and their metabolites (NAS, 2006). The interpretation of biomarker data can be further improved by the development of other cellular and molecular approaches to include advances in genomics, proteomics, and other approaches that make use of molecular-environmental interactions (Lioy et al., 2005). Physiological parameters can also vary with life stage, age, sex, and other demographic information (Price et al., 2003b). Physiologic and metabolic factors and how they vary with life stage have been the subject of recent research. Pharmacokinetic models are frequently developed from data obtained from young adults. Therapeutic drugs have been used as surrogates to study pharmacokinetic differences in fetuses, children, and adults (Ginsberg et al., 2004). Specific considerations of susceptibilities for other populations (e.g., children, older adults) require knowledge of the physiological parameters that most influence the disposition of the chemicals in the body (Thompson et al., 2009). Physiological parameters include alveolar ventilation, cardiac output, organ and tissue weights and volumes, blood flows to organs and tissues, clearance parameters, and body composition (Thompson et al., 2009). Price et al. (2003b) developed a tool for capturing the correlation between organs and tissue and compartment volumes, blood flows, body weight, sex, and other demographic information. A database that records key, age-specific pharmacokinetic model inputs for healthy older adults and for older adults with conditions such as diabetes, chronic obstructive pulmonary disease, obesity, heart disease, and renal disease has been developed by the U.S. EPA (Thompson et al., 2009; U.S. EPA, 2008c).

Computational exposure models can play an important role in estimating exposures to environmental chemicals (Sheldon and Cohen-Hubal, 2009). In general, these models combine measurements of the concentration of the chemical agent in the environment (e.g., air, water, soil, food) with information about the individual's activity patterns to estimate exposure (IPCS, 2005). Several models have been developed and may be used to support risk management decisions. For example, the U.S. EPA SHEDS model is a probabilistic model that simulates daily activities to predict distributions of daily exposures in a population (U.S. EPA, 2009c). Other models such as the Modeling Environment for Total Risk Studies incorporates and expands the approach used by SHEDS and considers multiple routes of exposure (Georgopoulos and Lioy, 2006).

1.10.1. Exposure and Dose Equations

Exposure can be quantified by multiplying the concentration of an agent times the duration of the contact. Exposure can be instantaneous when the contact between an agent and a target occurs at a single point in time and space (Zartarian et al., 2007). The summation of instantaneous exposures over the exposure duration is called the time-integrated exposure (Zartarian et al., 2007). Equation 1-1 shows the time-integrated exposure.

$$E = \int_{t_1}^{t_2} C(t)\,dt \qquad \text{(Eqn. 1-1)}$$

where:

E = Time-integrated exposure (mass/volume),
$t_2 - t_1$ = Exposure duration (ED) (time), and
C = Exposure concentration as a function of time (mass/volume).

Dividing the time-integrated exposure by the exposure duration, results in the time-averaged exposure (Zartarian et al., 2007).

Dose can be classified as an intake dose or an absorbed dose (U.S. EPA, 1992a). Starting with a general integral equation for exposure, several dose equations can be derived depending upon boundary assumptions. One of the more useful of these derived equations is the average daily dose (ADD). The ADD, which is used for many non-cancer effects, averages exposures or doses over the period of time exposure occurred. The ADD can be calculated by averaging the intake dose over body weight and an averaging time as shown in Equations 1-2 and 1-3.

$$ADD = \frac{Intake\ Dose}{Body\ Weight\ x\ \ Averaging\ Time} \qquad \text{(Eqn. 1-2)}$$

The exposure can be expressed as follows:

$$\text{Intake Dose} = C \times IR \times ED \qquad \text{(Eqn. 1-3)}$$

where:

C = Concentration of the Agent (mass/volume),
IR = Intake Rate (mass/time), and
ED = Exposure Duration (time).

Concentration of the agent is the mass of the agent in the medium (air, food, soil, etc.) per unit volume contacting the body and has units of mass/volume or mass/mass.

The intake rate refers to the rates of inhalation, ingestion, and dermal contact, depending on the route of exposure. For ingestion, the intake rate is simply the amount of contaminated food ingested by an individual during some specific time period (units of mass/time). Much of this handbook is devoted to rates of ingestion for some broad classes of food. For inhalation, the intake rate is that at which contaminated air is inhaled. Factors presented in this handbook that affect dermal exposure are skin surface area and estimates of the amount of solids that adheres to the skin, film thickness of liquids to skin, transfer of residues, and skin thickness. It is important to note that there are other key factors in the calculation of dermal exposures that are not covered in this handbook (e.g., chemical-specific absorption factors).

The exposure duration is the length of time of contact with an agent. For example, the length of time a person lives in an area, frequency of bathing, time spent indoors versus outdoors, and in various microenvironments, all affect the exposure duration. Chapter 16, Activity Factors, gives some examples of population behavior and macro and micro activities that may be useful for estimating exposure durations.

When the above parameter values IR and ED remain constant over time, they are substituted directly into the dose equation. When they change with time, a summation approach is needed to calculate dose. In either case, the exposure duration is the length of time exposure occurs at the concentration and the intake rate specified by the other parameters in the equation.

Note that the advent of childhood age groupings means that separate ADDs should be calculated for each age group considered. Chronic exposures can then be calculated by summing across each life stage-specific ADD.

Cancer risks have traditionally been calculated in those cases where a linear non-threshold model is assumed, in terms of lifetime probabilities by utilizing dose values presented in terms of lifetime ADDs (LADDs). The LADD takes the form of Equation 1-2, with lifetime replacing averaging time. While the use of LADDs may be appropriate when developing screening-level estimates of cancer risk, the U.S. EPA recommends that risks should be calculated by integrating exposures or risks throughout all life stages (U.S. EPA, 1992a).

For some types of analyses, dose can be expressed as a total amount (with units of mass, e.g., mg) or as a dose rate in terms of mass/time (e.g., mg/day), or as a rate normalized to body mass (e.g., with units of mg of chemical per kg of body weight per day [mg/kg-day]). The LADD is usually expressed in terms of mg/kg-day or other mass/mass-time units.

In most cases (inhalation and ingestion exposures), the dose-response parameters for carcinogenic risks have been adjusted for the difference in absorption across body barriers between humans and the experimental animals used to derive such parameters. Therefore, the exposure assessment in these cases is based on the intake dose, with no explicit correction for the fraction absorbed. However, the exposure assessor needs to make such an adjustment when calculating dermal exposure and in other specific cases when current information indicates that the human absorption factor used in the derivation of the dose-response factor is inappropriate.

For carcinogens, the duration of a lifetime has traditionally been assigned the nominal value of 70 years as a reasonable approximation. For dose estimates to be used for assessments other than carcinogenic risk, various averaging periods have been used. For acute exposures, the doses are usually averaged over a day or a single event. For non-chronic non-cancer effects, the time period used is the actual period of exposure (exposure duration). The objective in selecting the exposure averaging time is to express the dose in a way that can be combined with the dose-response relationship to calculate risk.

The body weight to be used in Equation 1-2 depends on the units of the exposure data presented in this handbook. For example, for food ingestion, the body weights of the surveyed populations were known in the USDA and NHANES surveys, and they were explicitly factored into the food intake data in order to calculate the intake as g/kg body weight-day. In this case, the body weight has already been included in the "intake rate" term in Equation 1-3, and the exposure assessor does not need to explicitly include body weight.

The units of intake in this handbook for the incidental ingestion of soil and dust are not normalized to body weight. In this case, the exposure assessor will need to use (in Equation 1-2) the average weight of the exposed population during the time when the exposure actually occurs. When making body-weight assumptions, care must be taken that the values used for the population parameters in the dose-response analysis are consistent with the population parameters used in the exposure analysis. Intraspecies adjustments based on life stage can be made using a correction factor (CF) (U.S. EPA, 2006d, 2011). Appendix 1A of this chapter discusses these adjustments in more detail. Some of the parameters (primarily concentrations) used in estimating exposure are exclusively site specific, and, therefore, default recommendations should not be used. It should be noted that body weight is correlated with food consumption rates, body surface area, and inhalation rates (for more information, see Chapters 6, 7, 9, 10, 11, 12, 13, and 14).

The link between the intake rate value and the exposure duration value is a common source of confusion in defining exposure scenarios. It is important to define the duration estimate so that it is consistent with the intake rate:

- The intake rate can be based on an individual event (e.g., serving size per event). The duration should be based on the number of events or, in this case, meals.
- The intake rate also can be based on a long-term average, such as 10 g/day. In this case, the duration should be based on the total time interval over which the exposure occurs.

The objective is to define the terms so that, when multiplied, they give the appropriate estimate of mass of agent contacted. This can be accomplished by basing the intake rate on either a long-term average (chronic exposure) or an event (acute exposure) basis, as long as the duration value is selected appropriately.

Inhalation dosimetry is employed to derive the human equivalent exposure concentrations on which inhalation unit risks (IURs), and reference concentrations (RfCs), are based (U.S. EPA, 1994). U.S. EPA has traditionally approximated children's respiratory exposure by using adult values, although a recent review (Ginsberg et al., 2005) concluded that there may be some cases where young children's greater inhalation rate per body weight or pulmonary surface area as compared to adults can result in greater exposures than adults. The implications of this difference for inhalation dosimetry and children's risk assessment were discussed at a peer involvement workshop hosted by the U.S. EPA in 2006 (Foos et al., 2008).

Consideration of life stage-particular physiological characteristics in the dosimetry analysis may result in a refinement to the human equivalent concentration (HEC) to ensure relevance in risk assessment across life stages, or might conceivably conclude with multiple HECs, and corresponding IUR values (e.g., separate for childhood and adulthood) (U.S. EPA, 2005b). The RfC methodology, which is described in *Methods for Derivation of Inhalation Reference Concentrations and Applications of Inhalation Dosimetry* (U.S. EPA, 1994), allows the user to incorporate population-specific assumptions into the models. Refer to U.S. EPA guidance (U.S. EPA, 1994) on how to make these adjustments.

There are no specific exposure factor assumptions in the derivation of RfDs for susceptible populations. With regard to childhood exposures for a susceptible population, for example, the assessment of the potential for adverse health effects in infants and children is part of the overall hazard and dose-response assessment for a chemical. Available data pertinent to children's health risks are evaluated along with data on adults and the no-observed-adverse-effect level (NOAEL) or benchmark dose (BMD) for the most sensitive critical effect(s), based on consideration of all health effects. By doing this, protection of the health of children will be considered along with that of other sensitive populations. In some cases, it is appropriate to evaluate the potential hazard to a susceptible population (e.g., children) separately from the assessment for the general population or other population groups. For more information regarding life stage-specific considerations for assessing children exposures, refer to the U.S. EPA report entitled *Framework for Assessing Environmental Exposures to Children* (U.S. EPA, 2006d).

1.10.2. Use of Exposure Factors Data in Probabilistic Analyses

Probabilistic risk assessment provides a range and likelihood estimate of risk rather than a single point estimate. It is a tool that can provide additional information to risk managers to improve decision making. Although this handbook is not intended to provide complete guidance on the use of Monte Carlo and other probabilistic analyses, some of the data in this handbook may be appropriate for use in probabilistic assessments. More detailed information on treating variability and uncertainty is discussed in Chapter 2 of this handbook. The use of Monte Carlo or other probabilistic analysis requires characterization of the variability of exposure factors and requires the selection of distributions or histograms for the input parameters of the dose equations presented in Section 1.10.1. The following suggestions are provided for consideration when using such techniques:

- The exposure assessor should only consider using probabilistic analysis when there are credible distribution data (or ranges) for the factor under consideration. Even if these distributions are known, it may not be necessary to apply this technique. For example, if only average exposure values are needed, these can often be computed accurately by using average values for each of the input parameters unless a non-linear model is used. Generally, exposure assessments follow a tiered approach to ensure the efficient use of resources. They may start with very simple techniques and move to more sophisticated models. The level of assessment needed can be determined initially during the problem formulation. There is also a tradeoff between the level of sophistication and the need to make timely decisions (NAS, 2009). Probabilistic analysis may not be necessary when conducting assessments for the first tier, which is typically done for screening purposes, i.e., to determine if unimportant pathways can be eliminated. In this case, bounding estimates can be calculated using maximum or near maximum values for each of the input parameters. Alternatively, the assessor may use the maximum values for those parameters that have the greatest variance.
- The selection of distributions can be highly site-specific and dependent on the purpose of the assessment. In some cases, the selection of distributions is driven by specific legislation. It will always involve some degree of judgment. Distributions derived from national data may not represent local conditions. Also, distributions may be representative of some age groups, but not representative when finer age categories are used. The assessor should evaluate the distributional data to ensure that it is representative of the population that needs to be characterized. In cases where site-specific data are available, the assessor may need to evaluate their quality and applicability. The assessor may decide to use distributional data drawn from the national or other surrogate population. In this case, it is important that the assessor address the extent to which local conditions may differ from the surrogate data.
- It is also important to consider the independence/dependence of variables and data used in a simulation. For example, it may

be reasonable to assume that ingestion rate and contaminant concentration in foods are independent variables, but ingestion rate and body weight may or may not be independent.

In addition to a qualitative statement of uncertainty, the representativeness assumption should be appropriately addressed as part of a sensitivity analysis. Distribution functions used in probabilistic analysis may be derived by fitting an appropriate function to empirical data. In doing this, it should be recognized that in the lower and upper tails of the distribution, the data are scarce, so that several functions, with radically different shapes in the extreme tails, may be consistent with the data. To avoid introducing errors into the analysis by the arbitrary choice of an inappropriate function, several techniques can be used. One technique is to avoid the problem by using the empirical data themselves rather than an analytic function. Another is to do separate analyses with several functions that have adequate fit but form upper and lower bounds to the empirical data. A third way is to use truncated analytical distributions. Judgment must be used in choosing the appropriate goodness-of-fit test.

Information on the theoretical basis for fitting distributions can be found in a standard statistics text, (e.g., Gilbert [1987], among others). Off-the-shelf computer software can be used to statistically determine the distributions that fit the data. Other software tools are available to identify outliers and for conducting Monte Carlo simulations.

If only a range of values is known for an exposure factor, the assessor has several options. These options include:

- keep that variable constant at its central value;
- assume several values within the range of values for the exposure factor;
- calculate a point estimate(s) instead of using probabilistic analysis; and
- assume a distribution. (The rationale for the selection of a distribution should be discussed at length.) The effects of selecting a different, but equally probable distribution should be discussed. There are, however, cases where assuming a distribution may introduce considerable amount of uncertainty. These include:
    - data are missing or very limited for a key parameter;
    - data were collected over a short time period and may not represent long-term trends (the respondent's usual behavior)—examples include food consumption surveys; activity pattern data;
    - data are not representative of the population of interest because sample size was small or the population studied was selected from a local area and was, therefore, not representative of the area of interest; for example, soil ingestion by children; and
    - ranges for a key variable are uncertain due to experimental error or other limitations in the study design or methodology; for example, soil ingestion by children.

1.11. AGGREGATE AND CUMULATIVE EXPOSURES

The U.S. EPA recognizes that individuals may be exposed to mixtures of chemicals both indoors and outdoors through more than one pathway. New directions in risk assessments in the U.S. EPA put more emphasis on total exposures via multiple pathways (U.S. EPA, 2003e, 2008b). Assessments that evaluate a single agent or stressor across multiple routes are not considered cumulative risk assessments. These are defined by the Food Quality Protection Act as aggregate risk assessments and can provide useful information to cumulative assessments (U.S. EPA, 2003e). Concepts and considerations to conduct aggregate risk assessments are provided in the U.S. EPA document entitled *General Principles for Performing Aggregate Exposure and Risk Assessments* (U.S. EPA, 2001c).

Cumulative exposure is defined as the exposure to multiple agents or stressors via multiple routes. In the context of risk assessment, it means that risks from multiple routes and agents need to be combined, not necessarily added (U.S. EPA, 2003b). Analysis needs to be conducted on how the various agents and stressors interact (U.S. EPA, 2003b).

In order to achieve effective risk assessment and risk management decisions, all media and routes of exposure should be assessed (NAS, 1991, 2009). Over the last several years, the U.S. EPA has developed a methodology for assessing risk from multiple chemicals (U.S. EPA, 1986c, 2000c). For more information, refer to the U.S. EPA's Framework for Cumulative Risk Assessment (U.S. EPA, 2003b). The recent report by the NAS also recommends the development of approaches to incorporate the interactions between chemical and non-chemical stressors (NAS, 2009).

1.12. ORGANIZATION OF THE HANDBOOK

All the chapters of this handbook have been organized in a similar fashion. An introduction is provided that discusses some general background information about the exposure factor. This discussion is followed by the recommendations for that exposure factor including summary tables of the recommendations and confidence ratings. The goal of the summary tables is to present the data in a simplified fashion by providing mean and upper percentile estimates and referring the reader to more detailed tables with more percentile estimates or other demographic information (e.g., sex) at the end of the chapter. Because of the large number of tables in this handbook, tables that include information other than the recommendations and confidence ratings are presented at the end of each chapter, before the appendices, if any. Following the recommendations, the key studies are summarized. Relevant data on the exposure factor are also provided. These data are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to the exposure factor of interest. Summaries of the key and relevant studies include discussions about their strengths and limitations. Note that because the studies often were performed for reasons unrelated to developing the factor of interest, the attributes that were characterized as limitations might not be limitations when viewed in the context of the study's original purpose.

The handbook is organized as follows:

Chapter 1	Introduction—includes discussions about general concepts in exposure assessments as well as the purpose, scope, and contents of the handbook.
Chapter 2	Variability and Uncertainty—provides a brief overview of the concepts of variability and uncertainty and directs the reader to other references for more in-depth information.
Chapter 3	Ingestion of Water and Other Select Liquids—provides information on drinking water consumption and data on intake of select liquids for the general population and various demographic groups; also provides data on intake of water while swimming.
Chapter 4	Non-dietary Ingestion—presents data on mouthing behavior necessary to estimate non-dietary exposures.
Chapter 5	Soil and Dust Ingestion—provides information on soil and dust ingestion for both adults and children.
Chapter 6	Inhalation Rates—presents data on average daily inhalation rates and activity-specific inhalation rates for the general population and various demographic groups.
Chapter 7	Dermal Exposure Factors—presents information on body surface area and solids adherence to the skin, as well as data on other non-chemical-specific factors that may affect dermal exposure.
Chapter 8	Body Weight—provides data on body weight for the general population and various demographic groups.
Chapter 9	Intake of Fruits and Vegetables—provides information on total fruit and vegetable consumption as well as intake of individual fruits and vegetables for the general population and various demographic groups.
Chapter 10	Intake of Fish and Shellfish—provides information on fish consumption for the general population, recreational freshwater and marine populations, and various demographic groups.
Chapter 11	Intake of Meats, Dairy Products, and Fats—provides information on meat, dairy products, and fats consumption for the general population and various demographic groups.
Chapter 12	Intake of Grain Products—provides information on grain consumption for the general population and various demographic groups.
Chapter 13	Intake of Home-produced Foods—provides information on home-produced food consumption for the general population and various demographic groups.
Chapter 14	Total Food Intake—provides information on total food consumption for the general population and various demographic groups; information on the composition of the diet is also provided.

Chapter 15 Human Milk Intake—presents data on human milk consumption for infants at various life stages.

Chapter 16 Activity Factors—presents data on activity patterns for the general population and various demographic groups.

Chapter 17 Consumer Products—provides information on frequency, duration, and amounts of consumer products used.

Chapter 18 Life Expectancy—presents data on the projected length of a lifetime, based on age and demographic factors.

Chapter 19 Building Characteristics—presents information on both residential and commercial building characteristics necessary to assess exposure to indoor air pollutants.

Figure 1-3 provides a schematic diagram that shows the linkages of a select number of exposure pathways with the exposure factors presented in this handbook and the corresponding exposure routes. Figure 1-4 provides a roadmap to assist users of this handbook in locating recommended values and confidence ratings for the various exposure factors presented in these chapters.

1.13. REFERENCES FOR CHAPTER 1

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Table 1-1. Availability of Various Exposure Metrics in Exposure Factors Data

Exposure Factors	Chapter	Average	Median	Upper Percentile	Multiple Percentiles
Ingestion of water and other select liquids (Chapter 3)	3	✓	✓	✓	✓
Non-dietary ingestion	4	✓	✓	✓	✓
Soil and dust ingestion	5	✓		✓[a]	
Inhalation rate	6	✓	✓	✓	✓
Surface area	7	✓	✓	✓	✓
Soil adherence	7	✓			
Body weight	8	✓	✓	✓	✓
Intake of fruits and vegetables	9	✓	✓	✓	✓
Intake of fish and shellfish	10	✓	✓	✓	✓
Intake of meats, dairy products, and fats	11	✓	✓	✓	✓
Intake of grain products	12	✓	✓	✓	✓
Intake of home produced foods	13	✓	✓	✓	✓
Total food intake	14	✓	✓	✓	✓
Human milk intake	15	✓		✓	
Total time indoors	16	✓			
Total time outdoors	16	✓			
Time showering	16	✓	✓	✓	✓
Time bathing	16	✓	✓	✓	✓
Time swimming	16	✓	✓	✓	✓
Time playing on sand/gravel	16	✓	✓	✓	✓
Time playing on grass	16	✓	✓	✓	✓
Time playing on dirt	16	✓	✓	✓	✓
Occupational mobility	16		✓		
Population mobility	16	✓	✓	✓	✓
Life expectancy	18	✓			
Volume of residence or building	19		✓	✓[b]	
Air exchange rates	19		✓	✓[b]	

✓ = Data available.
[a] Including soil pica and geophagy.
[b] Lower percentile.

Table 1-2. Criteria Used to Rate Confidence in Recommended Values

General Assessment Factors	Elements Increasing Confidence	Elements Decreasing Confidence
Soundness		
Adequacy of Approach	The studies used the best available methodology and capture the measurement of interest.	There are serious limitations with the approach used; study design does not accurately capture the measurement of interest.
	As the sample size relative to that of the target population increases, there is greater assurance that the results are reflective of the target population.	Sample size too small to represent the population of interest.
	The response rate is greater than 80% for in-person interviews and telephone surveys, or greater than 70% for mail surveys.	The response rate is less than 40%.
	The studies analyzed primary data.	The studies are based on secondary sources.
Minimal (or defined) Bias	The study design minimizes measurement errors.	Uncertainties with the data exist due to measurement error.
Applicability and Utility		
Exposure Factor of Interest	The studies focused on the exposure factor of interest.	The purpose of the studies was to characterize a related factor.
Representativeness	The studies focused on the U.S. population.	Studies are not representative of the U.S. population.
Currency	The studies represent current exposure conditions.	Studies may not be representative of current exposure conditions.
Data Collection Period	The data collection period is sufficient to estimate long-term behaviors.	Shorter data collection periods may not represent long-term exposures.
Clarity and Completeness		
Accessibility	The study data are publicly available.	Access to the primary data set was limited.
Reproducibility	The results can be reproduced, or methodology can be followed and evaluated.	The results cannot be reproduced, the methodology is hard to follow, and the author(s) cannot be located.
Quality Assurance	The studies applied and documented quality assurance/quality control measures.	Information on quality assurance/control was limited or absent.

Table 1-2. Criteria Used to Rate Confidence in Recommended Values (continued)

General Assessment Factors	Increasing Confidence	Decreasing Confidence
Variability and Uncertainty		
Variability in Population	The studies characterize variability in the population studied.	The characterization of variability is limited.
Uncertainty	The uncertainties are minimal and can be identified. Potential bias in the studies are stated or can be determined from the study design.	Estimates are highly uncertain and cannot be characterized. The study design introduces biases in the results.
Evaluation and Review		
Peer Review	The studies received a high level of peer review (e.g., they are published in peer-reviewed journals).	The studies received limited peer review.
Number and Agreement of Studies	The number of studies is greater than three. The results of studies from different researchers are in agreement.	The number of studies is one. The results of studies from different researchers are in disagreement.

Table 1-3. Age-Dependent Potency Adjustment Factor by Age Group for Mutagenic Carcinogens

Exposure Age Group[a]	Exposure Duration (year)	Age-Dependent Potency Adjustment Factor
Birth to <1 month	0.083	10×
1 <3 months	0.167	10×
3 <6 months	0.25	10×
6 <12 months	0.5	10×
1 to <2 years	1	10×
2 to <3 years	1	3×
3 to <6 years	3	3×
6 to <11 years	5	3×
11 to <16 years	5	3×
16 to <21 years	5	1×
≥21 years (21 to <70 years)	49	1×

[a] U.S. EPA's recommended childhood age groups (excluding ages >21 years).

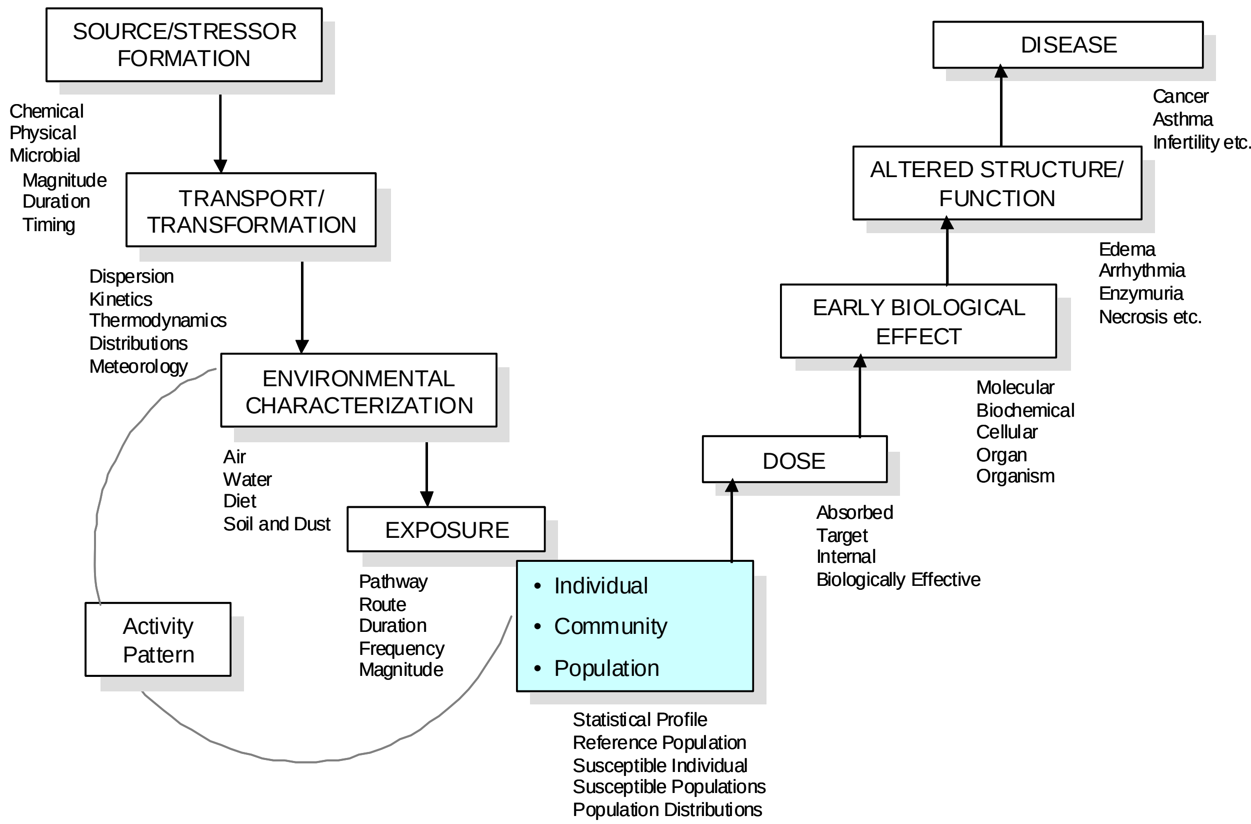
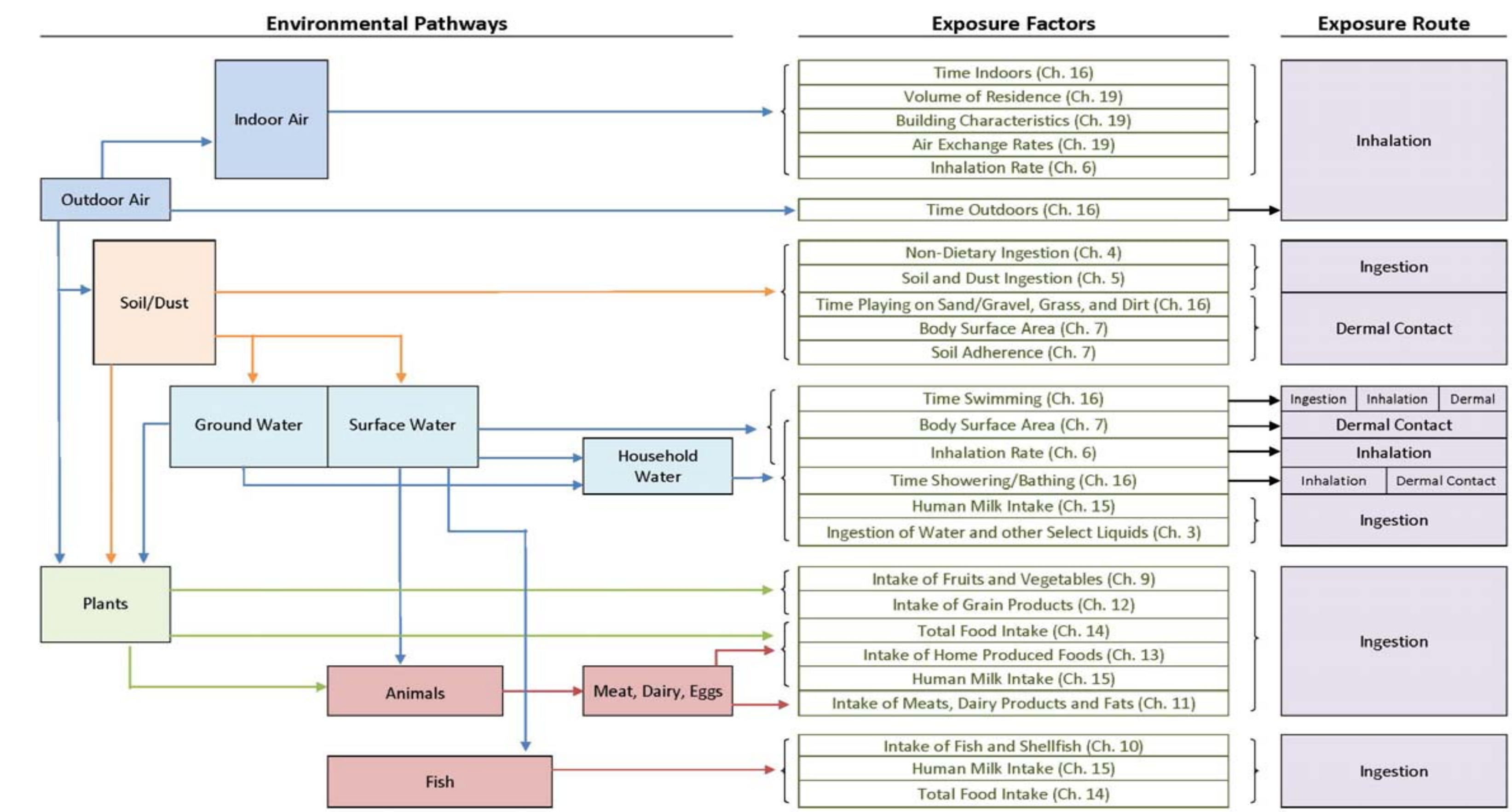


Figure 1-2. Exposure-Dose-Effect Continuum.

Source: Redrawn from U.S. EPA, 2003e; IPCS, 2006; Ott, 2007.

The exposure-dose-effect continuum depicts the trajectory of an agent from its source to an effect. The agent can be transformed and transported through the environment via air, water, soil, dust, and diet. Individuals can become in contact with the agent through inhalation, ingestion, or skin/eye contact. The individual's physiology, behavior, and activity patterns as well as the concentration of the agent will determine the magnitude, frequency, and duration of the exposure. The exposure becomes an absorbed dose once the agent crosses the absorption barrier (i.e., skin, lungs, eyes, gastrointestinal tract, placenta). Interactions of the chemical or its metabolites with a target tissue may lead to an adverse health outcome. The text under the boxes indicates the specific information that may be needed to characterize each step in the exposure-dose-effect continuum.



Notes:
The pathways presented are selected pathways. This diagram is not meant to be comprehensive.
Consumer Products (Ch. 17), such as perfume, are not shown on this diagram. Humans can be exposed to consumer products through all pathways and routes.
Body Weight (Ch. 8) and Lifetime (Ch. 18) potentially modify all exposure pathways.

Figure 1-3. Schematic Diagram of Exposure Pathways, Factors, and Routes.

Figure 1-4. Road Map to Exposure Factor Recommendations.

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

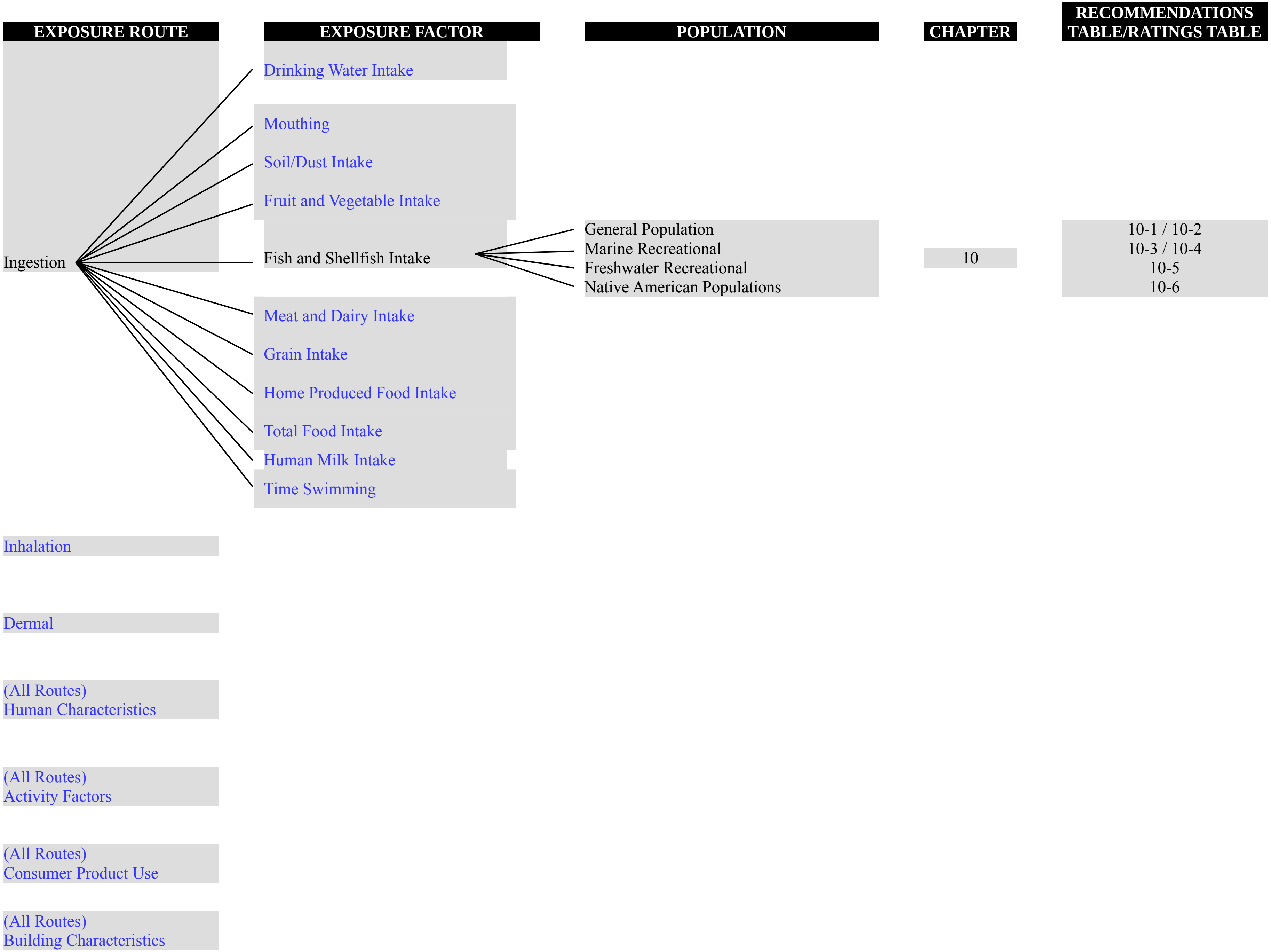
EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake	Adults Children Pregnant Women	3	3-1 / 3-2 3-3 / 3-4
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing	Frequency Duration	4	4-1 / 4-2
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake	Adults Children	5	5-1 / 5-2
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake	Adults Children	9	9-1 / 9-2
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				


EXPOSURE ROUTE
EXPOSURE FACTOR
POPULATION
CHAPTER
RECOMMENDATIONS TABLE/RATINGS TABLE
Drinking Water Intake
Mouthing
Soil/Dust Intake
Fruit and Vegetable Intake
Ingestion
Fish and Shellfish Intake
General Population
Marine Recreational
Freshwater Recreational
Native American Populations
10
10-1 / 10-2
10-3 / 10-4
10-5
10-6
Meat and Dairy Intake
Grain Intake
Home Produced Food Intake
Total Food Intake
Human Milk Intake
Time Swimming
Inhalation
Dermal
(All Routes)
Human Characteristics
(All Routes)
Activity Factors
(All Routes)
Consumer Product Use
(All Routes)
Building Characteristics

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake	Adults Children	11	11-1 / 11-2
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake	Adults Children	12	12-1 / 12-2
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake	Adults Children	13	13-1 / 13-2
	Total Food Intake			
	Human Milk Intake			
	Time Swimming			

Inhalation

Dermal

(All Routes)
Human Characteristics

(All Routes)
Activity Factors

(All Routes)
Consumer Product Use

(All Routes)
Building Characteristics

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake	Adults Children	14	14-1 / 14-2
	Human Milk Intake			
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake	Exclusively Breastfed Infants	15	15-1 / 15-2
	Time Swimming			
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion	Drinking Water Intake			
	Mouthing			
	Soil/Dust Intake			
	Fruit and Vegetable Intake			
	Fish and Shellfish Intake			
	Meat and Dairy Intake			
	Grain Intake			
	Home Produced Food Intake			
	Total Food Intake			
	Human Milk Intake			
	Time Swimming	Adults Children	16	16-1 / 16-2
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR		POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion					
Inhalation	Inhalation Rate	Long Term	Adults Children	6	6-1 / 6-3
		Short Term	Adults Children		6-2 / 6-3
Dermal					
(All Routes) Human Characteristics					
(All Routes) Activity Factors					
(All Routes) Consumer Product Use					
(All Routes) Building Characteristics					

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal	Body Surface Area	Adults	7	7-1, 7-2 / 7-3
		Children		
	Adherence of Solids	Adults		7-4 / 7-5
		Children		
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal				
(All Routes) Human Characteristics	Body Weight	Adults Children	8	8-1 / 8-2
	Lifetime			
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal				
(All Routes) Human Characteristics	Body Weight			
	Lifetime	Males Females	18	18-1 / 18-2
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors	Activity Patterns	Adults Children	16	16-1 / 16-2
	Occupational Mobility	Adults		16-3 / 16-4
	Population Mobility	Adults Children		16-5 / 16-6
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use	Frequency of Use Amount Used Duration	General Population	17	No Recommendations
(All Routes) Building Characteristics				

EXPOSURE ROUTE	EXPOSURE FACTOR	POPULATION	CHAPTER	RECOMMENDATIONS TABLE/RATINGS TABLE
Ingestion				
Inhalation				
Dermal				
(All Routes) Human Characteristics				
(All Routes) Activity Factors				
(All Routes) Consumer Product Use				
(All Routes) Building Characteristics	Air Exchange Rates	Residential Buildings	19	19-1 / 19-2
		Commercial Buildings		19-3 / 19-4
	Building Volume	Residential Buildings		19-1 / 19-2
		Commercial Buildings		19-3 / 19-4

APPENDIX 1A

RISK CALCULATIONS USING EXPOSURE FACTORS HANDBOOK DATA AND DOSE-RESPONSE INFORMATION FROM THE INTEGRATED RISK INFORMATION SYSTEM (IRIS)

APPENDIX 1A—RISK CALCULATIONS USING EXPOSURE FACTORS HANDBOOK DATA AND DOSE-RESPONSE INFORMATION FROM THE INTEGRATED RISK INFORMATION SYSTEM (IRIS)

1A-1. INTRODUCTION

When estimating risk to a specific population from chemical exposure, whether it is the entire national population or some smaller population of interest, exposure data (either from this handbook or from other sources) must be combined with dose-response information. The dose-response information typically comes from the Integrated Risk Information System (IRIS) database, which maintains a list of toxicity (i.e., dose-response) values for a number of chemical agents (www.epa.gov/iris). Care must be taken to ensure that population parameters from the dose-response assessment are consistent with the population parameters used in the exposure analysis. This appendix discusses procedures for ensuring this consistency.

The U.S. EPA's approach to estimating risks associated with toxicity from non-cancer effects is fundamentally different from its approach to estimating risks associated with toxicity from carcinogenic effects. One difference is that different assumptions are made regarding the mode of action that is involved in the generation of these two types of effects. For non-cancer effects, the Agency assumes that these effects are produced through a non-linear (e.g., "threshold") mode of action (i.e., there exists a dose below which effects do not occur) (U.S. EPA, 1993). For carcinogenic effects, deemed to operate through a mutagenic mode of action or for which the mode of action is unknown, the Agency assumes there is the absence of a "threshold" (i.e., there exists no level of exposure that does not pose a small, but finite, probability of generating a carcinogenic response).

For carcinogens, quantitative estimates of risks for the oral route of exposure are generated using cancer slope factors. The cancer slope factor is an upper bound estimate of the increase in cancer risk per unit of dose and is typically expressed in units of $(\text{mg/kg-day})^{-1}$. Because dose-response assessment typically involves extrapolating from laboratory animals to humans, a human equivalent dose (HED) is calculated from the animal data in order to derive a cancer slope factor that is appropriately expressed in human equivalents. The Agency endorses a hierarchy of approaches to derive human equivalent oral exposures from data in laboratory animal species, with the preferred approach being physiologically based toxicokinetic (PBTK) modeling. In the absence of PBTK modeling, U.S. EPA advocates using body weight to the ¾ power ($BW^{3/4}$) as the default scaling factor for extrapolating toxicologically equivalent doses of orally administered agents from animals to humans (U.S. EPA, 2011).

Application of the $BW^{3/4}$ scaling factor is based on adult animal and human body weights to adjust for dosimetric differences (predominantly toxicokinetic) between adult animals and humans (U.S. EPA, 2011). The internal dosimetry of other life stages (e.g., children, pregnant or lactating mothers) may be different from that of an adult (U.S. EPA, 2011). In some cases where data are available on effects in infants or children, adult PBTK models (if available) could be parameterized in order to predict the dose metric in children, as described in U.S. EPA's report, *A Framework for Assessing Health Risk of Environmental Exposures to Children* (U.S. EPA, 2006, 2011). However, more research is needed to develop models for children's dosimetric adjustments across life stages and experimental animal species (U.S. EPA, 2006).

In Summary:

- *No correction factors are applied to RfDs, RfCs, cancer slope factors, and inhalation unit risks when combined with exposure information from specific populations of interest.*
- *ADAFs are applied to oral slope factors for chemicals with a mutagenic mode of action as in Table 1A-1.*
- *Correction factors are applied to water unit risks for both body weight and water intake rate for specific populations of interest.*

For cancer data from chronic animal studies, no explicit lifetime adjustment is necessary when extrapolating to humans because the assumption is that events occurring in a lifetime animal bioassay will occur with equal probability in a human lifetime. For cancer data from human studies (either occupational or general population), the Agency typically makes no explicit assumptions regarding body weight or human lifetime. For both of these parameters, there is an implicit assumption that the exposed population of interest has the same characteristics as the population analyzed by the Agency in deriving its dose-response information. In the rare situation where this assumption is known to be violated, the Agency has made appropriate corrections so that the dose-response parameters are representative of the national average population.

For carcinogens acting through a mutagenic MOA, where chemical-specific data concerning early life susceptibility are lacking, early life susceptibility should be assumed, and the following ADAFs should be applied to the cancer slope factor as described in the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005) and summarized in Section 1.9 of this handbook:

- 10-fold for exposures occurring before 2 years of age;
- 3-fold for exposures occurring between the ages of 2 and 16 years of age; and
- no adjustment for exposures occurring after 16 years of age.

In addition to cancer slope factors, dose-response measures for carcinogens are also expressed as increased cancer risk per unit concentration for estimating risks from exposure to substances found in air or water (U.S. EPA, 1992). For exposure via inhalation, this dose-response value is referred to as an IUR and is typically expressed in units of $(\mu g/m^3)^{-1}$. For exposure via drinking water, this dose-response value is termed the unit risk for drinking water (oral) (U.S. EPA, 1992). These unit risk estimates implicitly assume standard adult intake rates (i.e., 2 L/day of drinking water; 20-m^3/day inhalation rate). It is generally not appropriate to adjust the inhalation unit risk for different body weights or inhalation rates because the amount of chemical that reaches the target site is not a simple function of two parameters (U.S. EPA, 2009). For drinking water unit risks, however, it would be appropriate for risk assessors to replace the standard intake rates with values representative of the exposed population of interest, as described in Section 1A-2 and Table 1A-1 below (U.S. EPA, 2005).

As indicated above, for non-cancer effects, dose-response assessment is based on a threshold hypothesis, which holds that there is a dose above which effects (or their precursors) begin to occur. The U.S. EPA defines the RfD as "an estimate of a daily oral exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime. It is derived from a benchmark dose lower confidence limit (BMDL), a no-observed-adverse-effect level, a lowest-observed-adverse-effect level, or another suitable point of departure, with uncertainty/variability factors applied to reflect limitations of the data used." The point of departure on which the RfD is based can come directly from animal dosing experiments or occasionally from human studies followed by application of uncertainty factors to reflect uncertainties such as extrapolating from subchronic to chronic exposure, extrapolating from animals to humans, and deficiencies in the toxicity database. Consistent with the derivation of oral cancer slope factors noted above, the U.S. EPA prefers the use of PBTK modeling to derive HEDs to extrapolate from data in laboratory animal species, but in the absence of a PBTK model, endorses the use of $BW^{3/4}$ as the appropriate default scaling factor for use in calculating HEDs for use in derivation of the oral RfD (U.S. EPA, 2011). Body-weight scaling using children's body weight may not be appropriate in the derivation of the RfD because RfDs are already intended to be protective of the entire population including susceptible populations such as children and other life stages (U.S. EPA, 2011). Uncertainty factors are used to account for intraspecies variation in susceptibility (U.S. EPA, 2011). As indicated above, body-weight scaling is meant to predominantly address toxicokinetic differences between animals and humans and can be viewed as a dosimetric adjustment factor (DAF). Data on toxicodynamic processes needed to assess the appropriateness of body-weight scaling for early life stages are not currently available (U.S. EPA, 2011).

The procedure for deriving dose-response values for non-cancer effects resulting from the inhalation route of exposure (i.e., RfCs) differs from the procedure used for deriving dose-response values for non-cancer effects resulting from the oral route of exposure (i.e., RfDs). The difference lies primarily in the source of the DAFs that are employed. As with the RfD, the U.S. EPA prefers the application of PBTK modeling in order to extrapolate laboratory animal exposure concentrations to HECs for the derivation of an RfC. In the absence of a PBTK model, the U.S. EPA advocates the use of a default procedure for deriving HECs that involve application of DAFs. This procedure uses species-specific physiologic and anatomic factors relevant to the physical form of the pollutant (i.e., particulate or gas) and categorizes the pollutant with regard to whether it elicits a response either locally (i.e., within the respiratory tract) or remotely (i.e., extrarespiratory). These factors are combined in determining an appropriate DAF. The default dosimetric adjustments and physiological parameters used in RfC derivations assume an adult male with an air intake rate of 20 m^3/day and a body weight of 70 kg (U.S. EPA, 1994).

Assumptions for extrathoracic, tracheobronchial, and pulmonary surface areas are also made based on an adult male (U.S. EPA, 1994). For gases, the parameters needed for deriving a DAF include species-to-species ratios of blood:gas partition coefficients. For particulates, the DAF is termed the regional deposition dose ratio and is derived from parameters that include region-specific surface areas, the ratio of animal-to-human minute volumes, and the ratio of animal-to-human regional fractional deposition. If DAFs are not available, simple ventilation rate adjustments can be made in generating HECs for use in derivation of the RfC (U.S. EPA, 2006). Toxicity values (RfCs) derived using the default approach from the inhalation dosimetry methodology described in U.S. EPA (1994) are developed for the human population as a whole, including sensitive groups. Therefore, no quantitative adjustments of these toxicity values are needed to account for different ventilation rates or body weights of specific age groups (U.S. EPA, 2009).

1A-2. CORRECTIONS FOR DOSE-RESPONSE PARAMETERS

The correction factors for the dose-response values tabulated in the IRIS database for non-cancer and carcinogenic effects are summarized in Table 1A-1. Use of these correction parameters is necessary to avoid introducing errors into the risk analysis. This table is applicable in most cases that will be encountered, but it is not applicable when (a) the effective dose has been derived with a PBTK model, and (b) the dose-response data have been derived from human data. In the former case, the population parameters need to be incorporated into the model. In the latter case, the correction factor for the dose-response parameter must be evaluated on a case-by case basis by examining the specific data and assumptions employed in the derivation of the parameter.

It is important to note that the 2 L/day per capita water intake assumption is closer to a 90th percentile intake value than an average value. If an average measure of exposure in adults is of interest, the drinking water unit risk can be adjusted by multiplying it by 1.0/2 or 0.5, where 1.0 L/day is the average per capita water intake for adults ≥21 years old (see Chapter 3 of this handbook). If the population of interest is children, rather than adults, then a body-weight adjustment is also necessary. For example, the average water intake for children 3 to <6 years of age is 0.33 L/day (see Chapter 3 of this handbook), and the average body weight in this age group is 18.6 kg (see Chapter 8 of this handbook). The water unit risk then needs to be adjusted by multiplying it by an adjustment factor derived from these age-group-specific values and calculated using the formula from Table 1A-1 as follows:

Water unit risk correction factor =

$$\left[\frac{0.33(L/day)}{2(L/day)}\right]\times\left[\frac{70(kg)}{18.6(kg)}\right]=0.6 \quad \text{(Eqn. 1A-1)}$$

1A-3. REFERENCES FOR APPENDIX 1A

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Table 1A-1. Procedures for Modifying IRIS Risk Values for Non-Standard Populations

IRIS Risk Measure [Units]	Correction Factor (CF) for modifying IRIS Risk Measures[a]
RfD	No correction factor needed
RfC	No correction factor needed
Slope Factor $[mg/(kg\text{-}day)]^{-1}$	No correction factor needed except for chemicals with mutagenic MOA. ADAFs are applied as follows: • 10-fold for exposure occurring before 2 years of age • 3-fold for exposure occurring between the ages of 2 and 16 • no adjustment for exposures occurring after 16 years of age
Water Unit Risk $[\mu g/L]^{-1}$	$[I_W^P/2] \times [70/(W^P)]$
Air Unit Risk $[\mu g/m^3]^{-1}$	No correction factor needed

[a] Modified risk measure = (CF) × IRIS value.
W = Body weight (kg)
I_W = Drinking water intake (liters per day)
W^P, I_W^P = Denote non-standard parameters from the actual population of interest

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2. VARIABILITY AND UNCERTAINTY

Accounting for variability and uncertainty is fundamental to exposure assessment and risk analysis. While more will be said about the distinction between variability and uncertainty in Section 2.1, it is useful at this point to motivate the treatment of variability and uncertainty in exposure assessment. Given that exposure and susceptibility to exposure is usually not uniform across a population, accounting for variability is the means by which a risk assessor properly accounts for risk to the population as a whole. However, a risk assessment usually involves uncertainties about the precision of a risk estimate. A heuristic distinction between variability and uncertainty is to consider uncertainty as a lack of knowledge about factors affecting exposure or risk, whereas variability arises from heterogeneity across people, places, or time.

Properly addressing variability and uncertainty will increase the likelihood that results of an assessment or analysis will be used in an appropriate manner. Characterizing and communicating variability and uncertainty should be done throughout all the components of the risk assessment process (NRC, 1994). Thus, careful consideration of the variability and uncertainty associated with the exposure factors information used in an exposure assessment is of utmost importance. Proper characterization of variability and uncertainty will also support effective communication of risk estimates to risk managers and the public.

This chapter provides an overview of variability and uncertainty in the context of exposure analysis and is not intended to present specific methodological guidance. It is intended to acquaint the exposure assessor with some of the fundamental concepts of variability and uncertainty as they relate to exposure assessment and the exposure factors presented in this handbook. It also provides summary descriptions of methods and considerations for evaluating and presenting the uncertainty associated with exposure estimates and a bibliography of references on a wide range of methodologies concerned with the application of variability and uncertainty analysis in exposure assessment. Subsequent sections in this chapter are devoted to the following topics:

2.1 Variability versus uncertainty;
2.2 Types of variability;
2.3 Addressing variability;
2.4 Types of uncertainty;
2.5 Reducing uncertainty;
2.6 Analyzing variability and uncertainty;
2.7 Literature review of variability and uncertainty analysis;
2.8 Presenting results of variability and uncertainty analyses; and
2.9 References.

There are numerous ongoing efforts in the U.S. Environmental Protection Agency (EPA) and elsewhere to further improve the characterization of variability and uncertainty. The U.S. EPA's Risk Assessment Forum has established guidelines for the use of probabilistic techniques (e.g.,, Monte Carlo analysis) to better assess and communicate risk (U.S. EPA, 1997a, b). The U.S. EPA's Science Policy Council is developing white papers on the use of expert elicitation for characterizing uncertainty in risk assessments. Expert judgment has been used in the past by some regulatory agencies when limited data or knowledge results in large uncertainties (NRC, 2009). The International Program on Chemical Safety (IPCS) has developed guidance on characterizing and communicating uncertainty in exposure assessment (WHO, 2008). Suggestions for further reading on variability and uncertainty include Babendreier and Castleton (2005), U.S. EPA (2008), Saltelli and Annoni (2010), Bogen et al. (2009), and Refsgaard (2007).

2.1. VARIABILITY VERSUS UNCERTAINTY

While some authors have treated variability as a specific type or component of uncertainty, the U.S. EPA (1995), following the NRC (1994) recommendation, has advised the risk assessor to distinguish between variability and uncertainty. Variability is a quantitative description of the range or spread of a set of values. Common measures include variance, standard deviation, and interquartile range. Variability arises from heterogeneity across individuals, places, or time. Uncertainty can be defined as a lack of precise knowledge, either qualitative or quantitative. In the context of exposure assessment, data uncertainty refers to the lack of knowledge about factors affecting exposure.

The key difference between uncertainty and variability is that variability cannot be reduced, only better characterized (NRC, 2009).

We will describe a brief example of human water consumption in relation to lead poisoning to help distinguish between variability and parameter uncertainty (a particular type of uncertainty). We might characterize the variability of water consumption across individuals by sampling from a population and measuring water consumption. From this sample, we obtain useful statistics on the variability of water consumption, which we assume here represents the population of interest. There may be similar statistics on the variability in the concentration of lead in the water consumed. A risk model may include a factor (i.e., dose response, representing the absorption of lead from ingested water to blood). The dose response may be represented by a constant in a risk model. However, knowledge about the dose response may be uncertain, motivating an uncertainty analysis. Dose response values are often relatively uncertain compared to exposure parameters. Therefore, in the above example, a high uncertainty surrounds the absorption of lead, whereas there is less uncertainty associated with the parameters of water consumption (i.e., population mean and standard deviation). One challenge in modeling dose-response uncertainty is the lack of consensus on its treatment.

Most of the data presented in this handbook concern variability. Factors contributing to variability in risk include variability in exposure potential (e.g., differing behavioral patterns, location), variability in susceptibility due to endogenous factors (e.g., age, sex, genetics, pre-existing disease), variability in susceptibility due to exogenous factors (e.g., exposures to other agents) (NRC, 2009).

2.2. TYPES OF VARIABILITY

Variability in exposure is dependent on contaminant concentrations as well as variability in human exposure factors. Human exposure factors may vary because of an individual's location, specific exposure time, or behavior. However, even if all of those factors were constant across a set of individuals, there could still be variability in risk because of variability in susceptibilities. Variations in contaminant concentrations and human exposure factors are not necessarily independent. For example, contaminant concentrations and behavior might be correlated.

A useful way to think about sources of variability is to consider these four broad categories:

1) Spatial variability: variability across locations;
2) Temporal variability: variability over time;
3) Intra-individual variability: variability within an individual; and
4) Inter-individual variability: variability across individuals.

Spatial variability refers to differences that may occur because of location. For example, outdoor pollutant levels can be affected at the regional level by industrial activities and at the local level by activities of individuals. In general, higher exposures tend to be associated with closer proximity to a pollutant source, whether it is an industrial plant or related to a personal activity such as showering or gardening. Susceptibilities may vary across locations, for example, some areas have particularly high concentrations of a younger or older population.

Temporal variability refers to variations over time, whether long- or short-term. Different seasons may cause varied exposure to pesticides, bacteria, or indoor air pollution, each of which might be considered an example of long-term variability. Examples of short-term variability are differences in industrial or personal activities on weekdays versus weekends or at different times of the day.

Intra-individual variability is a function of fluctuations in an individual's physiologic (e.g., body weight), or behavioral characteristics (e.g., ingestion rates or activity patterns). For example, patterns of food intake change from day to day and may do so significantly over a lifetime. Intra-individual variability may be associated with spatial or temporal variability. For example, because an individual's dietary intake may reflect local food sources, intake patterns may change if place of residence changes. Also, physical activity may vary depending upon the season, life stage, or other factors associated with temporal variability.

Inter-individual variability refers to variation across individuals. Three broad categories include the following:

1) individual characteristics such as sex, age, race, height, or body weight (including any obesity), phenotypic genetic expression, and pathophysiological conditions;
2) individual behaviors such as activity patterns, and ingestion rates; and
3) susceptibilities due to such things as life stage or genetic predispositions.

Inter-individual variability may also be related to spatial and temporal factors.

2.3. ADDRESSING VARIABILITY

In this handbook, variability is addressed by presenting data on the exposure factors in one of the following three ways: (1) as tables with percentiles or ranges of values for various age groups or other populations, (2) as probability distributions with specified parameter estimates and related confidence intervals, or (3) as a qualitative discussion. One approach to exposure assessment is to assume a single value for a given exposure level, often the mean or median, in order to calculate a single point estimate of risk. Often however, individuals vary in their exposure, and an exposure assessment would be remiss to exclude other possible exposure levels. Thus, an exposure assessment often involves a quantification of the exposure at high levels of the exposure factor, i.e., 90th, 95th, and 99th percentiles, and not only the mean or median exposure. Where possible, confidence limits for estimated percentiles should be provided. The U.S. EPA's approach to variability assessment is described in *Risk Assessment Principles and Practices: Staff Paper* (U.S. EPA, 2004). Accounting for variability in an exposure assessment may be limited to a deterministic model in which high-end values are used or may involve a probabilistic approach, e.g., Monte Carlo Analysis (U.S. EPA, 1997a).

Populations are by nature heterogeneous. Characterizing the variability in the population can assist in focusing analysis on segments of the population that may be at higher risk from environmental exposure. Although population variability cannot be reduced, data variability can be lessened by disaggregating the population into segments with similar characteristics.

Although much of this handbook is concerned with variability in exposure, it is critical to note that there are also important variations among individuals in a population with respect to susceptibility. As noted in NRC (2009), people differ in susceptibility to the toxic effects of a given chemical exposure because of such factors as genetics, lifestyle, predisposition to diseases and other medical conditions, and other chemical exposures that influence underlying toxic processes. Susceptibility is also a function of life stages, e.g., children may be at risk of high exposure relative to adults. Susceptibility factors are broadly considered to include any factor that increases (or decreases) the response of an individual to a dose relative to a typical individual in the population. The distribution of disease in a population can result not only from differences in susceptibility, but from differing exposures of individuals and target groups in a population. Taken together, variations in disease susceptibility and exposure potential give rise to potentially important variations in vulnerability to the effects of environmental chemicals (NRC, 2009).

2.4. TYPES OF UNCERTAINTY

Uncertainty in exposure analysis is related to the lack of knowledge concerning one or more components of the assessment process. The U.S. EPA (1992) has classified uncertainty in exposure assessment into three broad categories: (1) scenario uncertainty, (2) parameter uncertainty, and (3) model uncertainty.

Scenario uncertainty

Scenario uncertainty arises from descriptive errors, aggregation errors, errors in professional judgment, and incomplete analysis. Descriptive errors are errors in information that translate into errors in the development of exposure pathways, scenarios, exposed population, and exposure estimates. Aggregation errors occur as a result of lumping approximations. These include, for example, assuming a homogeneous population, and spatial and temporal assumptions. Uncertainty can also arise from errors in professional judgment. These errors affect how an exposure scenario is defined, the selection of exposure parameters, exposure routes and pathways, populations of concern, chemicals of concern, and the selection of appropriate models. An incomplete analysis can also be a source of uncertainty because important exposure scenarios and susceptible populations may be overlooked.

Parameter uncertainty

Risk assessments depict reality interpreted through mathematical representations that describe major processes and relationships. Process or mechanistic models use equations to describe the processes that an environmental agent undergoes in the environment in traveling from the source to the target organism. Mechanistic models have also been developed to represent the toxicokinetic and toxicodynamic processes that take place inside the organism, leading to the toxic endpoint. The specific parameters of the equations found in these models are factors that influence the release, transport, and transformation of the environmental agent, the exposure of the target organism to the agent, transport and metabolism of the agent in the body, and interactions on the cellular and molecular levels. Empirical models are also used to define relationships between two values, such as the dose and the response. Uncertainty in parameter estimates stem from a variety of sources, including the following:

a. Measurement errors:
   1. Random errors in analytical devices (e.g., imprecision of continuous monitors that measure stack emissions).
   2. Systemic bias (e.g., estimating inhalation from indoor ambient air without considering the effect of volatilization of contaminants from hot water during showers).
b. Use of surrogate data for a parameter instead of direct analysis of it (e.g., use of standard emission factors for industrialized processes).
c. Misclassification (e.g., incorrect assignment of exposures of subjects in historical epidemiologic studies due to faulty or ambiguous information).
d. Random sampling error (e.g., variation in estimates due to who was randomly selected).
e. Non-representativeness with regard to specified criteria (e.g., developing emission factors for dry cleaners based on a sample of “dirty” plants that do not represent the overall population of plants).

Model uncertainty

Model uncertainties arise because of gaps in the scientific theory that is required to make predictions on the basis of causal inferences. Common types of model uncertainties in various risk assessment-related activities include the following:

a. Relationship errors (e.g., incorrectly inferring the basis of correlations between chemical structure and biological activity).
b. Oversimplified representations of reality (e.g., representing a three-dimensional aquifer with a two-dimensional mathematical model).
c. Incompleteness, i.e., exclusion of one or more relevant variables (e.g., relating asbestos to lung cancer without considering the effect of smoking on both those exposed to asbestos and those unexposed).
d. Use of surrogate variables for ones that cannot be measured (e.g., using wind speed at the nearest airport as a proxy for wind speed at the facility site).
e. Failure to account for correlations that cause seemingly unrelated events to occur more frequently than expected by chance (e.g., two separate components of a nuclear plant are both missing a particular washer because the same newly hired assembler put them together).
f. Extent of (dis)aggregation used in the model (e.g., whether to break up the fat compartment into subcutaneous and abdominal fat in a physiologically based pharmacokinetic, or PBPK, model).

Although difficult to quantify, model uncertainty is inherent in risk assessment that seeks to capture the complex processes impacting release, environmental fate and transport, exposure, and exposure response.

2.5. REDUCING UNCERTAINTY

Identification of the sources of uncertainty in an exposure assessment is the first step in determining how to reduce uncertainty. Because uncertainty in exposure assessments is fundamentally tied to a lack of knowledge concerning important exposure factors, strategies for reducing uncertainty often involve the application of more resources to gather either more or targeted data. Example strategies to reduce uncertainty include (1) collecting new data, (2) implementing an unbiased sample design, (3) identifying a more direct measurement method or a more appropriate target population, (4) using models to estimate missing values, (5) using surrogate data, (6) using default assumptions, (7) narrowing the scope of the assessment, and (8) obtaining expert elicitation. The best strategy likely depends on a combination of resource availability, time constraints, and the degree of confidence necessary in the results.

2.6. ANALYZING VARIABILITY AND UNCERTAINTY

There are different strategies available for addressing variability and uncertainty that vary in their level of sophistication. The level of effort required to conduct the analysis needs to be balanced against the need for transparency and timeliness.

Exposure assessments are often developed in a tiered approach. The initial tier usually screens out the exposure scenarios or pathways that are not expected to pose much risk, to eliminate them from more detailed, resource-intensive review. Screening-level assessments typically examine exposures on the high end of the expected exposure distribution. Because screening-level analyses usually are included in the final exposure assessment, it may contain scenarios that differ in sophistication, data quality, and amenability to quantitative expressions of variability or uncertainty. Several approaches can be used to analyze uncertainty in parameter values. When uncertainty is high, for example, an assessor may set order-of-magnitude bounding estimates of parameter ranges (e.g., from 0.1 to 10 liters for daily water intake). Another method may involve setting a range for each parameter as well as point estimates for certain parameters determined by available data or professional judgment.

A sensitivity analysis can be used to determine which parameters and exposures have the most impact on an exposure assessment. General concepts in sensitivity analysis are described in Saltelli et al. (2008). The International Program on Chemical Safety proposes a four-tier approach for addressing uncertainty and variability (WHO, 2006). The four tiers are similar to those proposed in U.S. EPA (1992) and include the use of default assumptions; a qualitative, systematic identification and characterization of uncertainty; a qualitative evaluation of uncertainty using bounding estimates, interval analysis, and sensitivity analysis; and a more sophisticated one- or two-stage probabilistic analysis (WHO, 2006).

Practical considerations regarding an uncertainty analysis include whether uncertainty would affect the results in a non-trivial way; an issue might be addressed by an initial sensitivity analysis in which a range of values are explored. An initial analysis of this sort might be facilitated by use of Microsoft Excel. Probabilistic risk analysis techniques are becoming more widely applied and are increasing in the level of sophistication. Bedford and Cooke (2001) describe in more detail the main tools and modeling techniques available for probabilistic risk analysis (Bedford and Cooke, 2001). If a probabilistic approach is pursued, another consideration is the choice of a software package. Popular software packages for Monte Carlo analysis range from the more general: Fortran, Mathematica, R, and SAS to the more specific: Crystal Ball, @Risk (Palisade Corporation), RISKMAN (PLG Inc.), and SimLab (Saltelli et al., 2004).

Increasingly, probabilistic methods are being utilized to analyze variability and uncertainty independently as well as simultaneously. It is sometimes challenging to distinguish between variability and parameter uncertainty in this context as both can involve the distributions of a random variable. For instance, parameter uncertainty can be estimated by the standard error of a random variable (itself a function of variability). Note that in this case, increasing the sample size necessarily reduces the parameter uncertainty (i.e., standard error).

More sophisticated techniques that attempt to simultaneously model both variability and uncertainty by sampling from their respective probability distributions are known as two-stage probabilistic analysis, or two-stage Monte Carlo analysis, which is discussed in great detail in Bogen and Spear (1987), Bogen (1990), Chapter 11 and Appendix I-3 of NRC (1994), and U.S. EPA (2001). These methods assume a probabilistic distribution for certain specified parameters. Random samples are drawn from each probabilistic distribution in a simulation and are used as input into a deterministic model. Analysis of the results from the simulations characterizes either the variability or uncertainty (or both) of the exposure assessment.

Through the implementation of computationally efficient Markov Chain Monte Carlo algorithms like Metropolis-Hastings, Bayesian methods offer an alternative approach to uncertainty analysis that is attractive in part because of increasing usability of software. For more on Bayesian methods, see Gelman et al. (2003), Gilks et al. (1995), Robert and Casella (2004).

The U.S. EPA has made significant efforts to use probabilistic techniques to characterize uncertainty. These efforts have resulted in documents such as the March 1997 *Guiding Principles for Monte Carlo Analysis* (U.S. EPA, 1997a), the May 1997 Policy Statement (U.S. EPA, 1997b), and the December 2001 Superfund document *Risk Assessment Guidance for Superfund: Volume III—Part A, Process for Conducting Probabilistic Risk Assessment* (U.S. EPA, 2001).

2.7. LITERATURE REVIEW OF VARIABILITY AND UNCERTAINTY ANALYSIS

There has been a great deal of recent scholarly research in the area of uncertainty with the widespread use of computer simulation. Some of this research also incorporates issues related to variability. The purpose of the literature review below is to give a brief description of notable developments. Section 2.9 provides references for further research.

Cox (1999) argues that, based on information theory, models with greater complexity lead to more certain risk estimates. This may only be true if there is some degree of certainty in the assumptions used by the model. Uncertainties associated with the model need to be evaluated (NRC, 2009). These methods were discussed in Bogen and Spear (1987), Cox and Baybutt (1981), Rish and Marnicio (1988), and U.S. EPA (1985). Seiler (1987) discussed the analysis of error propagation with respect to general mathematical formulations typically found in risk assessment, such as linear combinations, powers of one variable, and multiplicative normally distributed variables. Even for large and uncertain errors, the formulations in Seiler (1987) are demonstrated to have practical value. Iman and Helton (1988) compared three methodologies for uncertainty and sensitivity analysis: (1) response surface analysis, (2) Latin hypercube sampling (with and without regression analysis), and (3) differential analysis. They found that Latin hypercube sampling with regression analysis had the best performance in terms of flexibility, estimate-ability, and ease of use. Saltelli (2002) and Frey (2002) offer views on the role of sensitivity analysis in risk assessment, and Frey and Patil (2002) compare methods for sensitivity analysis and recommend that two or more different sensitivity assessment methods should be used in order to obtain robust results. A Bayesian perspective on sensitivity analysis is described in Greenland (2001), who recommends that sensitivity analysis and Monte Carlo risk analysis should begin with specification of prior distributions, as in Bayesian analysis. Bayesian approaches to uncertainty analysis are described in Nayak and Kundu (2001).

Price et al. (1999) review the history of the inter-individual variability factor, as well as the relative merits of the sensitive population conceptual model versus the finite sample size model in determining the magnitude of the variability factor. They found that both models represent different sources of uncertainty and that both should be considered when developing inter-individual uncertainty factors. Uncertainties related to inter-individual and inter-species variability are treated in Hattis (1997) and Meek (2001), respectively. And Renwick (1999) demonstrates how inter-species and inter-individual uncertainty factors can be decomposed into kinetic and dynamic defaults by taking into account toxicodynamic and toxicokinetic differences. Burin and Saunders (1999) evaluate the robustness of the intra-species uncertainty factor and recommend intra-species uncertainty factoring in the range of 1-10.

Based on Monte Carlo analysis, Shlyakhter (1994) recommends inflation of estimated uncertainties by default safety factors in order to account for unsuspected uncertainties.

Jayjock (1997) defines uncertainty as either natural variability or lack of knowledge and also provides a demonstration of uncertainty and sensitivity analysis utilizing computer simulation. Additional approaches for coping with uncertainties in exposure modeling and monitoring are addressed by Nicas and Jayjock (2002).

Distributional risk assessment should be employed when data are available that support its use. Fayerweather et al. (1999) describe distributional risk assessment, as well as its strengths and weaknesses. Exposure metrics for distributional risk assessment using log-normal distributions of time spent showering (Burmaster, 1998a), water intake (Burmaster, 1998b), and body weight (Burmaster and Crouch, 1997; Burmaster, 1998c) have been developed. The lognormal distribution provides a succinct mathematical form that facilitates exposure and risk analyses. The fitted lognormal distribution is an approximation that should be carefully evaluated. One approach is to compare the lognormal distribution with other distributions (e.g., Weibull, Gamma). This is the approach used by Jacobs et al. (1998) and U.S. EPA (2002) in developing estimates of fish consumption and U.S. EPA (2004) and Kahn and Stralka (2008a) for estimates of water ingestion. These estimates were derived from the Continuing Survey of Food Intake by Individuals (CSFII), which was a Nationwide statistical survey of the population of the United States conducted by the U.S. Department of Agriculture. The CSFII collected extensive information on food and beverage intake from a sample that represented the population of the United States, and the sample weights provided with the data supported the estimation of empirical distributions of intakes for the entire population and various target populations such as intake distributions by various age categories. Kahn and Stralka (2008b) used the CSFII data to estimate empirical distributions of water ingestion by pregnant and lactating women and compared the results to those presented by Burmaster (1998b). The comparison highlights the differences between the older data used by Burmaster and the CSFII and the differences between fitted approximate lognormal distributions and empirical distributions. The CSFII also collected data on body weight self-reported by respondents that supported the estimation of body-weight distributions by age categories, which are presented in Kahn and Stralka (2008a). Detailed summary tables of results based on the CSFII data used by Kahn and Stralka (2008a) are presented in Kahn (2008) personal communication (Kahn, 2008).

When sensitivity analysis or uncertainty propagation analysis indicates that a parameter profoundly influences exposure estimates, the assessor should, if possible, develop a probabilistic description of its range. It is also possible to use estimates derived from a large-scale survey such as the CSFII as a basis for alternative parameter values that may be used in a sensitivity analysis. The CSFII provides the basis for an objective point of reference for food and beverage intake variables, which are critical components of many risk and exposure assessments. For example, an assumed value for a mean or upper percentile could be compared to a suitable value from the CSFII to assess sensitivity. Deterministic and probabilistic approaches to risk assessment are reviewed for non-carcinogenic health effects in Karlbelah et al. (2003), with attention to quantifying sources of uncertainty. Kelly and Campbell (2000) review guidance for conducting Monte Carlo analysis and clarify the distinction between variability and uncertainty. This distinction is represented by two-stage Monte Carlo simulation, where a probability distribution represents variability in a population, while a separate distribution for uncertainty defines the degree of variation in the parameters of the population variability distribution. Another example of two-stage Monte Carlo simulation is given in Xue et al. (2006). Price et al. (1997) utilize a Monte Carlo approach to characterize uncertainties for a method aimed at estimating the probability of adverse, non-cancer health effects for exposures exceeding the reference dose. Their method relies on general toxicologic information for a compound, such as the no-observed-adverse-effect-level dose (NOAEL). Semple et al. (2003) examine uncertainty arising in reconstructed exposure estimates using Monte Carlo methods. Uncertainty in PBPK models is discussed in Simon (1997) and Bois (2010). Slob and Pieters (1998) propose replacing uncertainty factors with probabilistic uncertainty distributions and discuss how uncertainties may be quantified for animal NOAELs and extrapolation factors. Zheng and Frey (2005) demonstrate the use of Monte Carlo methods for characterizing uncertainty and emphasize that uncertainty estimates will be biased if contributions from sampling error and measurement error are not accounted for separately.

Distributional biometric data for probabilistic risk assessment are available for some exposure factors. Empirical distributions are provided in this handbook when available. If the data are unavailable or otherwise inadequate, expert judgment can be used to generate a subjective probabilistic representation. Such judgments should be developed in a consistent, well-documented manner. Morgan and Henrion (1990) and Rish (1988) describe techniques to solicit expert judgment, while Weiss (2001) demonstrates use of a Web-based survey.

Standard statistical methods may be less cumbersome than a probabilistic approach and may be preferred, if there are enough data to justify their use and they are sufficient to support the environmental decision needed. Epidemiologic analyses may, for example, be used to estimate variability in human populations, as in Peretz et al. (1997), who describe variation in exposure time. Sources of variation and uncertainty may also be explored and quantified using a linear regression modeling framework, as in Robinson and Hurst (1997). A general framework for statistical assessment of uncertainty and variance is given for additive and multiplicative models in Rai et al. (1996) and Rai and Krewski (1998), respectively. Wallace and Williams (2005) describe a robust method for estimating long-term exposures based on short-term measurements.

In addition to the use of defaults and quantitative analysis, exposure and risk assessors often rely on expert judgment when information is insufficient to establish uncertainty bounds (NRC, 2009). There are, however, some biases introduced during expert elicitation. Some of these include availability, anchoring and adjustment, representativeness, disqualification, belief in “law of small numbers,” and overconfidence (NRC, 2009). Availability refers to the tendency to assign greater probability to commonly encountered or frequently mentioned events (NRC, 2009). Anchoring and adjustment is the tendency to be over-influenced by the first information seen or provided (NRC, 2009). Representativeness is the tendency to judge an event by reference to another (NRC, 2009). Disqualification is the tendency to ignore data or evidence that contradicts strongly held convictions (NRC, 2009). The belief in the “law of small numbers” is to believe that small samples from a population are more representative than is justified (NRC, 2009). Overconfidence is the tendency of experts to belief that their answers are correct (NRC, 2009).

2.8. PRESENTING RESULTS OF VARIABILITY AND UNCERTAINTY ANALYSES

The risk assessor is advised to distinguish between variability of exposure and associated uncertainties. A risk assessment should include three components involving elements of variability and uncertainty: (1) the estimated risk itself (X), (2) the level of confidence (Y) that the risk is no higher than X, and (3) the percent of the population (Z) that X is intended to apply to in a variable population (NRC, 1994). This information will provide risk managers with a better understanding of how exposures are distributed over the population and of the certainty of the exposure assessment.

Sometimes analyzing all exposure scenarios is unfeasible. At minimum, the assessor should describe the rationale for excluding reasonable exposure scenarios; characterize the uncertainty in these decisions as high, medium, or low; and state whether they were based on data, analogy, or professional judgment. Where uncertainty is high, a sensitivity analysis can be used to estimate upper limits on exposure by way of a series of "what if" questions.

Although assessors have historically used descriptors (e.g., high-end, worst case, average) to communicate risk variability, the 1992 *Guidelines for Exposure Assessment* (U.S. EPA, 1992) established quantitative definitions for these risk descriptors. The data presented in this handbook are one of the tools available to exposure assessors to construct the various risk descriptors. A thorough risk assessment should include particular assumptions about human behavior and biology that are a result of variability. A useful example is given in NRC (1994):

> "…a poor risk characterization for a hazardous air pollutant might say 'The risk number R is a plausible upper bound.'" A better characterization would say, "The risk number R applies to a person of reasonably high-end behavior living at the fenceline 8 hours a day for 35 years."

In addition to presenting variability in exposure, frequently, exposure assessments include an uncertainty analysis. An exposure assessment will include assumptions about the contaminant, contaminant exposure routes and pathways, location, time, population characteristics, and susceptibilities. Each of these assumptions may be associated with uncertainties. Uncertainties may be presented using a variety of techniques, depending on the requirements of the assessment, the amount of data available, and the audience. Simple techniques include risk designations, i.e., high, medium, or low (un)certainties. Sophisticated techniques may include quantitative descriptions of the uncertainty analysis or graphical representations.

The exposure assessor may need to make many decisions regarding the use of existing information in constructing scenarios and setting up the exposure equations. In presenting the scenario results, the assessor should strive for a balanced and impartial treatment of the evidence bearing on the conclusions with the key assumptions highlighted. For these key assumptions, one should cite data sources and explain any adjustments of the data.

The exposure assessor should describe the rationale for any conceptual or mathematical models. This discussion should address their verification and validation status, how well they represent the situation being assessed (e.g., average versus high-end estimates), and any plausible alternatives in terms of their acceptance by the scientific community.

To the extent possible, this handbook provides information that can be used in a risk assessment to characterize variability, and to some extent, uncertainty. In general, variability is addressed by providing probability distributions, where available, or qualitative discussions of the data sets used. Uncertainty is addressed by applying confidence ratings to the recommendations provided for the various factors, along with detailed discussions of any limitations of the data presented.

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3. INGESTION OF WATER AND OTHER SELECT LIQUIDS

3.1. INTRODUCTION

Water ingestion is another pathway of exposure to environmental chemicals. Contamination of water may occur at the water supply source (ground water or surface water); during treatment (for example, toxic by-products may be formed during chlorination); or post-treatment (such as leaching of lead or other materials from plumbing systems). People may be exposed to contaminants in water when consuming water directly as a beverage, indirectly from foods and drinks made with water, or incidentally while swimming. Estimating the magnitude of the potential dose of toxics from water ingestion requires information on the quantity of water consumed. The purpose of this section is to describe key and relevant published studies that provide information on water ingestion for various populations and to provide recommended ingestion rate values for use in exposure assessments. The studies described in this section provide information on ingestion of water consumed as a beverage, ingestion of other select liquids, and ingestion of water while swimming. Historically, the U.S. Environmental Protection Agency (EPA) has assumed a drinking water ingestion rate of 2 L/day for adults and 1 L/day for infants and children under 10 years of age (U.S. EPA, 2000). This rate includes water consumed in the form of juices and other beverages containing tap water. The National Research Council (NRC, 1977) estimated that daily consumption of water may vary with levels of physical activity and fluctuations in temperature and humidity. It is reasonable to assume that people engaging in physically-demanding activities or living in warmer regions may have higher levels of water ingestion. However, there is limited information on the effects of activity level and climatic conditions on water ingestion.

The U.S. EPA selected the analysis by Kahn and Stralka (2008a) and Kahn (2008) of the (USDA's) 1994–1996, 1998 Continuing Survey of Food Intake by Individuals (CSFII) as a key study of drinking water ingestion for the general population of children <3 years of age. U.S. EPA's 2010 analysis of 2003-2006 data from the National Health and Nutrition Examination Survey (NHANES) was selected as a key study of drinking water ingestion for the general population of individuals ≥3 years of age. Although NHANES 2003–2006 contains the most up-to-date information on water intake rates, estimates for children <3 years of age obtained from the NHANES survey are less reliable due to sample size limitations. Kahn and Stralka (2008b) was selected as a key study of drinking water ingestion for pregnant and lactating women. Kahn and Stralka (2008b) used data from U.S. Department of Agriculture's (USDA's) 1994–1996, 1998 Continuing Survey of Food Intake by Individuals (CSFII). The 2010 U.S. EPA analysis of NHANES data and the analyses by Kahn (2008) and Kahn and Stralka (2008a, b) generated ingestion rates for direct and indirect ingestion of water. *Direct ingestion* is defined as direct consumption of water as a beverage, while *indirect ingestion* includes water added during food preparation but not water intrinsic to purchased foods (i.e., water that is naturally contained in foods) (Kahn and Stralka, 2008a, b). Data for consumption of water from various sources (i.e., the community water supply, bottled water, and other sources) are also presented. It is noted that the type of water people are drinking has changed in the last decade, as evidenced by the increase in bottled water consumption. However, the majority of the U.S. population consumes water from public (i.e., community) water distribution systems; about 15% of the U.S. population obtains their water from private (i.e., household) wells, cisterns, or springs (U.S. EPA, 2002). Regardless of the source of the water, the physiological need for water should be the same among populations using community or private water systems. For the purposes of exposure assessments involving site-specific contaminated drinking water, ingestion rates based on the community supply are most appropriate. Given the assumption that bottled water, and purchased foods and beverages that contain water are widely distributed and less likely to contain source-specific water, the use of total water ingestion rates may overestimate the potential exposure to toxic substances present only in local water supplies; therefore, tap water ingestion of community water, rather than total water ingestion, is emphasized in this section.

The key studies on water ingestion for the general population (CSFII and NHANES) and the population of pregnant/lactating women (CSFII) are both based on short-term survey data (2 days). Although short-term data may be suitable for obtaining mean or median ingestion values that are representative of both short- and long-term ingestion distributions, upper- and lower-percentile values may be different for short-term and long-term data. It should also be noted that most currently available water ingestion surveys are based on respondent recall. This may be a source of uncertainty in the estimated ingestion rates because of the subjective nature of this type of survey technique. Percentile distributions for water ingestion are presented in this handbook, where sufficient data are available. Data are not provided for the location of water consumption (i.e., home, school, daycare center, etc.).

Limited information was available regarding incidental ingestion of water while swimming. A recent pilot study (Dufour et al., 2006) has provided some quantitative experimental data on water ingestion among swimmers. These data are provided in this chapter.

Section 3.2 provides the recommendations and confidence ratings for water ingestion among the general population and pregnant and lactating women, and among swimmers. Section 3.3.1 provides the key studies for general water ingestion rates, Section 3.4.1 provides ingestion rates for pregnant and lactating women, and Section 3.6.1 provides ingestion rates for swimming. For water ingestion at high activity levels or hot climates, no recommendations are provided, but Section 3.5 includes relevant studies. Relevant studies on all subcategories of water ingestion are also presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of water and select liquids.

3.2. RECOMMENDATIONS

3.2.1. Water Ingestion from Consumption of Water as a Beverage and from Food and Drink

The recommended water ingestion from the consumption of water as a beverage and from foods and drinks are based on Kahn and Stralka (2008a) and Kahn (2008) for children <3 years of age and on U.S. EPA's 2010 analysis of NHANES data from 2003–2006 for individuals ≥3 years of age. Table 3-1 presents a summary of the recommended values for direct and indirect ingestion of community water. Per capita mean and 95th percentile values range from 184 mL/day to 1,046 mL/day and 837 mL/day to 2,958 mL/day, respectively, depending on the age group. Consumer-only mean and 95th percentile values range from 308 mL/day to 1,288 mL/day and 858 mL/day to 3,092 mL/day, respectively, depending on the age group. Per capita intake rates represent intake that has been averaged over the entire population (including those individuals that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessments for which average daily dose estimates are of interest because they represent both individuals who drank water during the survey period and individuals who may drink water at some time but did not consume it during the survey period. Consumer-only intake rates represent the quantity of water consumed only by individuals who reported water intake during the survey period. Table 3-2 presents a characterization of the overall confidence in the accuracy and appropriateness of the recommendations for drinking water intake.

3.2.2. Pregnant and Lactating Women

Based upon the results of Kahn and Stralka (2008b), per capita mean and 95th percentile values for ingestion of drinking water among pregnant women were 819 mL/day and 2,503 mL/day, respectively. The per capita mean and 95th percentile values for lactating women were 1,379 mL/day and 3,434 mL/day, respectively. Table 3-3 presents a summary of the recommended values for water ingestion rates. Table 3-4 presents the confidence ratings for these recommendations.

3.2.3. Water Ingestion While Swimming or Diving

Based on the results of the Dufour et al. (2006) study, mean water ingestion rates of 49 mL/hour for children under 18 years of age and 21 mL/hour for adults are recommended for exposure scenarios involving swimming activities. Although these estimates were derived from swimming pool experiments, Dufour et al. (2006) noted that swimming behavior of recreational pool swimmers may be similar to freshwater swimmers. Estimates may be different for salt water swimmers and competitive swimmers. The recommended upper percentile water ingestion rate for swimming activities among children is based on the 97th percentile value of 120 mL/hour (90 mL/0.75 hour) from Dufour et al. (2006). Because the data set for adults is limited, the maximum value observed in the Dufour et al. (2006) study is used as an upper percentile value for adults: 71 mL/hour (53 mL/0.75 hour). Table 3-5 presents a summary of the recommended values for water ingestion rates. Table 3-6 presents the confidence ratings for these recommendations. Data on the amount of time spent swimming can be found in Chapter 16 (see Table 16-1) of this handbook.

Table 3-1. Recommended Values for Drinking Water Ingestion Rates[a]

Age Group	Mean		95th Percentile		Multiple Percentiles
	mL/day	mL/kg-day	mL/day	mL/kg-day	
Per Capita[b]					
Birth to <1 month[c]	184	52	839[d]	232[d]	See Tables 3-7 and 3-11 for children <3 years old and Tables 3-23 and 3-28 for individuals >3 years old.
1 to <3 months[c]	227	48	896[d]	205[d]	
3 to <6 months[c]	362	52	1,056	159	
6 to <12 months[c]	360	41	1,055	126	
1 to <2 years[c]	271	23	837	71	
2 to <3 years[c]	317	23	877	60	
3 to <6 years	327	18	959	51	
6 to <11 years	414	14	1,316	43	
11 to <16 years	520	10	1,821	32	
16 to <18 years	573	9	1,783	28	
18 to <21 years	681	9	2,368	35	
≥21 years	1,043	13	2,958	40	
>65 years	1,046	14	2,730	40	
All ages[e]	869	14	2,717	42	
Consumers-Only[f]					
Birth to <1 month[c]	470[d]	137[d]	858[d]	238[d]	See Tables 3-15 and 3-19 for children <3 years old and Tables 3-33 and 3-38 for individuals >3 years old.
1 to <3 months[c]	552	119	1,053[d]	285[d]	
3 to <6 months[c]	556	80	1,171[d]	173[d]	
6 to <12 months[c]	467	53	1,147	129	
1 to <2 years[c]	308	27	893	75	
2 to <3 years[c]	356	26	912	62	
3 to <6 years	382	21	999	52	
6 to <11 years	511	17	1,404	47	
11 to <16 years	637	12	1,976	35	
16 to <18 years	702	10	1,883	30	
18 to <21 years	816	11	2,818	36	
≥21 years	1,227	16	3,092	42	
>65 years	1,288	18	2,960	43	
All ages[e]	1,033	16	2,881	44	

a Ingestion rates for combined direct and indirect water from community water supply.
b Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those individuals that reported no intake).
c Based on Kahn and Stralka (2008a) and Kahn (2008).
d Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
e Based on U.S. EPA analysis of NHANES 2003–2006 data.
f Consumer-only intake represents the quantity of water consumed only by individuals that reported consuming water during the survey period.

Source: Kahn and Stralka (2008a); Kahn (2008); U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-2. Confidence in Recommendations for Drinking Water Ingestion Rates		
General Assessment Factors	**Rationale**	**Rating**
Soundness		Medium to High
Adequacy of Approach	The survey methodology and data analysis were adequate. The surveys sampled approximately 20,000 individuals (CSFII) and 18,000 (NHANES) individuals; sample size varied with age.	
Minimal (or defined) Bias	No physical measurements were taken. The method relied on recent recall of standardized volumes of drinking water containers.	
Applicability and Utility		High
Exposure Factor of Interest	The key studies were directly relevant to water ingestion.	
Representativeness	The data were demographically representative (based on stratified random sample). Sample sizes for some age groups were limited.	
Currency	Data were collected between 1994 and 1998 for CSFII and between 2003 and 2006 for NHANES.	
Data Collection Period	Data were collected for 2 non-consecutive days. However, long-term variability may be small. Use of a short-term average as a chronic ingestion measure can be assumed.	
Clarity and Completeness		High
Accessibility	The CSFII and NHANES data are publicly available.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	CSFII and NHANES data collection follow strict QA/QC procedures. Quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		High
Variability in Population	Full distributions were developed.	
Uncertainty	Except for data collection based on recall, sources of uncertainty were minimal.	
Evaluation and Review		Medium
Peer Review	The CSFII and NHANES surveys received a high level of peer review. The CSFII data were published in the peer-reviewed literature. The U.S. EPA analysis of NHANES has not been peer-reviewed outside the Agency.	
Number and Agreement of Studies	There were two key studies for drinking water ingestion among the general population.	
Overall Rating		**Medium to High**, **Low** for footnote "d" on Table 3-1

Table 3-3. Recommended Values for Water Ingestion Rates of Community Water for Pregnant and Lactating Women[a]

Per Capita[b]				
Group	Mean		95th Percentile	
	mL/day	mL/kg-day	mL/day	mL/kg-day
Pregnant women	819[c]	13[c]	2,503[c]	43[c]
Lactating women	1,379[c]	21[c]	3,434[c]	55[c]
Consumers-Only[d]				
Group	Mean		95th Percentile	
	mL/day	mL/kg-day	mL/day	mL/kg-day
Pregnant women	872[c]	14[c]	2,589[c]	43[c]
Lactating women	1,665[c]	26[c]	3,588[c]	55[c]

[a] Ingestion rates for combined direct and indirect water from community water supply.

[b] Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those individuals that reported no intake).

[c] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

[d] Consumer-only intake represents the quantity of water consumed only by individuals that reported consuming water during the survey period.

Source: Kahn and Stralka, 2008b.

Table 3-4. Confidence in Recommendations for Water Ingestion for Pregnant/Lactating Women

General Assessment Factors	Rationale	Rating
Soundness		Low
Adequacy of Approach	The survey methodology and data analysis were adequate. The sample size was small, approximately 99 pregnant and lactating women.	
Minimal (or defined) Bias	No physical measurements were taken. The method relied on recent recall of standardized volumes of drinking water containers.	
Applicability and Utility		Low to Medium
Exposure Factor of Interest	The key study was directly relevant to water ingestion.	
Representativeness	The data were demographically representative (based on stratified random sample).	
Currency	Data were collected between 1994 and 1998.	
Data Collection Period	Data were collected for 2 non-consecutive days. However, long-term variability may be small. Use of a short-term average as a chronic ingestion measure can be assumed.	
Clarity and Completeness		Medium
Accessibility	The CSFII data are publicly available. The Kahn and Stralka (2008b) analysis of the CSFII 1994–1996, 1998 data was published in a peer-reviewed journal.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of the CSFII data was good; quality control of the secondary data analysis was not well described.	
Variability and Uncertainty		Low
Variability in Population	Full distributions were given in a separate document (Kahn, 2008).	
Uncertainty	Except for data collection based on recall, sources of uncertainty were minimal.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received a high level of peer review. The Kahn and Stralka (2008b) study was published in a peer-reviewed journal.	
Number and Agreement of Studies	There was one key study for pregnant/lactating women water ingestion.	
Overall Rating		**Low**

Table 3-5. Recommended Values for Water Ingestion While Swimming

Age Group	Mean		Upper Percentile	
	mL/event[a]	mL/hour	mL/event[a]	mL/hour
Children	37	49	90[b]	120[b]
Adults	16	21	53[c]	71[c]

[a] Participants swam for 45 minutes.
[b] 97^{th} percentile.
[c] Based on maximum value.

Source: Dufour et al., 2006.

Table 3-6. Confidence in Recommendations for Water Ingestion While Swimming		
General Assessment Factors	**Rationale**	**Rating**
Soundness		Medium
Adequacy of Approach	The approach appears to be appropriate given that cyanuric acid (a tracer used in treated pool water) is not metabolized, but the sample size was small (41 children and 12 adults). The Dufour et al. (2006) study analyzed primary data on water ingestion during swimming.	
Minimal (or defined) Bias	Data were collected over a period of 45 minutes; this may not accurately reflect the time spent by a recreational swimmer.	
Applicability and Utility		Low to Medium
Exposure Factor of Interest	The key study was directly relevant to water ingestion while swimming.	
Representativeness	The sample was not representative of the U.S. population. Data cannot be divided into by age categories.	
Currency	It appears that the study was conducted in 2005.	
Data Collection Period	Data were collected over a period of 45 minutes.	
Clarity and Completeness		Medium
Accessibility	The Dufour et al. (2006) study was published in a peer-reviewed journal.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance methods were not described in the study.	
Variability and Uncertainty		Low
Variability in Population	Full distributions were not available. Data were not broken out by age groups.	
Uncertainty	There were multiple sources of uncertainty (e.g., sample population may not reflect swimming practices for all swimmers, rates based on swimming duration of 45 minutes, differences by age group not defined).	
Evaluation and Review		Medium
Peer Review	Dufour et al. (2006) was published in a peer-reviewed journal.	
Number and Agreement of Studies	There was one key study for ingestion of water when swimming.	
Overall Rating		**Low**

3.3. DRINKING WATER INGESTION STUDIES

3.3.1. Key Drinking Water Ingestion Study

3.3.1.1. *Kahn and Stralka (2008a)—Estimated Daily Average Per Capita Water Ingestion by Child and Adult Age Categories Based on USDA's 1994–1996 and 1998 Continuing Survey of Food Intakes by Individuals and Supplemental Data, Kahn (2008)*

Kahn and Stralka (2008a) analyzed the combined 1994–1996 and 1998 CSFII data sets to examine water ingestion rates of more than 20,000 individuals surveyed, including approximately 10,000 under age 21 and 9,000 under age 11. USDA surveyed households in the United States and District of Columbia and collected food and beverage recall data as part of the CSFII (USDA, 1998). Data were collected by an in-home interviewer. The Day 2 interview was conducted 3 to 10 days later and on a different day of the week. Each individual in the survey was assigned a sample weight based on his or her demographic data. These weights were taken into account when calculating mean and percentile water ingestion rates from various sources. Kahn and Stralka (2008a) derived mean and percentile estimates of daily average water ingestion for the following age categories: <1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, 1 to <2 years of age, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, 16 to <18 years, 18 to <21 years of age, 21 years and older, 65 years and older, and all ages. The increased sample size for children younger than 11 years of age (from 4,339 in the initial 1994–1996 survey to 9,643 children in the combined 1994–1996, 1998 survey) enabled water ingestion estimates to be categorized into the finer age categories recommended by U.S. EPA (2005). Consumer-only and per capita water ingestion estimates were reported in the Kahn and Stralka (2008a) study for two water source categories: all sources and community water. "All sources" included water from all supply sources such as community water supply (i.e., tap water), bottled water, other sources, and missing sources. "Community water" included tap water from a community or municipal water supply. Other sources included wells, springs, and cisterns; missing sources represented water sources that the survey respondent was unable to identify. The water ingestion estimates included both water ingested directly as a beverage (direct water) and water added to foods and beverages during final preparation at home or by local food service establishments such as school cafeterias and restaurants (indirect water). Commercial water added by a manufacturer (i.e., water contained in soda or beer) and intrinsic water in foods and liquids (i.e., milk and natural undiluted juice) were not included in the estimates. Kahn and Stralka (2008a) only reported the mean and 90th and 95th percentile estimates of per capita and consumers-only ingestion. The full distributions of ingestion estimates were provided by the author (Kahn, 2008). Tables 3-7 to 3-22 presents full distributions for the various water source categories (community water, bottled water, other sources, and all sources). Tables 3-7 to 3-10 provide per capita ingestion estimates of total water (combined direct and indirect water) in mL/day for the various water source categories (i.e., community, bottled, other, and all sources). Tables 3-11 to 3-14 present the same information as Tables 3-7 to 3-10 but in units of mL/kg-day. Tables 3-15 to 3-18 provide consumers-only combined direct and indirect water ingestion estimates in mL/day for the various source categories. Tables 3-19 to 3-22 present the same information as Tables 3-15 to 3-18 but in units of mL/kg-day. Estimates that do not meet the minimum sample size requirements as described in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993) are flagged in the tables.

The CSFII 1994–1996, 1998 data have both strengths and limitations with regard to estimating water ingestion. These are discussed in detail in U.S. EPA (2004) and Kahn and Stralka (2008a). The principal advantages of this survey are that (1) it was designed to be representative of the United States population, including children and low income groups, (2) sample weights were provided that facilitated proper analysis of the data and accounted for non-response; and (3) the number of individuals sampled (more than 20,000) is sufficient to allow categorization within narrowly defined age categories. One limitation of this survey is that data were collected for only 2 days. As discussed in Section 3.3.1.2 with regard to U.S. EPA's analysis of NHANES data, short-term data may not accurately reflect long-term intake patterns, especially at the extremes (i.e., tails) of the distribution of water intake. This study is considered key because the sample size for children less than 3 years of age are larger than in the most up-to-date information from NHANES 2003–2006 (see Section 3.3.1.2). Therefore, recommendations for these age groups are based on this analysis.

3.3.1.2. *U.S. EPA Analysis of NHANES 2003–2006 Data*

In 2010, U.S. EPA analyzed the combined 2003-2004 and 2005–2006 NHANES data sets to examine water ingestion rates for the general population. The 2003–2006 data set included information on more than 18,000 individuals surveyed, including approximately 10,000 under age 21 and 5,000 under age 11. The U.S. Centers for Disease Control and Prevention surveyed households across the United States and collected food and beverage recall data as part of the NHANES. The first dietary recall interview was conducted in-person in a Mobile Examination Center, and the second was collected by telephone 3 to 10 days later on a different day of the week. Each individual in the survey was assigned a sample weight based on his or her demographic data. These weights were taken into account when calculating mean and percentile water ingestion rates from various sources.

In 2010, U.S. EPA, Office of Pesticide Programs used NHANES 2003–2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the USDA's CSFII (USDA, 2000; U.S. EPA, 2000). In FCID, NHANES data on the foods people reported eating were converted to the quantities of agricultural commodities eaten, including water that was added in the preparation of foods and beverages. FCID was used in the U.S. EPA analysis to derive estimates of water that was ingested from the consumption of foods and beverages.

U.S. EPA derived mean and percentile estimates of daily average water ingestion for the following age categories: Birth to <1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, 1 to <2 years of age, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, 16 to <18 years, and 18 to <21 years of age, 21 years and older, 65 years and older, and all ages.

Consumer-only and per capita water ingestion estimates were generated for four water source categories: community water, bottled water, other sources, and all sources. Consumer-only intake represents the quantity of water consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who reported consumption of water. Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those individuals that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessments for which average dose estimates are of interest because they represent both individuals who drank water during the survey period and individuals who may drink water at some time but did not consume it during the survey period. "All sources" included water from all supply sources such as community water supply (i.e., tap water), bottled water, other sources, and missing/unknown sources. "Community water" included tap water from a community or municipal water supply. "Other sources" included wells, springs, cisterns, other non-specified sources, and missing/unknown sources that the survey respondent was unable to identify. The water ingestion estimates included both water ingested directly as a beverage (direct water) and water added to foods and beverages during final preparation at home or by local food service establishments such as school cafeterias and restaurants (indirect water). Commercial water added by a manufacturer (i.e., water contained in soda or beer) and intrinsic water in foods and liquids (i.e., milk and natural undiluted juice) were not included in the estimates. NHANES water consumption respondent data were averaged over both days of dietary data when they were available; otherwise, 1-day data were used. Intake rate distributions were provided in units of mL/day and mL/kg-day. The body weights of survey participants were used in developing intake rate estimates in units of mL/kg-day.

Tables 3-23 to 3-42 present full distributions for the various water source categories (community water, bottled water, other sources, and all sources). Tables 3-23 to 3-26 provide per capita ingestion estimates of total water (combined direct and indirect water) in mL/day for the various water source categories (i.e., community, bottled, other, and all sources). Table 3-27 presents the 90% confidence intervals (CIs) around the estimated means and the 90% bootstrap intervals (BIs) around the 90^{th} and 95^{th} percentiles of total water ingestion from all water sources. Tables 3-28 to 3-32 present the same information as Tables 3-23 to 3-27 but in units of mL/kg-day. Tables 3-33 to 3-36 provide consumers-only combined direct and indirect water ingestion estimates in mL/day for the various source categories. Table 3-37 presents confidence and bootstrap intervals for total water ingestion estimates by consumers-only from all sources. Tables 3-38 to 3-42 present the same information as Tables 3-33 to 3-37 but in units of mL/kg-day. Estimates that do not meet the minimum sample size as described in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993), are flagged in the tables. The design effect used to determine the minimum required sample size was domain specific (i.e., calculated separately for various age groups). The data show that the total quantity of water ingested from all sources per unit mass of body weight was at a maximum in the first half year of life and decreased with increasing age. When indexed to body weight, the per capita ingestion rate of water from all sources combined for children under 6 months of age was approximately 2.5 times higher than that of adults ≥21 years (see Table 3-31), and consumers younger than 6 months of age ingested approximately 3.5 times the amount of water (all sources combined) as adults (see Table 3-41). The pattern of decreasing water ingestion per unit of body weight was also observed in consumers-only estimates of community water (see Table 3-38), and other sources (see Table 3-40). However, this trend was not observed in per capita estimates of community water, bottled water, and other sources due to the lack of available responses under these age and water source categories.

It should be noted that per capita estimates of water intake from all sources using the NHANES 2003–2006 data are higher than estimates derived previously from CSFII 1994–1996, 1998 for adults (see Section 3.3.1.1). Among adults, total per-capita water consumption increased by 234 mL, or 16%. Per-capita bottled water consumption among adults nearly doubled, from 189 to 375 mL/day. Among infants, there appear to be erratic changes in water consumption patterns. In particular, ingestion rate estimates of bottled water for children <12 months old are considerably less when compared to values obtained from CSFII. This is due to the fact that NHANES does not allow for the allocation of any bottled water consumed indirectly in the preparation of foods and beverages. This may have an impact on the bottled water consumption for infants whose formula is prepared with bottled water. Among older children and adolescents, overall water consumption increased by 0% to 10%, and bottled water consumption increased 25% to 211%. Almost none of the NHANES—CSFII differences are statistically significant, except for all adults and all respondents, which have very large sample sizes.

The advantages of U.S. EPA's analysis of the 2003–2006 NHANES surveys are (1) that the surveys were designed to obtain statistically valid sample of the civilian non-institutionalized U.S. population (i.e., the sampling frame was organized using 2000 U.S. population census estimates); (2) NHANES oversampled low income persons, adolescents 12-19 years, persons 60 years and older, Blacks, and Mexican Americans; (3) several sets of sampling weights were available for use with the intake data to facilitate proper analysis of the data; (4) the sample size was sufficient to allow categorization within narrowly defined age categories, and the large sample provided useful information on the overall distribution of ingestion by the population and should adequately reflect the range among respondent variability; (5) the survey was conducted over 2 non-consecutive days, which improved the variance over consecutive days of consumption; and (6) the most current data set was used. One limitation of the data is that the data were collected over only 2 days and do not necessarily represent "usual" intake. "Usual dietary intake" refers to the long-term average of daily intakes by an individual. Thus, water ingestion estimates based on short-term data may differ from long-term rates, especially at the tails of the distribution. There are, however, several limitations associated with these data. Water intake estimates for children under 3 years of age are less statistically reliable due to sample size. In addition, NHANES does not allow for the allocation of indirect water intake in the estimation of bottled water consumption. Another limitation of these data is that the survey design, while being well-tailored for the overall population of the United States and conducted throughout the year to account for seasonal variation, is of limited utility for assessing small and potentially at-risk populations based on ethnicity, medical status, geography/climate, or other factors such as activity level.

3.3.2. Relevant Drinking Water Ingestion Studies

3.3.2.1. *Wolf (1958)—Body Water Content*

Wolf (1958) provided information on the water content of human bodies. Wolf (1958) stated that a newborn baby is about 77% water while an adult male is about 60% water by weight. An adult male gains and loses about 2,750 mL of water each day. Water intake in dissimilar mammals varies according to 0.88 power of body weight.

3.3.2.2. *National Research Council (1977)—Drinking Water and Health*

NRC (1977) calculated the average per capita water (liquid) consumption per day to be 1.63 L. This figure was based on a survey of the following literature sources: Evans (1941); Bourne and Kidder (1953); Walker et al. (1957); Wolf (1958); Guyton (1968); McNall and Schlegel (1968); Randall (1973); NRC (1974); and Pike and Brown (1975), as cited in NRC (1977). Although the calculated average intake rate was 1.63 L/day, NRC (1977) adopted a larger rate (2 L/day) to represent the intake of the majority of water consumers. This value is relatively consistent with the total tap water intakes rate estimated from the key study presented previously. However, the use of the term "liquid" was not clearly defined in this study, and it is not known whether the populations surveyed are representative of the adult U.S. population. Consequently, the results of this study are of limited use in recommending total tap water intake rates, and this study is not considered a key study.

3.3.2.3. *Hopkins and Ellis (1980)—Drinking Water Consumption in Great Britain*

A study conducted in Great Britain over a 6-week period during September and October 1978, estimated the drinking water consumption rates of 3,564 individuals from 1,320 households in England, Scotland, and Wales (Hopkins and Ellis, 1980). The participants were selected randomly and were asked to complete a questionnaire and a diary indicating the type and quantity of beverages consumed over a 1-week period. Total liquid intake included total tap water taken at home and away from home; purchased alcoholic beverages; and non-tap water-based drinks. Total tap water included water content of tea, coffee, and other hot water drinks; homemade alcoholic beverages; and tap water consumed directly as a beverage. Table 3-43 presents the assumed tap water contents for these beverages. Based on responses from 3,564 participants, the mean intake rates and frequency distribution data for various beverage categories were estimated by Hopkins and Ellis (1980). Table 3-44 lists these data. The mean per capita total liquid intake rate for all individuals surveyed was 1.59 L/day, and the mean per capita total tap water intake rate was 0.96 L/day, with a 90th percentile value of about 1.57 L/day. Liquid intake rates were also estimated for males and females in various age groups. Table 3-45 summarizes the total liquid and total tap water intake rates for 1,758 males and 1,800 females grouped into six age categories (Hopkins and Ellis, 1980). The mean and 90th percentile total tap water intake values for adults over age 18 years are, respectively, 1.07 L/day and 1.87 L/day, as determined by pooling data for males and females for the three adult age ranges in Table 3-45. This calculation assumes, as does Table 3-44 and 3-45, that the underlying distribution is normal and not lognormal.

The advantage of these data is that the responses were not generated on a recall basis but by recording daily intake in diaries. The latter approach may result in more accurate responses being generated. Diaries were maintained for 1 week, which is longer than other surveys (e.g., CSFII). The use of total liquid and total tap water was well defined in this study. Also, these data were based on the population of Great Britain and not the United States. Drinking patterns may differ among these populations as a result of varying weather conditions and socioeconomic factors. For these reasons, this study is not considered a key study in this document.

3.3.2.4. *Canadian Ministry of National Health and Welfare (1981)—Tap Water Consumption in Canada*

In a study conducted by the Canadian Ministry of National Health and Welfare, 970 individuals from 295 households were surveyed to determine the per capita total tap water intake rates for various age/sex groups during winter and summer seasons (Canadian Ministry of National Health and Welfare, 1981). Intake rate was also evaluated as a function of physical activity. The population that was surveyed matched the Canadian 1976 census with respect to the proportion in different age, regional, community size, and dwelling type groups. Participants monitored water intake for a 2-day period (1 weekday, and 1 weekend day) in both late summer of 1977 and winter of 1978. All 970 individuals participated in both the summer and winter surveys. The amount of tap water consumed was estimated based on the respondents' identification of the type and size of beverage container used, compared to standard-sized vessels. The survey questionnaires included a pictorial guide to help participants in classifying the sizes of the vessels. For example, a small glass of water was assumed to be equivalent to 4.0 ounces of water, and a large glass was assumed to contain 9.0 ounces of water. The study also accounted for water derived from ice cubes and popsicles, and water in soups, infant formula, and juices. The survey did not attempt to differentiate between tap water consumed at home and tap water consumed away from home. The survey also did not attempt to estimate intake rates for fluids other than tap water. Consequently, no intake rates for total fluids were reported.

Table 3-46 presents daily consumption distribution patterns for various age groups. For adults (over 18 years of age) only, the average total tap water intake rate was 1.38 L/day, and the 90th percentile rate was 2.41 L/day as determined by graphical interpolation. These data follow a lognormal distribution. Table 3-47 presents the intake data for males, females, and both sexes combined as a function of age and expressed in units of mL/kg body weight. The tap water survey did not include body weights of the participants, but the body-weight information was taken from a Canadian health survey dated 1981; it averaged 65.1 kg for males and 55.6 kg for females. Table 3-48 presents intake rates for specific age groups and seasons. The average daily total tap water intake rate for all ages and seasons combined was 1.34 L/day, and the 90th percentile rate was 2.36 L/day. The summer intake rates are nearly the same as the winter intake rates. The authors speculate that the reason for the small seasonal variation is that in Canada, even in the summer, the ambient temperature seldom exceeded 20°C, and marked increase in water consumption with high activity levels has been observed in other studies only when the ambient temperature has been higher than 20°C. Table 3-49 presents average daily total tap water intake rates as a function of the level of physical activity, as estimated subjectively. Table 3-50 presents the amounts of tap water consumed that are derived from various foods and beverages. Note that the consumption of direct "raw" tap water is almost constant across all age groups from school-age children through the oldest ages. The increase in total tap water consumption beyond school age is due to coffee and tea consumption.

This survey may be more representative of total tap water consumption than some other less comprehensive surveys because it included data for some tap water-containing items not covered by other studies (i.e., ice cubes, popsicles, and infant formula). One potential source of error in the study is that estimated intake rates were based on identification of standard vessel sizes; the accuracy of this type of survey data is not known. The cooler climate of Canada may have reduced the importance of large tap water intakes resulting from high activity levels, therefore making the study less applicable to the United States. The authors were not able to explain the surprisingly large variations between regional tap water intakes; the largest regional difference was between Ontario (1.18 L/day) and Quebec (1.55 L/day).

3.3.2.5. *Gillies and Paulin (1983)—Variability of Mineral Intakes from Drinking Water*

Gillies and Paulin (1983) conducted a study to evaluate variability of mineral intake from drinking water. A study population of 109 adults (75 females; 34 males) ranging in age from 16 to 80 years (mean age = 44 years) in New Zealand was asked to collect duplicate samples of water consumed directly from the tap or used in beverage preparation during a 24-hour period. Participants were asked to collect the samples on a day when all of the water consumed would be from their own home. Individuals were selected based on their willingness to participate and their ability to comprehend the collection procedures. The mean total tap water intake rate for this population was 1.25 (±0.39) L/day, and the 90th percentile rate was 1.90 L/day. The median total tap water intake rate (1.26 L/day) was very similar to the mean intake rate. The reported range was 0.26 to 2.80 L/day.

The advantage of these data is that they were generated using duplicate sampling techniques. Because this approach is more objective than recall methods, it may result in more accurate responses. However, these data are based on a short-term survey that may not be representative of long-term behavior, the population surveyed is small, and the procedures for selecting the survey population were not designed to be representative of the New Zealand population, and the results may not be applicable to the United States. For these reasons, the study is not regarded as a key study in this document.

3.3.2.6. *Pennington (1983)—Revision of the Total Diet Study Food List and Diets*

Based on data from the U.S. Food and Drug Administration's Total Diet Study, Pennington (1983) reported average intake rates for various foods and beverages for five age groups of the population. The Total Diet Study is conducted annually to monitor the nutrient and contaminant content of the U.S. food supply and to evaluate trends in consumption. Representative diets were developed based on 24-hour recall and 2-day diary data from the 1977-1978 USDA Nationwide Food Consumption Survey (NFCS) and 24-hour recall data from the Second National Health and Nutrition Examination Survey (NHANES II). The numbers of participants in NFCS and NHANES II were approximately 30,000 and 20,000, respectively. The diets were developed to "approximate 90% or more of the weight of the foods usually consumed" (Pennington, 1983). The source of water (bottled water as distinguished from tap water) was not stated in the Pennington study. For the purposes of this report, the consumption rates for the food categories defined by Pennington (1983) were used to calculate total fluid and total water intake rates for five age groups. Total water includes water, tea, coffee, soft drinks, and soups and frozen juices that are reconstituted with water. Reconstituted soups were assumed to be composed of 50% water, and juices were assumed to contain 75% water. Total fluids include total water in addition to milk, ready-to-use infant formula, milk-based soups, carbonated soft drinks, alcoholic beverages, and canned fruit juices. Table 3-51 presents these intake rates. Based on the average intake rates for total water for the two adult age groups, 1.04 and 1.26 L/day, the average adult intake rate is about 1.15 L/day. These rates should be more representative of the amount of source-specific water consumed than are total fluid intake rates. Because this study was designed to measure food intake, and it used both USDA 1978 data and NHANES II data, there was not necessarily a systematic attempt to define tap water intake per se, as distinguished from bottled water. For this reason, it is not considered a key tap water study in this document.

3.3.2.7. *U.S. EPA (1984)—An Estimation of the Daily Average Food Intake by Age and Sex for Use in Assessing the Radionuclide Intake of the General Population*

Using data collected by USDA in the 1977–1978 NFCS, U.S. EPA (1984) determined daily food and beverage intake levels by age to be used in assessing radionuclide intake through food consumption. Tap water, water-based drinks, and soups were identified subcategories of the total beverage category. Table 3-52 presents daily intake rates for tap water, water-based drinks, soup, and total beverages. As seen in Table 3-52, mean tap water intake for different adult age groups (age 20 years and older) ranged from 0.62 to 0.76 L/day, water-based drinks intake ranged from 0.34 to 0.69 L/day, soup intake ranged from 0.04 to 0.06 L/day, and mean total beverage intake levels ranged from 1.48 to 1.73 L/day. Total tap water intake rates were estimated by combining the average daily intakes of tap water, water-based drinks, and soups for each age group. For adults (ages 20 years and older), mean total tap water intake rates range from 1.04 to 1.47 L/day, and for children (ages <1 to 19 years), mean intake rates range from 0.19 to 0.90 L/day. The total tap water intake rates, derived by combining data on tap water, water-based drinks, and soup should be more representative of source-specific drinking water intake than the total beverage intake rates reported in this study. The chief limitation of the study is that the data were collected in 1978 and do not reflect the expected increase in the U.S. consumption of soft drinks and bottled water or changes in the diet within the last three decades. Since the data were collected for only a 3-day period, the extrapolation to chronic intake is uncertain. Also, these intake rates do not include reconstituted infant formula.

3.3.2.8. *Cantor et al. (1987)—Bladder Cancer, Drinking Water Source, and Tap Water Consumption*

The National Cancer Institute, in a population-based, case control study investigating the possible relationship between bladder cancer and drinking water, interviewed approximately 8,000 adult White individuals, 21 to 84 years of age (2,805 cases and 5,258 controls) in their homes, using a standardized questionnaire (Cantor et al., 1987). The cases and controls resided in one of five metropolitan areas (Atlanta, Detroit, New Orleans, San Francisco, and Seattle) and five States (Connecticut, Iowa, New Jersey, New Mexico, and Utah). The individuals interviewed were asked to recall the level of intake of tap water and other beverages in a typical week during the winter prior to the interview. Total beverage intake was divided into the following two components: (1) beverages derived from tap water; and (2) beverages from other sources. Tap water used in cooking foods and in ice cubes was apparently not considered. Participants also supplied information on the primary source of the water consumed (i.e., private well, community supply, bottled water, etc.). The control population was randomly selected from the general population and frequency matched to the bladder cancer case population in terms of age, sex, and geographic location of residence. The case population consisted of Whites only and had no people under the age of 21 years; 57% were over the age of 65 years. The fluid intake rates for the bladder cancer cases were not used because their participation in the study was based on selection factors that could bias the intake estimates for the general population. Based on responses from 5,258 White controls (3,892 males; 1,366 females), average tap water intake rates for a "typical" week were compiled by sex, age group, and geographic region. Table 3-53 lists these rates. The average total fluid intake rate was 2.01 L/day for men of which 70% (1.4 L/day) was derived from tap water, and 1.72 L/day for women of which 79% (1.35 L/day) was derived from tap water. Table 3-54 presents frequency distribution data for the 5,228 controls, for which the authors had information on both tap water consumption and cigarette smoking habits. These data follow a lognormal distribution having an average value of 1.30 L/day and an upper 90th percentile value of approximately 2.40 L/day. These values were determined by graphically interpolating the data of Table 3-54 after plotting it on log probability graph paper. These values represent the usual level of intake for this population of adults in the winter. Limitations associated with this data set are that the population surveyed was older than the general population and consisted exclusively of Whites. Also, the intake data are based on recall of behavior during the winter only. Extrapolation of the data to other seasons is difficult.

The authors presented data on person-years of residence with various types of water supply sources (municipal versus private, chlorinated versus non-chlorinated, and surface versus well water). Unfortunately, these data cannot be used to draw conclusions about the national average apportionment of surface versus groundwater since a large fraction (24%) of municipal water intake in this survey could not be specifically attributed to either ground or surface water.

3.3.2.9. *Ershow and Cantor (1989)—Total Water and Tap Water Intake in the U.S.: Population-Based Estimates of Quantities and Sources*

Ershow and Cantor (1989) estimated water intake rates based on data collected by the USDA 1977–1978 NFCS. The survey was conducted through interviews and diary entries. Daily intake rates for tap water and total water were calculated for various age groups for males, females, and both sexes combined. Tap water was defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages." Total water was defined as tap water plus "water intrinsic to foods and beverages" (i.e., water contained in purchased food and beverages). The authors showed that the age, sex, and racial distribution of the surveyed population closely matched the estimated 1977 U.S. population.

Table 3-55 presents daily total tap water intake rates, expressed as mL/day by age group. These data follow a lognormal distribution. Table 3-56 presents the same data, expressed as mL per kg body weight per day. Table 3-57 presents a summary of these tables, showing the mean, the 10^{th} and 90^{th} percentile intakes, expressed as both mL/day and mL/kg-day as a function of age. This shows that the mean and 90^{th} percentile intake rates for adults (ages 20 to 65+) are approximately 1,410 mL/day and 2,280 mL/day, and for all ages, the mean and 90^{th} percentile intake rates are 1,193 mL/day and 2,092 mL/day. Note that older adults have greater intakes than do adults between age 20 and 64, an observation bearing on the interpretation of the Cantor et al. (1987) study, which surveyed a population that was older than the national average (see Section 3.3.2.8).

Ershow and Cantor (1989) also measured total water intake for the same age groups and concluded that it averaged 2,070 mL/day for all groups combined and that tap water intake (1,190 mL/day) is 55% of the total water intake. (Table 3-58 presents the detailed intake data for various age groups). Ershow and Cantor (1989) also concluded that, for all age groups combined, the proportion of tap water consumed as drinking water, or used to prepare foods and beverages is 54, 10, and 36%, respectively. (Table 3-59 presents the detailed data on proportion of tap water consumed for various age groups). Ershow and Cantor (1989) also observed that males of all age groups had higher total water and tap water consumption rates than females; the variation of each from the combined-sexes mean was about 8%.

With respect to region of the country, the northeast states had slightly lower average tap water intake (1,200 mL/day) than the three other regions (which were approximately equal at 1,400 mL/day).

This survey has an adequately large size (26,446 individuals), and it is a representative sample of the U.S. population with respect to age distribution and residential location. The data are more than 20 years old and may not be entirely representative of current patterns of water intake, but, in general, the rates are similar to those presented in the key drinking water study in this chapter.

3.3.2.10. *Roseberry and Burmaster (1992)—Lognormal Distributions for Water Intake*

Roseberry and Burmaster (1992) fit lognormal distributions to the water intake data population-wide distributions for total fluid and total tap water intake based on proportions of the population in each age group. Their publication shows the data and the fitted lognormal distributions graphically. The mean was estimated as the zero intercept, and the standard deviation (SD) was estimated as the slope of the best-fit line for the natural logarithm of the intake rates plotted against their corresponding z-scores (Roseberry and Burmaster, 1992). Least squares techniques were used to estimate the best-fit straight lines for the transformed data. Table 3-60 presents summary statistics for the best-fit lognormal distribution. In this table, the simulated balanced population represents an adjustment to account for the difference in the age distribution of the U.S. population in 1988 from the age distribution in 1978 when Ershow and Cantor (1989) collected their data. Table 3-61 summarizes the quantiles and means of tap water intake as estimated from the best-fit distributions. The mean total tap water intake rates for the two adult populations (ages 20 to 65 years, and 65+ years) were estimated to be 1.27 and 1.34 L/day.

These intake rates were based on the data originally presented by Ershow and Cantor (1989). Consequently, the same advantages and disadvantages associated with the Ershow and Cantor (1989) study apply to this data set.

3.3.2.11. *Levy et al. (1995)—Infant Fluoride Intake from Drinking Water Added to Formula, Beverages, and Food*

Levy et al. (1995) conducted a study to determine fluoride intake by infants through drinking water and other beverages prepared with water and baby foods. The study was longitudinal and covered the ages from birth to 9 months old. A total of 192 mothers, recruited from the *post partum* wards of two hospitals in Iowa City, completed mail questionnaires and 3-day beverage and food diaries for their infants at ages 6 weeks, and 3, 6, and 9 months (Levy et al., 1995). The questionnaire addressed feeding habits, water sources and ingestion, and the use of dietary fluoride supplements during the preceding week (Levy et al., 1995). Data on the quantity of water consumed by itself or as an additive to infant formula, other beverages, or foods were obtained. In addition, the questionnaire addressed the infants' ingestion of cows' milk, breast milk, ready-to-feed (RTF) infant products (formula, juices, beverages, baby food), and table foods.

Mothers were contacted for any clarifications of missing data and discrepancies (Levy et al., 1995). Levy et al. (1995) assessed non-response bias and found no significant differences in the reported number of adults or children in the family, water sources, or family income at 3, 6, or 9 months. Table 3-62 provides the range of water ingestion from water by itself and from addition to selected foods and beverages. The percentage of infants ingesting water by itself increased from 28% at 6 weeks to 66% at 9 months, respectively, and the mean intake increased slightly over this time frame. During this time frame, the largest proportion of the infants' water ingestion (i.e., 36% at 9 months to 48% at 6 months) came from the addition of water to formula. Levy et al. (1995) noted that 32% of the infants at age 6 weeks and 23% of the infants at age 3 months did not receive any water from any of the sources studied. Levy et al. (1995) also noted that the proportion of children ingesting some water from all sources gradually increased with age.

The advantages of this study are that it provides information on water ingestion of infants starting at 6 weeks old, and the data are for water only and for water added to beverages and foods. The limitations of the study are that the sample size was small for each age group, it captured information from a select geographical location, and data were collected through self-reporting. The authors noted, however, that the 3-day diary has been shown to be a valid assessment tool. Levy et al. (1995) also stated that (1) for each time period, the ages of the infants varied by a few days to a few weeks, and are, therefore, not exact and could, at early ages, have an effect on age-specific intake patterns, and (2) the same number of infants were not available at each of the four time periods.

3.3.2.12. *USDA (1995)—Food and Nutrient Intakes by Individuals in the United States, 1 Day, 1989–1991*

USDA (1995) collected data on the quantity of "plain drinking water" and various other beverages consumed by individuals in one day during 1989 through 1991. The data were collected as part of USDA's CSFII. The data used to estimate mean per capita intake rates combined 1-day dietary recall data from three survey years: 1989, 1990, and 1991 during which 15,128 individuals supplied 1-day intake data. Individuals from all income levels in the 48 conterminous states and Washington D.C. were included in the sample. A complex 3-stage sampling design was employed, and the overall response rate for the study was 58%. To minimize the biasing effects of the low response rate and adjust for the seasonality, a series of weighting factors was incorporated into the data analysis. Table 3-63 presents the intake rates based on this study. Table 3-63 includes data for (a) "plain drinking water," which might be assumed to mean tap water directly consumed rather than bottled water; (b) coffee and tea, which might be assumed to be constituted from tap water; (c) fruit drinks and ades, which might be assumed to be reconstituted from tap water rather than canned products; and (d) the total of the three sources. With these assumptions, the mean per capita total intake of water is estimated to be 1,416 mL/day for adult males (i.e., 20 years of age and older), 1,288 mL/day for adult females (i.e., 20 years of age and older), and 1,150 mL/day for all ages and both sexes combined. Although these assumptions appear reasonable, a close reading of the definitions used by USDA (1995) reveals that the word "tap water" does not occur, and this uncertainty prevents the use of this study as a key study of tap water intake.

The advantages of using these data are that (1) the survey had a large sample size; and (2) the authors attempted to represent the general U.S. population by oversampling low-income groups and by weighting the data to compensate for low response rates. The disadvantages are that (1) the word “tap water” was not defined, and the assumptions that must be used in order to compare the data with the other tap water studies might not be valid; (2) the data collection period reflects only a 1-day intake period and may not reflect long-term drinking water intake patterns; (3) data on the percentiles of the distribution of intakes were not given; and (4) the data are almost 20 years old and may not be entirely representative of current intake patterns.

3.3.2.13. *U.S. EPA (1996)— Descriptive Statistics from a Detailed Analysis of the National Human Activity Pattern Survey (NHAPS) Responses*

The U.S. EPA collected information on the number of glasses of drinking water and juice reconstituted with tap water consumed by the general population as part of the National Human Activity Pattern Survey (NHAPS) (U.S. EPA, 1996). NHAPS was conducted between October 1992 and September 1994. Over 9,000 individuals in the 48 contiguous United States provided data on the duration and frequency of selected activities and the time spent in selected microenvironments via 24-hour diaries. Over 4,000 NHAPS respondents also provided information on the number of 8-ounce glasses of water and the number of 8-ounce glasses of juice reconstituted with water that they drank during the 24-hour survey period (see Tables 3-64 and 3-65). The median number of glasses of tap water consumed was 1–2, and the median number of glasses of juice with tap water consumed was 1–2.

For both individuals who drank tap water and individuals who drank juices reconstituted with tap water, the number of glasses consumed in a day ranged from 1 to 20 glasses. The highest percentage of the population (37.1%) who drank tap water, consumed in the range of 3–5 glasses a day, and the highest percentage of the population (51.5%) who consumed juice reconstituted with tap water consumed 1–2 glasses in a day. Based on the assumption that each glass contained 8 ounces of water (226.4 mL), the total volume of tap water and juice with tap water consumed would range from 0.23 L/day (1 glass) to 4.5 L/day (20 glasses) for respondents who drank tap water. Using the same assumption, the volume of tap water consumed for the population who consumed 3–5 glasses would be 0.68 L/day to 1.13 L/day, and the volume of juice with tap water consumed for the population who consumed 1–2 glasses would be 0.23–0.46 L/day. Assuming that the average individual consumes 3-5 glasses of tap water plus 1–2 glasses of juice with tap water, the range of total tap water intake for this individual would range from 0.9 L/day to 1.64 L/day. These values are consistent with the average intake rates observed in other studies.

The advantages of NHAPS are that the data were collected for a large number of individuals and that the data are representative of the U.S. population. However, evaluation of drinking water intake rates was not the primary purpose of the study, and the data do not reflect the total volume of tap water consumed. In addition, using the assumptions described above, the estimated drinking water intake rates from this study are within the same ranges observed for other drinking water studies.

3.3.2.14. *Heller et al. (2000)—Water Consumption and Nursing Characteristics of Infants by Race and Ethnicity*

Heller et al. (2000) analyzed data from the 1994-1996 CSFII to evaluate racial/ethnic differences in the ingestion rates of water in children younger than 2 years old. Using data from 946 children in this age group, the mean amounts of water consumed from eight sources were determined for various racial/ethnic groups, including Black non-Hispanic, White non-Hispanic, Hispanic, and “other” (Asian, Pacific Islander, American Indian, Alaskan Native, and other non-specified racial/ethnic groups). The sources analyzed included (1) plain tap water, (2) milk and milk drinks, (3) reconstituted powdered or liquid infant formula made from drinking water, (4) ready-to-feed and other infant formula, (5) baby food, (6) carbonated beverages, (7) fruit and vegetable juices and other non-carbonated drinks, and (8) other foods and beverages. In addition, Heller et al. (2000) calculated mean plain water and total water ingestion rates for children by age, sex, region, urbanicity, and poverty category. Ages were defined as less than 12 months and 12 to 24 months. Regions were categorized as Northeast, Midwest, South, and West. The states represented by each of these regions were not reported in Heller et al. (2000). However, it is likely that these regions were defined in the same way as in Sohn et al. (2001). See Section 3.3.2.16 for a discussion on the Sohn et al. (2001) study. Urbanicity of the residence was defined as urban (i.e., being in a Metropolitan Statistical Area [MSA], suburban [outside of an MSA], or rural [being in a non-MSA]). Poverty category was derived from the poverty income ratio. In this study, a poverty income ratio was calculated by dividing the family’s annual income by the federal poverty threshold for that size household. The poverty categories used were 0–1.30, 1.31 to 3.50, and greater than 3.50 times the federal poverty level (Heller et al., 2000).

Table 3-66 provides water ingestion estimates for the eight water sources evaluated, for each of the race/ethnic groups. Heller et al. (2000) reported that Black non-Hispanic children had the highest mean plain tap water intake (21 mL/kg-day), and White non-Hispanic children had the lowest mean plain tap water intake (13 mL/kg-day). The only statistically significant difference between the racial/ethnic groups was found to be in plain tap water consumption and total water consumption. Reconstituted baby formula made up the highest proportion of total water intake for all race/ethnic groups. Table 3-67 presents tap water and total water ingestion by age, sex, region, urbanicity, and poverty category. On average, children younger than 12 months of age consumed less plain tap water (11 mL/kg-day) than children aged 12–24 months (18 mL/kg-day). There were no significant differences in plain tap water consumption by sex, region, or urbanicity. Heller et al. (2000) reported a significant association between higher income and lower plain tap water consumption. For total water consumption, ingestion per kg body weight was lower for the 12–24 month-old children than for those younger than 12 months of age. Urban children consumed more plain tap water and total water than suburban and rural children. In addition, plain tap water and total water ingestion was found to decrease with increasing poverty category (i.e., higher wealth).

A major strength of the Heller et al. (2000) study is that it provides information on tap water and total water consumption by race, age, sex, region, urbanicity, and family income. The weaknesses in the CSFII data set have been discussed under Kahn and Stralka (2008a) and U.S. EPA (2004) and include surveying participants for only 2 days.

3.3.2.15. *Sichert-Hellert et al. (2001)—Fifteen-Year Trends in Water Intake in German Children and Adolescents: Results of the DONALD Study*

Water and beverage consumption was evaluated by Sichert-Hellert et al. (2001) using 3-day dietary records of 733 children, ages 2 to 13 years, enrolled in the Dortmund Nutritional and Anthropometric Longitudinally Designed Study (DONALD study). The DONALD study is a cohort study, conducted in Germany, that collects data on diet, metabolism, growth, and development from healthy subjects between infancy and adulthood (Sichert-Hellert et al., 2001). Beginning in 1985, approximately 40 to 50 infants were enrolled in the study annually. Mothers of the participants were recruited in hospital maternity wards. Older children and parents of younger children were asked to keep dietary records for 3 days by recording and weighing (to the nearest 1 gram) all foods and fluids, including water, consumed.

Sichert-Hellert et al. (2001) evaluated 3,736 dietary records from 733 subjects (354 males and 379 females) collected between 1985 and 1999. Total water ingestion was defined as the sum of water content from food (intrinsic water), beverages, and oxidation. Beverages included milk, mineral water, tap water, juice, soft drinks, and coffee and tea. Table 3-68 presents the mean water ingestion rates for these different sources, as well as mean total water ingestion rates for three age ranges of children (aged 2 to 3 years, aged 4 to 8 years, and aged 9 to 13 years). According to Sichert-Hellert et al. (2001), mean total water ingestion increased with age from 1,114 mL/day in the 2- to 3-year-old subjects to 1,891 and 1,676 mL/day in 9- to 13-year-old boys and girls, respectively. However, mean total water intake per body weight decreased with age. Sichert-Hellert et al. (2001) observed that the most important source of total water ingestion was mineral water for all children, except the 2- to 3-year-olds. For these children, the most important source of total water ingestion was milk.

One of the limitations of this study is that it evaluated water and beverage consumption in German children and, as such, it may not be representative of consumption patterns of U.S. children.

3.3.2.16. *Sohn et al. (2001)—Fluid Consumption Related to Climate Among Children in the United States*

Sohn et al. (2001) investigated the relationship between fluid consumption among children aged 1 to 10 years and local climate using data from the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994). Children aged 1 to 10 years who completed the 24-hour dietary interview (or proxy interview for the younger children) during the NHANES III survey were selected for the analysis. Breast-fed children were excluded from the analysis. Among 8,613 children who were surveyed, 688 (18%) were excluded due to incomplete data. A total of 7,925 eligible children remained. Since data for climatic conditions were not collected in the NHANES III survey, the mean daily maximum temperature from 1961 to 1990, averaged for the month during which the NHANES III survey was conducted, was obtained for each survey location from the U.S. Local Climate Historical Database. Of the 7,925 eligible children with complete dietary data, temperature information was derived for only 3,869 children (48.8%) since detailed information on survey location, in terms of county and state, was released only for counties with a population of more than a half million.

Sohn et al. (2001) calculated the total amount of fluid intake for each child by adding the fluid intake from plain drinking water and the fluid intake from foods and beverages other than plain drinking water provided by NHANES III. Sohn et al. (2001) identified major fluid sources as milk (and milk drinks), juice (fruit and vegetable juices and other non-carbonated drinks), carbonated drinks, and plain water. Fluid intake from sources other than these major sources was grouped into other foods and beverages. Other foods and beverages included bottled water, coffee, tea, baby food, soup, water-based beverages, and water used for dilution of food. Table 3-69 presents mean fluid ingestion rates of selected fluids for the total sample population and for the subsets of the sample population with and without temperature information. The estimated mean total fluid and plain water ingestion rates for the 3,869 children for whom temperature information was obtained are presented in Table 3-70 according to age (years), sex, race/ethnicity, poverty/income ratio, region, and urbanicity. Poverty/income ratio was defined as the ratio of the reported family income to the federal poverty level. The following categories were assigned low socioeconomic status (SES) = 0.000 to 1.300 times the poverty/income ratio; medium SES = 1.301 to 3.500 times the poverty/income level; and high SES = 3.501 or greater times the poverty/income level. Regions were as Northeast, Midwest, South, and West, as defined by the U.S. Census (see Table 3-70). Sohn et al. (2001) did not find a significant association between mean daily maximum temperature and total fluid or plain water ingestion, either before or after controlling for sex, age, SES, and race or ethnicity. However, significant associations between fluid ingestion and age, sex, socioeconomic status, and race and ethnicity were reported.

The main strength of the Sohn et al. (2001) study is the evaluation of water intake as it relates to weather data. The main limitations of this study were that northeast and western regions were over-represented since temperature data were only available for counties with populations in excess of a half million. In addition, Whites were under-represented compared to other racial or ethnic groups. Other limitations include lack of data for children from extremely cold or hot weather conditions.

3.3.2.17. *Hilbig et al. (2002)—Measured Consumption of Tap Water in German Infants and Young Children as Background for Potential Health Risk Assessment: Data of the DONALD Study*

Hilbig et al. (2002) estimated tap water ingestion rates based on 3-day dietary records of 504 German children aged 3, 6, 9, 12, 18, 24, and 36 months. The data were collected between 1990 and 1998 as part of the DONALD study. Details of data collection for the DONALD study have been provided previously under the Sichert-Hellert et al. (2001) study in Section 3.3.2.15 of this handbook. Tap water ingestion rates were calculated for three subgroups of children: (1) breast-fed infants ≤12 months of age (exclusive and partial breast-fed infants), (2) formula-fed infants ≤12 months of age (no human milk, but including weaning food), and (3) mixed-fed young children aged 18 to 36 months. Hilbig et al. (2002) defined "total tap water from household" as water from the tap consumed as a beverage or used in food preparation. "Tap water from food manufacturing" was defined as water used in industrial production of foods, and "Total Tap Water" was defined as tap water consumed from both the household and that used in manufacturing.

Table 3-71 summarizes total tap water ingestion (in mL/day and mL/kg-day) and tap water ingestion from household and manufacturing sources (in mL/kg-day) for breast-fed, formula-fed, and mixed-fed children. Mean total tap water intake was higher in formula-fed infants (53 mL/kg-day) than in breast-fed infants (17 g/kg-day) and mixed-fed young children (19 g/kg-day). Tap water from household sources constituted 66 to 97% of total tap water ingestion in the different age groups.

The major limitation of this study is that the study sample consists of families from an upper social background in Germany (Hilbig et al., 2002). Because the study was conducted in Germany, the data may not be directly applicable to the U.S. population.

3.3.2.18. *Marshall et al. (2003a)—Patterns of Beverage Consumption during the Transition Stage of Infant Nutrition*

Marshall et al. (2003a) investigated beverage ingestion during the transition stage of infant nutrition. Mean ingestion of infant formula, cows' milk, combined juice and juice drinks, water, and other beverages was estimated using a frequency questionnaire. A total of 701 children, aged 6 months through 24 months, participated in the Iowa Fluoride Study (IFS). Mothers of newborns were recruited from 1992 through 1995. The parents were sent questionnaires when the children were 6, 9, 12, 16, 20, and 24 months old. Of the 701 children, 470 returned all six questionnaires, 162 returned five, 58 returned four, and 11 returned three, with the minimum criteria being three questionnaires to be included in the data set (Marshall et al., 2003a). The questionnaire was designed to assess the type and quantity of the beverages consumed during the previous week. The validity of the questionnaire was assessed using a 3-day food diary for reference (Marshall et al., 2003a). Table 3-72 presents the percentage of subjects consuming beverages and mean daily beverage ingestion for children with returned questionnaires. Human milk ingestion was not quantified, but the percent of children consuming human milk was provided at each age category (see Table 3-72). Juice (100%) and juice drinks were not distinguished separately but categorized as juice and juice drinks. Water used to dilute beverages beyond normal dilution and water consumed alone were combined. Based on Table 3-72, 97% of the children consumed human milk, formula, or cows' milk throughout the study period, and the percentage of infants consuming human milk decreased with age, while the percent consuming water increased (Marshall et al., 2003a). Marshall et al. (2003a) observed that, in general, lower family incomes were associated with less breast-feeding and increased ingestion of other beverages.

The advantage of this study is that it provides mean ingestion data for various beverages. Limitations of the study are that it is based on samples gathered in one geographical area and may not be reflective of the general population. The authors also noted the following limitations: the parents were not asked to differentiate between 100% juice and juice drinks; the data are parent-reported and could reflect perceptions of appropriate ingestion instead of actual ingestion, and a substantial number of the infants from well educated, economically secure households dropped out during the initial phase.

3.3.2.19. *Marshall et al. (2003b)—Relative Validation of a Beverage Frequency Questionnaire in Children Aged 6 Months through 5 Years Using 3-Day Food and Beverage Diaries*

Marshall et al. (2003b) conducted a study based on data taken from 700 children in the IFS. This study compared estimated beverage ingestion rates reported in questionnaires for the preceding week and diaries for the following week. Packets were sent periodically (every 4 to 6 months) to parents of children aged 6 weeks through 5 years of age. This study analyzed data from children, aged 6 and 12 months, and 2 and 5 years of age. Beverages were categorized as human milk, infant formula, cows' milk, juice and juice drinks, carbonated and rehydration beverages, prepared drinks (from powder) and water. The beverage questionnaire was completed by parents and summarized the average amount of each beverage consumed per day by their children. The data collection for the diaries maintained by parents included 1 weekend day and 2 weekdays and included detailed information about beverages consumed. Table 3-73 presents the mean ingestion rates of all beverages for children aged 6 and 12 months and 3 and 5 years. Marshall et al. (2003b) concluded that estimates of beverage ingestion derived from quantitative questionnaires are similar to those derived from diaries. They found that it is particularly useful to estimate ingestion of beverages consumed frequently using quantitative questionnaires.

The advantage of this study is that the survey was conducted in two different forms (questionnaire and diary), and that diaries for recording beverage ingestion were maintained by parents for 3 days. The main limitation is the lack of information regarding whether the diaries were populated on consecutive or non-consecutive days. The IFS survey participants may not be representative of the general population of the United States since participants were primarily White, and from affluent and well-educated families in one geographic region of the country.

3.3.2.20. *Skinner et al. (2004)—Transition in Infants' and Toddlers' Beverage Patterns*

Skinner et al. (2004) investigated the pattern of beverage consumption by infants and children participating in the Feeding Infant and Toddlers Study (FITS) sponsored by Gerber Products Company. The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers (Devaney et al., 2004). It included a stratified random sample of 3,022 infants and toddlers between 4 and 24 months of age. Parents or primary caregivers of sampled infants and toddlers completed a single 24-hour dietary recall of all foods and beverages consumed by the child on the previous day by telephone interview. All recalls were completed between March and July 2002. Detailed information on data collection, coding, and analyses related to FITS is provided in Devaney et al. (2004).

Beverages consumed by FITS participants were identified as total milks (i.e., human milk, infant formulas, cows' milk, soy milk, goats' milk), 100% juices, fruit drinks, carbonated beverages, water, and "other" drinks (i.e., tea, cocoa, dry milk mixtures, and electrolyte replacement beverages). There were six age groupings in the FITS study: 4 to 6, 7 to 8, 9 to 11, 12 to 14, 15 to 18, and 19 to 24 months. Skinner et al. (2004) calculated the percentage of children in each age group consuming any amount in a beverage category and the mean amounts consumed. Table 3-74 provides the mean beverage consumption rates in mL/day for the six age categories. Skinner et al. (2004) found that some form of milk beverage was consumed by almost all children at each age; however, total milk ingestion decreased with increasing age. Water consumption also doubled with age, from 163 mL/day in children aged 4 to 6 months old to 337 mL/day in children aged 19 to 24 months old. The percentages of children consuming water increased from 34% at 4 to 6 months of age to 77% at 19 to 24 months of age.

A major strength of the Skinner et al. (2004) study is the large sample size (3,022 children). However, beverage ingestion estimates are based on 1 day of dietary recall data and human milk quantity derived from studies that weighed infants before and after each feeding to determine the quantity of human milk consumed (Devaney et al., 2004); therefore, estimates of total milk ingestion may not be accurate.

3.4. PREGNANT AND LACTATING WOMEN

3.4.1. Key Study on Pregnant and Lactating Women

3.4.1.1. *Kahn and Stralka (2008b)—Estimates of Water Ingestion for Women in Pregnant, Lactating and Non-Pregnant and Non-Lactating Child Bearing Age Groups Based on USDA's 1994–1996, 1998 CSFII*

The combined 1994–1996 and 1998 CSFII data sets were analyzed to examine the ingestion of water by various segments of the U.S. population as described in Section 3.3.1.1. Kahn and Stralka (2008b) provided water intake data for pregnant, lactating, and child-bearing age women. Mean and upper percentile distribution data were provided. Lactating women had an estimated per capita mean community water ingestion of 1.38 L/day, the highest water ingestion rates of any identified subpopulation. The mean consumer-only population was 1.67 L/day. Tables 3-75 through 3-82 provide estimated drinking water intakes for pregnant and lactating women, and non-pregnant, non-lactating women aged 15–44 years old. The same advantages and disadvantages discussed in Section 3.3.1.1 apply to these data.

3.4.2. Relevant Studies on Pregnant and Lactating Women

3.4.2.1. *Ershow et al. (1991)—Intake of Tap Water and Total Water by Pregnant and Lactating Women*

Ershow et al. (1991) used data from the 1977-1978 USDA NFCS to estimate total fluid and total tap water intake among pregnant and lactating women (ages 15–49 years). Data for 188 pregnant women, 77 lactating women, and 6,201 non-pregnant, non-lactating control women were evaluated. The participants were interviewed based on 24-hour recall and then asked to record a food diary for the next 2 days. "Tap water" included tap water consumed directly as a beverage and tap water used to prepare food and tap water-based beverages. "Total water" was defined as all water from tap water and non-tap water sources, including water contained in food. Tables 3-83 and 3-84 present estimated total fluid and total tap water intake rates for the three groups, respectively. Lactating women had the highest mean total fluid intake rate (2.24 L/day) compared with both pregnant women (2.08 L/day) and control women (1.94 L/day). Lactating women also had a higher mean total tap water intake rate (1.31 L/day) than pregnant women (1.19 L/day) and control women (1.16 L/day). The tap water distributions are neither normal nor lognormal, but lactating women had a higher mean tap water intake than controls and pregnant women. Ershow et al. (1991) also reported that rural women (N = 1,885) consumed more total water (1.99 L/day) and tap water (1.24 L/day) than urban/suburban women (N = 4,581, 1.93 and 1.13 L/day, respectively). Total water and tap water intake rates were lowest in the northeastern region of the United States (1.82 and 1.03 L/day) and highest in the western region of the United States (2.06 L/day and 1.21 L/day). Mean intake per unit body weight was highest among lactating women for both total fluid and total tap water intake. Total tap water intake accounted for over 50% of mean total fluid in all three groups of women (see Table 3-84). Drinking water accounted for the largest single proportion of the total fluid intake for control (30%), pregnant (34%), and lactating women (30%) (see Table 3-85). All other beverages combined accounted for approximately 46%, 43%, and 45% of the total water intake for control, pregnant, and lactating women, respectively. Food accounted for the remaining portion of total water intake.

The same advantages and limitations associated with the Ershow and Cantor (1989) data also apply to these data sets (see Section 3.3.2.9). A further advantage of this study is that it provides information on estimates of total water and tap water intake rates for pregnant and lactating women. This topic has rarely been addressed in the literature.

3.4.2.2. *Forssen et al. (2007)—Predictors of Use and Consumption of Public Drinking Water Among Pregnant Women*

Forssen et al. (2007) evaluated the demographic and behavioral characteristics that would be important in predicting water consumption among pregnant women in the United States. Data were collected through telephone interviews with 2,297 pregnant women in three geographical areas in the southern United States. Women 18 years old and ≤12 weeks pregnant were recruited from the local communities and from both private and public prenatal care facilities in the southern United States. Variables studied included demographic, health status and history (e.g., diabetes, pregnancy history), behavioral (e.g., exercise, smoking, caffeine consumption), and some physiological characteristics (e.g., pre-pregnancy weight). Daily amount of water ingestion was estimated based on cup sizes defined in the interview. Water consumption was reported as cold tap water (filtered and unfiltered) and bottled water. Other behavioral information on water use such as showering and bathing habits, use of swimming pools, hot tubs, and Jacuzzis was collected. The overall mean tap water ingested was 1.7 L/day (percentiles: 25^{th} = 0.5 L/day, 50^{th} = 1.4 L/day, 75^{th} = 2.4 L/day, and 90^{th} = 3.8 L/day). The overall mean bottled water ingested was 0.6 L/day (percentiles: 25^{th} = 0.1 L/day, 50^{th} = 0.2 L/day, 75^{th} = 0.6 L/day, and 90^{th} = 1.8 L/day). Table 3-86 presents water ingestion by the different variables studied, and Table 3-87 presents the percentage of ingested tap water that is filtered and unfiltered by various variables. The advantage of this study is that it investigated water consumption in relation to multiple variables. However, the study population was not random and not representative of the entire United States. There are also limitations associated with recall bias.

3.5. HIGH ACTIVITY LEVELS/HOT CLIMATES

3.5.1. Relevant Studies on High Activity Levels/Hot Climates

3.5.1.1. *McNall and Schlegel (1968)—Practical Thermal Environmental Limits for Young Adult Males Working in Hot, Humid Environments*

McNall and Schlegel (1968) conducted a study that evaluated the physiological tolerance of adult males working under varying degrees of physical activity. Subjects were required to operate pedal-driven propeller fans for 8-hour work cycles under varying environmental conditions. The activity pattern for each individual was cycled as 15 minutes of pedaling and 15 minutes of rest for each 8-hour period. Two groups of eight subjects each were used. Work rates were divided into three categories as follows: high activity level (0.15 horsepower [hp] per person), medium activity level (0.1 hp per person), and low activity level (0.05 hp per person). Evidence of physical stress (i.e., increased body temperature, blood pressure, etc.) was recorded, and individuals were eliminated from further testing if certain stress criteria were met. The amount of water consumed by the test subjects during the work cycles was also recorded. Water was provided to the individuals on request.

Table 3-88 presents the water intake rates obtained at the three different activity levels and the various environmental temperatures. The data presented are for test subjects with continuous data only (i.e., those test subjects who were not eliminated at any stage of the study as a result of stress conditions). Water intake was the highest at all activity levels when environmental temperatures were increased. The highest intake rate was observed at the low activity level at 100°F (0.65 L/hour); however, there were no data for higher activity levels at 100°F. It should be noted that this study estimated intake on an hourly basis during various levels of physical activity. These hourly intake rates cannot be converted to daily intake rates by multiplying by 24 hours/day because they are only representative of intake during the specified activity levels, and the intake rates for the rest of the day are not known. Therefore, comparison of intake rate values from this study cannot be made with values from the previously described studies on drinking water intake.

3.5.1.2. *U.S. Army (1983)—Water Consumption Planning Factors Study*

The U.S. Army has developed water consumption planning factors to enable them to transport an adequate amount of water to soldiers in the field under various conditions (U.S. Army, 1983). Both climate and activity levels were used to determine the appropriate water consumption needs. Consumption factors have been established for the following uses: (1) drinking, (2) heat treatment, (3) personal hygiene, (4) centralized hygiene, (5) food preparation, (6) laundry, (7) medical treatment, (8) vehicle and aircraft maintenance, (9) graves registration, and (10) construction. Only personal drinking water consumption factors are described here. Drinking water consumption planning factors are based on the estimated amount of water needed to replace fluids lost by urination, perspiration, and respiration. It assumes that water lost to urinary output averages 1 quart/day (0.9 L/day), and perspiration losses range from almost nothing in a controlled environment to 1.5 quarts/day (1.4 L/day) in a very hot climate where individuals are performing strenuous work. Water losses to respiration are typically very low except in extreme cold where water losses can range from 1 to 3 quarts/day (0.9 to 2.8 L/day). This occurs when the humidity of inhaled air is near zero, but expired air is 98% saturated at body temperature (U.S. Army, 1983).

Drinking water is defined by the U.S. Army (1983) as "all fluids consumed by individuals to satisfy body needs for internal water." This includes soups, hot and cold drinks, and tap water. Planning factors have been established for hot, temperate, and cold climates based on the following mixture of activities among the workforce: 15% of the force performing light work, 65% of the force performing medium work, and 20% of the force performing heavy work. Hot climates are defined as tropical and arid areas where the temperature is greater than 80°F. Temperate climates are defined as areas where the mean daily temperature ranges from 32°F to 80°F. Cold regions are areas where the mean daily temperature is less than 32°F. Table 3-89 presents drinking water consumption factors for these three climates. These factors are based on research on individuals and small unit training exercises. The estimates are assumed to be conservative because they are rounded up to account for the subjective nature of the activity mix and minor water losses that are not considered (U.S. Army, 1983).

The advantage of using these data is that they provide a conservative estimate of drinking water intake among individuals performing at various levels of physical activity in hot, temperate, and cold climates. However, the planning factors described here are based on assumptions about water loss from urination, perspiration, and respiration, and are not based on survey data or actual measurements.

3.6. WATER INGESTION WHILE SWIMMING AND DIVING

3.6.1. Key Study on Water Ingestion While Swimming

3.6.1.1. *Dufour et al. (2006)—Water Ingestion during Swimming Activities in a Pool: A Pilot Study*

Dufour et al. (2006) estimated the amount of water ingested while swimming, using cyanuric acid as an indicator of pool water ingestion exposure. Cyanuric acid is a breakdown product of chloroisocyanates, which are commonly used as disinfectant stabilizers in recreational water treatment. Because ingested cyanuric acid passes through the body unmetabolized, the volume of water ingested can be estimated based on the amount of cyanuric acid measured in the pool water and in the urine of swimmers, as follows:

$$V_{pool\ water\ ingested} = V_{urine} \times CA_{urine}/CA_{pool} \quad \text{(Eqn. 3-1)}$$

where:

$V_{pool\ water\ ingested}$	= volume of pool water ingested (mL),
V_{urine}	= volume of urine collected over a 24-hour period (mL),
CA_{urine}	= concentration of cyanuric acid in urine (mg/L), and
CA_{pool}	= concentration of cyanuric acid in pool water (mg/L).

According to Dufour et al. (2006), dermal absorption of cyanuric acid has been shown to be negligible. Thus, the concentration in urine is assumed to represent the amount ingested. Dufour et al. (2006) estimated pool water intake among 53 swimmers that participated in a pilot study at an outdoor swimming pool treated with chloroisocyanate. This pilot study population included 12 adults (4 males and 8 females) and 41 children under 18 years of age (20 males and 21 females). The study participants were asked not to swim for 24 hours before or after a 45-minute period of active swimming in the pool. Pool water samples were collected prior to the start of swimming activities, and swimmers' urine was collected for 24 hours after the swimming event ended. The pool water and urine sample were analyzed for cyanuric acid.

Table 3-90 presents the results of this pilot study. The mean volumes of water ingested over a 45-minute period were 16 mL for adults and 37 mL for children. The maximum volume of water ingested by adults was 53 mL, and by children, was 154 mL/45 minutes, as found in the recommendations table for water ingestion while swimming (see Table 3-5). The 97th percentile volume of water ingested by children was approximately 90 mL/45 minutes (see Table 3-5).

The advantage of this study is that it is one of the first attempts to measure water ingested while swimming. However, the number of study participants was low, and data cannot be broken out by the recommended age categories. As noted by Dufour et al. (2006), swimming behavior of pool swimmers may be similar to freshwater swimmers but may differ from salt water swimmers.

Based on the results of the Dufour et al. (2006) study, the recommended mean water ingestion rates for exposure scenarios involving swimming activities are 21 mL/hour for adults and 49 mL/hour for children under 18 years of age. Because the data set is limited, upper percentile water ingestion rates for swimming are based on the 97th percentile value for children and the maximum value for adults from the Dufour et al. (2006) study. These values are 71 mL/hour for adults and 120 mL/hour for children (see Table 3-5). Also, competitive swimmers may swallow more water than the recreational swimmers observed in this study (Dufour et al., 2006).

3.6.2. Relevant Studies on Water Ingestion While Swimming, Diving, or Engaging in Recreational Water Activities

3.6.2.1. *Schijven and de Roda Husman (2006)—A Survey of Diving Behavior and Accidental Occupational and Sport Divers to Assess the Risk of Infection with Waterborne Pathogenic Microorganisms*

Schijven and de Roda Husman (2006) estimated the amount of water ingested by occupational and sports divers in The Netherlands. Questionnaires were used to obtain information on the number of dives for various types of water bodies, and the approximate volume of water ingested per dive. Estimates of the amount of water ingested were made by comparing intake to common volumes (i.e., a few drops = 2.75 mL; shot glass = 25 mL; coffee cup = 100 mL; soda glass = 190 mL). The study was conducted among occupational divers in 2002 and among sports divers in 2003 and included responses from more than 500 divers. Table 3-91 provides the results of this study. On average, occupational divers ingested 9.8 mL/dive marine water and 5.7 mL/dive freshwater. Sports divers wearing an ordinary diving mask ingested 9.0 mL/dive marine water and 13 mL/dive fresh recreational water. Sports divers who wore full face masks ingested less water. The main limitation of this study is that no measurements were taken. It relies on estimates of the perceived amount of water ingested by the divers.

3.6.2.2. *Schets et al. (2011)—Exposure Assessment for Swimmers in Bathing Waters and Swimming Pools*

Schets et al. (2011) collected exposure data for swimmers in freshwater, seawater, and swimming pools in 2007 and 2009. Information on the frequency, duration, and amount of water swallowed were collected via questionnaires administered to nearly 10,000 people in The Netherlands. Individuals 15 years of age and older were considered to be adults and answered questions for themselves, and a parent answered the questions for their eldest child under 15 years of age. Survey participants estimated the amount of water that they swallowed while swimming by responding in one of four ways: (1) none or only a few drops; (2) one or two mouthfuls; (3) three to five mouthfuls; or (4) six to eight mouthfuls. Schets et al. (2011) conducted a series of experiments to measure the amount of water that corresponded to a mouthful of water and converted the data in the four response categories to volumes of water ingested. Monte Carlo analyses were used to combine the distribution of volume (i.e., mouthful) measurements with the distribution of responses in the four response categories to generate distributions of the amount of water swallowed per event for adult men and women, and children less than 15 year of age. Table 3-92 presents the means and 95% confidence intervals for the duration of swimming and amount of water ingested during swimming. Frequency data were also provided by Schets et al. (2011), but these data are not presented here because they are for the population of The Netherlands and may not be representative of swimming frequency in the U.S. According to Schets et al. (2011), the mean volume of water ingested by children (<15 years) during an average swimming pool event lasting 81 minutes was 51 mL or 0.63 mL/min (38 mL/hour). The values for children were slightly lower for swimming in freshwater and seawater. For adults, the mean volume of water ingested ranged from 0.5 to 0.6 mL/min (30 to 36 mL/hour) for men and 0.3 to 0.4 mL/min (20 to 26 mL/hour) for women (see Table 3-92).

The advantages of this study are that it is based on a relatively large sample size and that data are provided for various types of swimming environments (i.e., pools, freshwater, and seawater). However, the data were collected from a population in The Netherlands and may not be entirely representative of the United States. While the ingestion data are based primarily on self-reported estimates, the mean values reported in this study are similar to those based on measurements of cyanuric acid in the urine of swimmers as reported by Dufour et al. (2006).

3.6.2.3. *Dorevitch et al. (2011)—Water Ingestion during Water Recreation*

Dorevitch et al. (2011) estimated the volumes of water ingested during "limited contact water recreation activities." These activities included such as canoeing, fishing, kayaking, motor boating, rowing, wading and splashing, and walking. Full contact scenarios (i.e., swimming and immersion) were also evaluated. Dorevitch et al. (2011) estimated water intake among individuals greater than 6 years of age using two different methods in studies conducted in 2009. In the first surface water study, self-reported estimates of ingestion were obtained via interview from 2,705 individuals after they engaged in recreation activities in Chicago area surface waters. A total of 2,705 participants reported whether they swallowed no water, a drop or two, a teaspoon, or one or more mouthfuls of water during one of the five limited contact recreational activities (i.e., canoeing, fishing, kayaking, motor boating, and rowing). A second study was conducted in swimming pools where 662 participants engaged in limited contact scenarios (i.e., canoeing, simulated fishing, kayaking, motor boating, rowing, wading/splashing, and walking), as well as full contact activities such as swimming and immersion. Participants were interviewed after performing their water activity and reported on their estimated water ingestion. In addition, 24-hour urine samples were collected for analysis of cyanuric acid, a tracer of swimming pool water. Translation factors for each of the reported categories of ingestion (e.g., none, drop/teaspoon, mouthful) were developed using the results of the urine analyses. These translation factors were used to estimate the volume of water ingested for the various water activities evaluated in this study (Dorevitch et al., 2011). Table 3-93 presents the estimated volumes of water ingested for the limited and full contact scenarios. Swimmers had the highest estimated water intake (mean = 10 mL/hr; 95% upper confidence limit = 35 mL/hr) among the activities evaluated.

The advantage of this study is that it provides information on the estimated volume of water ingested during both limited and full contact recreational activities. However, the data are based on self-reporting, and data are not provided for individual age groups of the population.

3.7. REFERENCES FOR CHAPTER 3

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Table 3-7. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: Community Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	91	184	-	-	-	322	687*	839*	860*
1 to <3 months	253	227	-	-	-	456	804	896*	1,165*
3 to <6 months	428	362	-	-	148	695	928	1,056	1,424*
6 to <12 months	714	360	-	17	218	628	885	1,055	1,511*
1 to <2 years	1,040	271	-	60	188	402	624	837	1,215*
2 to <3 years	1,056	317	-	78	246	479	683	877	1,364*
3 to <6 years	4,391	380	4	98	291	547	834	1,078	1,654
6 to <11 years	1,670	447	22	133	350	648	980	1,235	1,870*
11 to <16 years	1,005	606	30	182	459	831	1,387	1,727	2,568*
16 to <18 years	363	731	16	194	490	961	1,562	1,983*	3,720*
18 to <21 years	389	826	24	236	628	1,119	1,770	2,540*	3,889*
>21 years	9,207	1,104	69	422	928	1,530	2,230	2,811	4,523
>65 years[c]	2,170	1,127	16	545	1,067	1,601	2,139	3,551	3,661
All ages	20,607	926	30	263	710	1,311	2,014	2,544	4,242

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
\- = Zero.
* The sample size does not meet minimum requirements as described in the "*Third Report on Nutrition Monitoring in the United States*" (LSRO, 1995).

Source: Kahn, 2008 (based on 1994–1996, 1998 USDA CSFII).

Table 3-8. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: Bottled Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	91	104	-	-	-	18	437*	556*	1,007*
1 to <3 months	253	106	-	-	-	-	541	771*	1,056*
3 to <6 months	428	120	-	-	-	-	572	774	1,443*
6 to <12 months	714	120	-	-	-	53	506	761	1,284*
1 to <2 years	1,040	59	-	-	-	-	212	350	801*
2 to <3 years	1,056	76	-	-	-	-	280	494	1,001*
3 to <6 years	4,391	84	-	-	-	-	325	531	1,031*
6 to <11 years	1,670	84	-	-	-	-	330	532	1,079*
11 to <16 years	1,005	111	-	-	-	-	382	709	1,431*
16 to <18 years	363	109	-	-	-	-	426	680*	1,605*
18 to <21 years	389	185	-	-	-	-	514	1,141*	2,364*
>21 years	9,207	189	-	-	-	-	754	1,183	2,129
>65 years[c]	2,170	136	-	-	-	-	591	1,038	1,957
All ages	20,607	163	-	-	-	-	592	1,059	2,007

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-9. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: Other Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	91	13	-	-	-	-	-	-	393*
1 to <3 months	253	35	-	-	-	-	-	367*	687*
3 to <6 months	428	45	-	-	-	-	-	365	938*
6 to <12 months	714	45	-	-	-	-	31	406	963*
1 to <2 years	1,040	22	-	-	-	-	-	118	482*
2 to <3 years	1,056	39	-	-	-	-	52	344	718*
3 to <6 years	4,391	43	-	-	-	-	58	343	830
6 to <11 years	1,670	61	-	-	-	-	181	468	1,047*
11 to <16 years	1,005	102	-	-	-	-	344	786	1,698*
16 to <18 years	363	97	-	-	-	-	295	740*	1,760*
18 to <21 years	389	47	-	-	-	-	-	246*	1,047*
>21 years	9,207	156	-	-	-	-	541	1,257	2,381
>65 years[c]	2,170	171	-	-	-	-	697	1,416	2,269
All ages	20,607	128	-	-	-	-	345	1,008	2,151

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-10. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: All Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	91	301	-	-	135	542	846*	877*	1,088*
1 to <3 months	253	368	-	-	267	694	889	1,020*	1,265*
3 to <6 months	428	528	-	89	549	812	1,025	1,303	1,509*
6 to <12 months	714	530	37	181	505	771	1,029	1,278	1,690*
1 to <2 years	1,040	358	68	147	287	477	735	961	1,281*
2 to <3 years	1,056	437	104	211	372	588	825	999	1,662*
3 to <6 years	4,391	514	126	251	438	681	980	1,200	1,794
6 to <11 years	1,670	600	169	304	503	803	1,130	1,409	2,167*
11 to <16 years	1,005	834	224	401	663	1,099	1,649	1,960	3,179*
16 to <18 years	363	964	236	387	742	1,273	1,842	2,344*	3,854*
18 to <21 years	389	1,075	189	406	803	1,394	2,117	2,985*	4,955*
>21 years	9,207	1,466	500	828	1,278	1,871	2,553	3,195	5,174
>65 years[c]	2,170	1,451	651	935	1,344	1,832	2,323	2,708	3,747
All ages	20,607	1,233	285	573	1,038	1,633	2,341	2,908	4,805

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-11. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	52	-	-	-	101	196*	232*	253*
1 to <3 months	245	48	-	-	-	91	151	205*	310*
3 to <6 months	411	52	-	-	20	98	135	159	216*
6 to <12 months	678	41	-	2	24	71	102	126	185*
1 to <2 years	1,002	23	-	5	17	34	53	71	106*
2 to <3 years	994	23	-	6	17	33	50	60	113*
3 to <6 years	4,112	22	-	6	17	31	48	61	93
6 to <11 years	1,553	16	1	5	12	22	34	43	71*
11 to <16 years	975	12	1	4	9	16	25	34	54*
16 to <18 years	360	11	-	3	8	15	23	31*	55*
18 to <21 years	383	12	1	4	10	16	17	35*	63*
>21 years	9,049	15	1	6	12	21	31	39	62
>65 years[c]	2,139	16	-	7	15	23	31	37	52
All ages	19,850	16	1	5	12	21	32	43	75

a Includes all participants whether or not they ingested any water from the source during survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the "*Third Report on Nutrition Monitoring in the United States*" (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-12. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	33	-	-	-	6	131*	243*	324*
1 to <3 months	245	22	-	-	-	-	97	161*	242*
3 to <6 months	411	16	-	-	-	-	74	117	193*
6 to <12 months	678	13	-	-	-	4	52	87	139*
1 to <2 years	1,002	5	-	-	-	-	18	28	67*
2 to <3 years	994	5	-	-	-	-	19	35	84*
3 to <6 years	4,112	5	-	-	-	-	18	30	59
6 to <11 years	1,553	3	-	-	-	-	10	18	41*
11 to <16 years	975	2	-	-	-	-	8	14	26*
16 to <18 years	360	2	-	-	-	-	6	10*	27*
18 to <21 years	383	3	-	-	-	-	8	19*	34*
>21 years	9.049	3	-	-	-	-	10	17	32
>65 years[c]	2,139	2	-	-	-	-	9	15	27
All ages	19,850	3	-	-	-	-	10	18	39

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-13. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: Other Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	4	-	-	-	-	-	-	122*
1 to <3 months	245	7	-	-	-	-	-	52*	148*
3 to <6 months	411	7	-	-	-	-	-	55	155*
6 to <12 months	678	5	-	-	-	-	3	35	95*
1 to <2 years	1,002	2	-	-	-	-	-	11	45*
2 to <3 years	994	3	-	-	-	-	4	23	61*
3 to <6 years	4,112	2	-	-	-	-	3	19	48
6 to <11 years	1,553	2	-	-	-	-	7	16	36*
11 to <16 years	975	2	-	-	-	-	7	14	34*
16 to <18 years	360	2	-	-	-	-	5	11*	27*
18 to <21 years	383	1	-	-	-	-	-	4*	14*
>21 years	9,049	2	-	-	-	-	7	17	33
>65 years[c]	2,139	2	-	-	-	-	10	20	35
All ages	19,850	2	-	-	-	-	6	16	35

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
- = Zero.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-14. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994--1996, 1998 CSFII: All Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	89	-	-	21	168	235*	269*	338*
1 to <3 months	245	77	-	-	46	134	173	246*	336*
3 to <6 months	411	75	-	9	73	118	156	186	225*
6 to <12 months	678	59	4	20	53	86	118	148	194*
1 to <2 years	1,002	31	6	13	24	39	63	85	122*
2 to <3 years	994	31	7	15	26	41	59	73	130*
3 to <6 years	4,112	29	7	14	25	38	56	69	102
6 to <11 years	1,553	21	6	10	18	27	39	50	76*
11 to <16 years	975	16	4	8	13	20	31	39	60*
16 to <18 years	360	15	4	6	12	18	28	37*	59*
18 to <21 years	383	16	3	6	12	21	32	41*	73*
>21 years	9,049	20	7	11	17	26	36	44	68
>65 years[c]	2,139	21	9	13	19	27	34	39	54
All ages	20,850	21	6	10	17	26	38	50	87

a Includes all participants whether or not they ingested any water from the source during survey period.

b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.

c U.S. EPA, 2004.

\- = Zero.

* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-15. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: Community Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	40	470*	32*	215*	482*	692*	849*	858*	919*
1 to <3 months	114	552	67*	339	533	801	943*	1,053*	1,264*
3 to <6 months	281	556	44	180	561	837	1,021	1,171*	1,440*
6 to <12 months	562	467	44	105	426	710	971	1,147	1,586*
1 to <2 years	916	308	43	107	229	428	674	893	1,248*
2 to <3 years	934	356	49	126	281	510	700	912	1,388*
3 to <6 years	3,960	417	57	146	336	581	867	1,099	1,684
6 to <11 years	1,555	480	74	177	373	682	994	1,251	2,024*
11 to <16 years	937	652	106	236	487	873	1,432	1,744	2,589*
16 to <18 years	341	792	106	266	591	987	1,647	2,002*	3,804*
18 to <21 years	364	895	114	295	674	1,174	1,860	2,565*	3,917*
>21 years	8,505	1,183	208	529	1,006	1,582	2,289	2,848	4,665
>65 years[c]	1,958	1,242	310	704	1,149	1,657	2,190	2,604	3,668
All ages	18,509	1,000	127	355	786	1,375	2,069	2,601	4,274

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the "*Third Report on Nutrition Monitoring in the United States*" (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-16. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: Bottled Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	25	-	-	-	-	-	-	-	-
1 to <3 months	64	450*	31*	62*	329*	743*	886*	1,045*	1,562*
3 to <6 months	103	507	48*	88	493	747	1,041*	1,436*	1,506*
6 to <12 months	200	425	47	114	353	630	945*	1,103*	1,413*
1 to <2 years	229	262	45	88	188	324	600	709*	1,083*
2 to <3 years	232	352	57	116	241	471	736	977*	1,665*
3 to <6 years	1,021	380	72	149	291	502	796	958	1,635*
6 to <11 years	332	430	88	168	350	557	850	1,081*	1,823*
11 to <16 years	192	570	116*	229	414	719	1,162*	1,447*	2,705*
16 to <18 years	63	615*	85*	198*	446*	779*	1,365*	1,613*	2,639*
18 to <21 years	97	769	118*	236	439	943	1,788*	2,343*	3,957*
>21 years	1,893	831	167	354	650	1,071	1,773	2,093	3,505
>65 years[c]	302	910	234	465	785	1,182	1,766	2,074	2,548
All ages	4,451	736	118	266	532	975	1,567	1,964	3,312

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
\- Insufficient sample size to estimate mean and percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-17. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: Other Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	3	-	-	-	-	-	-	-	-
1 to <3 months	19	-	-	-	-	-	-	-	-
3 to <6 months	38	562*	59*	179*	412*	739*	983*	1,205*	2,264*
6 to <12 months	73	407*	31*	121*	300*	563*	961*	1,032*	1,144*
1 to <2 years	98	262	18*	65	143	371	602*	899*	1,204*
2 to <3 years	129	354	56*	134	318	472	704*	851*	1,334*
3 to <6 years	533	396	59	148	314	546	796	1,019	1,543*
6 to <11 years	219	448	89	177	347	682	931	1,090*	1,596*
11 to <16 years	151	687	171*	296	482	947	1,356*	1,839*	2,891*
16 to <18 years	53	657*	152*	231*	398*	823*	1,628*	1,887*	2,635*
18 to <21 years	33	569*	103*	142*	371*	806*	1,160*	1,959*	1,962*
>21 years	1,386	1,137	236	503	976	1,533	2,161	2,739	4,673
>65 years[c]	323	1,259	360	680	1,188	1,660	2,136	2,470	3,707*
All ages	2,735	963	148	347	741	1,344	1,970	2,468	3,814

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
\- Insufficient sample size to estimate means and percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-18. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: All Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	58	511*	51*	266*	520*	713*	858*	986*	1,274*
1 to <3 months	178	555	68*	275	545	801	946*	1,072*	1,470*
3 to <6 months	363	629	69	384	612	851	1,064	1,330*	1,522*
6 to <12 months	667	567	90	250	551	784	1,050	1,303	1,692*
1 to <2 years	1,017	366	84	159	294	481	735	978	1,281*
2 to <3 years	1,051	439	105	213	375	589	825	1,001	1,663*
3 to <6 years	4,350	518	134	255	442	682	980	1,206	1,796
6 to <11 years	1,659	603	177	310	506	805	1,131	1,409	2,168*
11 to <16 years	1,000	837	229	404	665	1,105	1,649	1,961	3,184*
16 to <18 years	357	983	252	395	754	1,276	1,865	2,346*	3,866*
18 to <21 years	383	1,094	219	424	823	1,397	2,144	3,002*	4,967*
>21 years	9,178	1,472	506	829	1,282	1,877	2,559	3,195	5,175
>65 years[c]	2,167	1,453	651	939	1,345	1,833	2,324	2,708	3,750
All ages	20,261	1,242	296	585	1,047	1,642	2,345	2,923	4,808

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-19. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	37	137*	11*	65*	138*	197*	235*	238*	263*
1 to <3 months	108	119	12*	71	107	151	228*	285*	345*
3 to <6 months	269	80	7	27	77	118	148	173*	222*
6 to <12 months	534	53	5	12	47	81	112	129	186*
1 to <2 years	880	27	4	9	20	36	56	75	109*
2 to <3 years	879	26	4	9	21	36	52	62	121*
3 to <6 years	3,703	24	3	8	19	33	49	65	97
6 to <11 years	1,439	17	3	6	13	23	35	45	72*
11 to <16 years	911	13	2	5	10	17	26	34	54*
16 to <18 years	339	12	1	4	9	16	24	32*	58*
18 to <21 years	361	13	2	5	10	17	29	35*	63*
>21 years	8,355	16	3	7	13	22	32	39	63
>65 years[c]	1,927	18	5	10	16	24	32	37	53
All ages	17,815	17	3	7	13	22	33	44	77

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-20. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	25	-	-	-	-	-	-	-	-
1 to <3 months	64	92*	7*	12*	76*	151*	164*	220*	411*
3 to <6 months	95	72	6*	15	69	100	149*	184*	213*
6 to <12 months	185	47	5*	11	34	73	104*	120*	166*
1 to <2 years	216	22	5	8	16	27	49	66*	103*
2 to <3 years	211	25	4	8	17	35	54	81*	91*
3 to <6 years	946	21	4	8	16	29	45	57	90*
6 to <11 years	295	15	3	5	11	19	30	42*	69*
11 to <16 years	180	11	2*	4	8	14	24*	27*	44*
16 to <18 years	63	10*	1*	3*	7*	11*	23*	27*	37*
18 to <21 years	93	11	2*	3	6	14	27*	30*	54*
>21 years	1,861	12	2	5	9	16	25	31	45
>65 years[c]	297	13	3	7	12	17	26	30	42*
All ages	4,234	13	2	5	9	17	27	36	72

a Excludes individuals who did not ingest water from the source during the survey period.
b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
c U.S. EPA, 2004.
- Insufficient sample size to estimate means and percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-21. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: Other Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	3	-	-	-	-	-	-	-	-
1 to <3 months	19	-	-	-	-	-	-	-	-
3 to <6 months	38	80*	10*	23*	59*	106*	170*	200*	246*
6 to <12 months	68	44*	4*	10*	33*	65*	95*	106*	147*
1 to <2 years	95	23	1*	5	13	28	46*	84*	125*
2 to <3 years	124	26	4*	10	21	34	55*	66*	114*
3 to <6 years	505	22	3	8	17	30	46	56	79*
6 to <11 years	208	16	3	6	12	23	32	39*	62*
11 to <16 years	148	13	3*	6	9	18	27*	36*	56*
16 to <18 years	52	10*	2*	4*	7*	12*	24*	29*	43*
18 to <21 years	33	8*	1*	2*	6*	10*	16*	27*	31*
>21 years	1,365	15	3	6	13	21	30	39	58
>65 years[c]	322	18	5	9	16	24	31	37	50*
All ages	2,657	16	3	6	12	21	32	41	67

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
\- Indicates insufficient sample size to estimate distribution percentiles.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-22. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on 1994–1996, 1998 CSFII: All Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	55	153*	13*	83*	142*	208*	269*	273*	400*
1 to <3 months	172	116	12*	50	107	161	216*	291*	361*
3 to <6 months	346	90	9	52	86	125	161	195*	233*
6 to <12 months	631	63	10	27	58	88	120	152	198*
1 to <2 years	980	31	7	14	25	40	64	86	122*
2 to <3 years	989	31	7	15	27	41	59	73	130*
3 to <6 years	4,072	29	7	15	25	38	56	70	102*
6 to <11 years	1,542	21	6	10	18	27	39	50	76*
11 to <16 years	970	16	4	8	13	20	31	39	60*
16 to <18 years	354	15	4	7	12	18	29	37*	60*
18 to <21 years	378	16	3	6	12	21	32	41*	73*
>21 years	9,020	20	7	11	17	26	36	44	68
>65 years[c]	2,136	21	9	13	19	27	34	39	54
All ages	19,509	21	6	11	17	26	38	50	87

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
[c] U.S. EPA, 2004.
* The sample size does not meet minimum requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn, 2008 (Based on 1994–1996, 1998 USDA CSFII).

Table 3-23. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Community Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	239*	-	-	78*	473*	693*	851*	956*
1 to <3 months	143	282*	-	-	41*	524*	784*	962*	1,102*
3 to <6 months	244	373*	-	-	378*	630*	794*	925*	1,192*
6 to <12 months	466	303	-	46	199	520	757*	866*	1,150*
1 to <2 years	611	223	-	27	134	310	577*	760*	1,206*
2 to <3 years	571	265	-	39	160	387	657*	861*	1,354*
3 to <6 years	1,091	327	-	67	245	465	746	959	1,570*
6 to <11 years	1,601	414	-	64	297	598	1,000	1,316	2,056*
11 to <16 years	2,396	520	-	60	329	688	1,338	1,821	2,953
16 to <18 years	1,087	573	-	59	375	865	1,378	1,783	3,053
18 to <21 years	1,245	681	-	88	355	872	1,808	2,368	3,911
≥21 years	8,673	1,043	-	227	787	1,577	2,414	2,958	4,405
≥65 years	2,287	1,046	-	279	886	1,587	2,272	2,730	4,123
All ages	18,216	869	-	134	560	1,299	2,170	2,717	4,123

[a] Includes all participants whether or not they ingested any water from the source during survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.

- = Zero.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-24. Per Capita[a] Estimates of Combined Direct[b] Water Ingestion Based on NHANES 2003--2006: Bottled Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	6*	-	-	-	-	8*	28*	59*
1 to <3 months	143	21*	-	-	-	-	46*	122*	336*
3 to <6 months	244	12*	-	-	-	-	27*	77*	184*
6 to <12 months	466	34	-	-	-	26	118*	187*	422*
1 to <2 years	611	65	-	-	-	82	230*	342*	586*
2 to <3 years	571	95	-	-	-	81	303*	575*	1,136*
3 to <6 years	1,091	108	-	-	-	118	355	526	883*
6 to <11 years	1,601	138	-	-	-	172	444	696	1,138*
11 to <16 years	2,396	202	-	-	-	259	612	938	1,630
16 to <18 years	1,087	339	-	-	-	428	1,063	1,545	2,772
18 to <21 years	1,245	391	-	-	-	497	1,174	1,697	2,966
≥21 years	8,673	375	-	-	-	518	1,199	1,718	3,004
≥65 years	2,287	152	-	-	-	9	533	948	2,288
All ages	18,216	321	-	-	-	399	1,065	1,502	2,811

[a] Includes all participants whether or not they ingested any water from the source during survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water, defined as water added in the preparation of food or beverages, was not accounted for in the estimation of bottled water intake.

\- = Zero.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-25. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Other Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	51*	-	-	-	92*	166*	229*	265*
1 to <3 months	143	82*	-	-	-	146*	243*	276*	544*
3 to <6 months	244	141*	-	-	75*	211*	274*	329*	1,045*
6 to <12 months	466	124	-	-	15	173	297*	770*	1,078*
1 to <2 years	611	82	-	-	5	50	271*	479*	867*
2 to <3 years	571	74	-	-	-	45	232*	459*	935*
3 to <6 years	1,091	62	-	-	-	38	179	433	883*
6 to <11 years	1,601	108	-	-	-	66	386	659	1,112*
11 to <16 years	2,396	163	-	-	-	94	495	1,030	2,242
16 to <18 years	1,087	201	-	-	-	105	603	1,231	2,581
18 to <21 years	1,245	167	-	-	-	72	432	1,154	2,474
≥21 years	8,673	282	-	-	-	151	972	1,831	3,289
≥65 years	2,287	301	-	-	-	186	1,248	1,765	2,645
All ages	18,216	237	-	-	-	123	747	1,480	3,095

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.
- = Zero.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-26. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: All Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	295*	-	-	104*	504*	852*	954*	1,043*
1 to <3 months	143	385*	-	-	169*	732*	1,049*	1,084*	1,265*
3 to <6 months	244	527*	-	24*	567*	889*	1,045*	1,192*	1,390*
6 to <12 months	466	461	50	124	379	761	995*	1,126*	1,521*
1 to <2 years	611	370	65	172	297	493	762*	912*	1,414*
2 to <3 years	571	435	88	190	340	585	920*	1,086*	1,447*
3 to <6 years	1,091	498	115	249	432	659	925	1,181	1,787*
6 to <11 years	1,601	660	144	335	573	870	1,184	1,567	2,302*
11 to <16 years	2,396	885	178	375	687	1,147	1,821	2,595	3,499
16 to <18 years	1,087	1,113	239	441	951	1,512	2,289	2,652	3,781
18 to <21 years	1,245	1,240	163	496	945	1,740	2,569	3,346	4,955
≥21 years	8,673	1,700	491	922	1,509	2,257	3,085	3,727	5,252
≥65 years	2,287	1,498	566	896	1,359	1,922	2,582	3,063	4,126
All ages	18,216	1,426	281	607	1,201	1,967	2,836	3,412	4,943

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.
\- = Zero.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-27. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/day)

Age	Sample size	Mean			90th percentile			95th percentile		
			90% CI			90% BI			90% BI	
		Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Birth to <1 month	88	295*	208*	382*	852*	635*	941*	954*	759*	1,037*
1 to <3 months	143	385*	325*	444*	1,049*	929*	1,074*	1,084*	1,036*	1,099*
3 to <6 months	244	527*	466*	588*	1,045*	1,023*	1,126*	1,190*	1,088*	1,250*
6 to <12 months	466	461	417	506	995*	903*	1,057*	1,126*	1,056*	1,212*
1 to <2 years	611	370	339	401	762*	673*	835*	912*	838*	1,084*
2 to <3 years	571	435	397	472	920*	836*	987*	1,086*	973*	1,235*
3 to <6 years	1,091	498	470	526	925	888	1,009	1,181	1,068	1,250
6 to <11 years	1,601	660	617	703	1,184	1,117	1,294	1,567	1,411	1,810
11 to <16 years	2,396	885	818	952	1,821	1,678	2,114	2,595	2,280	2,807
16 to <18 years	1,087	1,113	1,027	1,199	2,289	2,055	2,412	2,652	2,502	2,868
18 to <21 years	1,245	1,240	1,128	1,352	2,569	2,377	2,991	3,346	3,044	3,740
≥21 years	8,673	1,700	1,641	1,759	3,085	3,027	3,147	3,727	3,586	3,858
≥65 years	2,287	1,498	1,442	1,555	2,582	2,470	2,671	3,063	2,961	3,328
All ages	18,216	1,426	1,377	1,474	2,836	2,781	2,896	3,412	3,352	3,499

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
CI = Confidence Interval.
BI = Bootstrap Interval.

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-28. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	52*	-	-	16*	94*	144*	169*	210*
1 to <3 months	143	49*	-	-	5*	92*	134*	164*	200*
3 to <6 months	244	52*	-	-	53*	85*	116*	132*	177*
6 to <12 months	466	34	-	5	21	56	85*	103*	133*
1 to <2 years	611	20	-	2	12	28	53*	67*	115*
2 to <3 years	571	19	-	3	12	27	48*	61*	102*
3 to <6 years	1,091	18	-	4	13	27	41	51	81*
6 to <11 years	1,601	14	-	2	9	20	32	43	75*
11 to <16 years	2,396	10	-	1	6	13	23	32	61
16 to <18 years	1,087	9	-	1	6	12	20	28	44
18 to <21 years	1,245	9	-	1	5	13	23	35	53
≥21 years	8,673	13	-	3	10	20	32	40	61
≥65 years	2,287	14	-	4	12	21	32	40	59
All ages	18,216	14	-	2	9.4	19	32	42	72

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.
- = Zero.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-29. Per Capita[a] Estimates of Combined Direct[b] Water Ingestion Based on NHANES 2003–2006: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	1*	-	-	-	-	1*	7*	18*
1 to <3 months	143	4*	-	-	-	-	8*	19*	60*
3 to <6 months	244	2*	-	-	-	-	4*	11*	24*
6 to <12 months	466	4	-	-	-	3	13*	22*	42*
1 to <2 years	611	6	-	-	-	7	20*	30*	49*
2 to <3 years	571	7	-	-	-	6	21*	40*	77*
3 to <6 years	1,091	6	-	-	-	7	19	31	53*
6 to <11 years	1,601	4	-	-	-	5	13	24	38*
11 to <16 years	2,396	4	-	-	-	5	11	17	25
16 to <18 years	1,087	5	-	-	-	6	16	24	42
18 to <21 years	1,245	5	-	-	-	7	17	24	45
≥21 years	8,673	5	-	-	-	7	15	22	39
≥65 years	2,287	2	-	-	-	0	7	13	29
All ages	18,216	5	-	-	-	6	15	22	40

[a] Includes all participants whether or not they ingested any water from the source during survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water, defined as water added in the preparation of food or beverages, was not accounted for in the estimation of bottled water intake.

\- = Zero.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-30. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Other Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	11*	-	-	-	22*	34*	45*	53*
1 to <3 months	143	14*	-	-	-	30*	39*	49*	81*
3 to <6 months	244	20*	-	-	9*	29*	44*	60*	142*
6 to <12 months	466	14	-	-	2	18	35*	74*	137*
1 to <2 years	611	7	-	-	1	5	24*	43*	75*
2 to <3 years	571	6	-	-	-	3	17*	34*	69*
3 to <6 years	1,091	3	-	-	-	2	11	22	47*
6 to <11 years	1,601	4	-	-	-	2	13	23	42*
11 to <16 years	2,396	3	-	-	-	2	9	16	35
16 to <18 years	1,087	3	-	-	-	1	9	19	32
18 to <21 years	1,245	2	-	-	-	1	5	15	34
≥21 years	8,673	4	-	-	-	2	12	23	45
≥65 years	2,287	4	-	-	-	3	17	23	37
All ages	18,216	4	-	-	-	2	12	23	45

a Includes all participants whether or not they ingested any water from the source during survey period.

b Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

\- = Zero.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-31. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: All Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	88	65*	-	-	19*	120*	173*	195*	247*
1 to <3 months	143	67*	-	-	29*	123*	180*	194*	230*
3 to <6 months	244	74*	-	4*	72*	116*	153*	179*	228*
6 to <12 months	466	52	6	14	42	84	113*	137*	181*
1 to <2 years	611	33	6	15	26	44	68*	80*	122*
2 to <3 years	571	32	6	15	25	42	67*	78*	123*
3 to <6 years	1,091	27	7	13	23	36	52	63	96*
6 to <11 years	1,601	22	5	11	18	28	42	52	78*
11 to <16 years	2,396	16	3	7	13	20	33	44	66
16 to <18 years	1,087	16	4	7	14	22	33	43	58
18 to <21 years	1,245	17	2	6	13	23	36	44	82
≥21 years	8,673	22	6	11	19	29	41	50	70
≥65 years	2,287	20	7	11	18	26	36	45	61
All ages	18,216	22	5	11	18	29	43	53	84

[a] Includes all participants whether or not they ingested any water from the source during survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

- = Zero.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-32. Per Capita[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/kg-day)

Age	Sample size	Mean			90th percentile			95th percentile		
		Estimate	90% CI		Estimate	90% BI		Estimate	90% BI	
			Lower Bound	Upper Bound		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Birth to <1 month	88	65*	45*	84*	173*	128*	195*	195*	168*	216*
1 to <3 months	143	67*	55*	78*	180*	152*	193*	194*	164*	204*
3 to <6 months	244	74*	65*	82*	153*	140*	178*	179*	157*	195*
6 to <12 months	466	52	47	57	113*	105*	124*	137*	123*	145*
1 to <2 years	611	33	30	36	68*	62*	73*	80*	73*	96*
2 to <3 years	571	32	29	35	67*	59*	72*	78*	71*	91*
3 to <6 years	1,091	27	25	29	52	47	54	63	57	68
6 to <11 years	1,601	22	20	23	42	39	46	52	49	55
11 to <16 years	2,396	16	15	17	33	30	37	44	38	53
16 to <18 years	1,087	16	15	18	33	29	35	43	36	45
18 to <21 years	1,245	17	15	19	36	33	39	44	41	47
≥21 years	8,673	22	21	23	41	40	42	50	48	51
≥65 years	2,287	20	20	21	36	34	38	45	42	46
All ages	18,216	22	21	23	43	42	44	53	51	54

[a] Includes all participants whether or not they ingested any water from the source during survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
CI = Confidence Interval.
BI = Bootstrap Interval.

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-33. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Community Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	51	409*	72*	172*	399*	492*	851*	852*	990*
1 to <3 months	85	531*	103*	341*	513*	745*	957*	1,019*	1,197*
3 to <6 months	192	520*	89*	312*	530*	739*	880*	929*	1,248*
6 to <12 months	416	356	43*	94	270	551	772*	948*	1,161*
1 to <2 years	534	277	36*	88	199	377	627*	781*	1,277*
2 to <3 years	508	321	43*	105	227	448	722*	911*	1,374*
3 to <6 years	985	382	53	137	316	515	778	999	1,592*
6 to <11 years	1,410	511	79	178	413	690	1,072	1,404	2,099*
11 to <16 years	2,113	637	77	192	436	808	1,535	1,976	3,147
16 to <18 years	944	702	97	236	515	966	1,571	1,883	3,467
18 to <21 years	1,086	816	88	216	503	1,065	1,921	2,818	4,106
≥21 years	7,616	1,227	192	469	991	1,741	2,546	3,092	4,576
≥65 years	1,974	1,288	325	628	1,137	1,760	2,395	2,960	4,137
All ages	15,940	1,033	124	333	743	1,474	2,318	2,881	4,312

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-34. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Bottled Water (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	11	55*	15*	20*	27*	46*	59*	190*	275*
1 to <3 months	28	135*	13*	31*	58*	145*	309*	347*	377*
3 to <6 months	65	69*	10*	15*	35*	84*	156*	202*	479*
6 to <12 months	190	111*	13*	30*	58*	147*	261*	359*	627*
1 to <2 years	247	193*	43*	73*	126*	277*	385*	474*	682*
2 to <3 years	220	276*	38*	74*	155*	333*	681*	1,000*	1,315*
3 to <6 years	430	297	72	118	207	389	615	825*	1,305*
6 to <11 years	661	350	81	118	236	445	740	898*	1,934*
11 to <16 years	1,171	477	116	215	333	595	1,000	1,297	1,990
16 to <18 years	549	726	151	252	467	893	1,609	2,121	3,096*
18 to <21 years	662	783	178	255	497	1,019	1,698	2,324	3,824
≥21 years	3,836	840	162	281	637	1,137	1,777	2,363	3,665
≥65 years	7,442	749	100	178	409	824	1,346	1,940	2,717
All ages	8,070	738	118	237	500	999	1,640	2,133	3,601

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water, defined as water added in the preparation of food or beverages, was not accounted for in the estimation of bottled water intake.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-35. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Other Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	41	121*	25*	59*	112*	166*	234*	246*	269*
1 to <3 months	67	187*	33*	120*	177*	236*	278*	400*	612*
3 to <6 months	160	237*	42*	130*	194*	265*	325*	730*	1,184*
6 to <12 months	287	223*	15*	46*	139*	235*	736*	877*	1,203*
1 to <2 years	312	155	9*	20	47	196	474*	628*	1,047*
2 to <3 years	256	163*	9*	19*	50*	214*	482*	798*	1,070*
3 to <6 years	449	155	9	22	57	178	485	631*	999*
6 to <11 years	609	270	16	40	124	386	814	1,065*	1,183*
11 to <16 years	1,116	367	15	44	131	451	1,044	1,467	2,376
16 to <18 years	467	457	12	49	133	530	1,368	2,159	3,122*
18 to <21 years	572	417	17	50	106	432	1,505	2,131	2,831*
≥21 years	3,555	672	32	80	216	926	1,980	2,774	4,285
≥65 years	834	816	64	143	546	1,319	1,923	2,309	3,283*
All ages	7,891	559	22	62	179	689	1,731	2,381	3,798

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-36. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: All Sources (mL/day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	54	481*	74*	217*	473*	658*	921*	996*	1,165*
1 to <3 months	92	665*	103*	457*	704*	1,014*	1,076*	1,099*	1,328*
3 to <6 months	209	660*	55*	379*	685*	965*	1,101*	1,215*	1,450*
6 to <12 months	453	477	64*	152	393	765	1,021*	1,128*	1,526*
1 to <2 years	596	378	78*	173	300	497	772*	914*	1,421*
2 to <3 years	560	441	95*	203	341	589	920*	1,087*	1,450*
3 to <6 years	1,077	506	130	259	437	665	933	1,182	1,787*
6 to <11 years	1,580	666	155	348	574	875	1,186	1,585	2,305*
11 to <16 years	2,362	898	217	385	689	1,149	1,829	2,600	3,499
16 to <18 years	1,059	1,138	259	499	973	1,519	2,298	2,672	3,788
18 to <21 years	1,210	1,277	250	528	986	1,754	2,617	3,358	4,964
≥21 years	8,608	1,712	509	934	1,516	2,258	3,091	3,733	5,253
≥65 years	2,281	1,503	573	898	1,361	1,925	2,585	3,066	4,126
All ages	17,860	1,444	304	623	1,218	1,981	2,842	3,422	4,960

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-37. Consumers-Only[a] Estimates of Combined Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/day)

Age	Sample size	Mean			90th percentile			95th percentile		
		Estimate	90% CI Lower Bound	90% CI Upper Bound	Estimate	90% BI Lower Bound	90% BI Upper Bound	Estimate	90% BI Lower Bound	90% BI Upper Bound
Birth to <1 month	54	481*	396*	566*	921*	715*	993*	996*	853*	1,041*
1 to <3 months	92	665*	626*	704*	1,076*	1,030*	1,097*	1,099*	1,073*	1,215*
3 to <6 months	209	660*	596*	724*	1,101*	1,032*	1,189*	1,215*	1,137*	1,256*
6 to <12 months	453	477	432	523	1,021*	906*	1,057*	1,128*	1,057*	1,238*
1 to <2 years	596	378	347	409	772*	674*	838*	914*	837*	1,086*
2 to <3 years	560	441	403	479	920*	837*	994*	1,087*	970*	1,242*
3 to <6 years	1,077	506	479	534	933	898	1,017	1,182	1,078	1,253
6 to <11 years	1,580	666	624	708	1,186	1,114	1,300	1,585	1,414	1,812
11 to <16 years	2,362	898	832	963	1,829	1,700	2,169	2,600	2,322	2,805
16 to <18 years	1,059	1,138	1,052	1,224	2,298	2,052	2,421	2,672	2,514	2,888
18 to <21 years	1,210	1,277	1,164	1,389	2,617	2,389	3,030	3,358	3,059	3,790
≥21 years	8,608	1,712	1,654	1,771	3,091	3,034	3,149	3,733	3,585	3,861
≥65 years	2,281	1,503	1,446	1,560	2,585	2,471	2,688	3,066	2,961	3,316
All ages	17,860	1,444	1,395	1,492	2,842	2,796	2,917	3,422	3,363	3,510

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
CI = Confidence Interval.
BI = Bootstrap Interval.

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-38. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	51	90*	13*	40*	89*	120*	167*	172*	228*
1 to <3 months	85	93*	17*	62*	91*	118*	163*	186*	210*
3 to <6 months	192	73*	10*	45*	74*	100*	128*	140*	191*
6 to <12 months	416	40	5*	10	30	64	87*	104*	135*
1 to <2 years	534	25	3*	8	17	31	56*	71*	117*
2 to <3 years	508	23	3*	8	16	33	52*	62*	108*
3 to <6 years	985	21	3	8	17	29	43	52	83*
6 to <11 years	1,410	17	2	6	13	23	35	47	78*
11 to <16 years	2,113	12	1	4	8	15	26	35	62
16 to <18 years	944	10	1	4	8	15	23	30	47
18 to <21 years	1,086	11	1	3	7	15	26	36	58
≥21 years	7,616	16	2	6	12	22	34	42	64
≥65 years	1,974	18	4	8	15	23	34	43	60
All ages	15,940	16	2	6	12	22	35	44	76

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-39. Consumers-Only[a] Estimates of Direct[b] Water Ingestion Based on NHANES 2003–2006: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	11	12*	3*	6*	7*	8*	17*	38*	58*
1 to <3 months	28	24*	2*	6*	9*	23*	55*	63*	68*
3 to <6 months	65	10*	2*	2*	5*	11*	21*	27*	81*
6 to <12 months	190	12*	2*	4*	7*	16*	29*	36*	63*
1 to <2 years	247	17*	4*	7*	13*	23*	35*	44*	62*
2 to <3 years	220	20*	3*	5*	11*	23*	48*	68*	111*
3 to <6 years	430	16	4	7	11	20	34	47*	67*
6 to <11 years	661	11	2	4	7	13	26	31*	60*
11 to <16 years	1,171	9	2	4	6	11	19	23	35
16 to <18 years	549	11	2	4	7	14	24	34	58*
18 to <21 years	662	11	3	4	7	14	24	33	52
≥21 years	3,836	11	2	3	8	14	23	29	51
≥65 years	7,442	11	1	2	6	11	18	28	41
All ages	8,070	11	2	4	8	14	24	31	54

[a] Excludes individuals who did not ingest water from the source during the survey period.
[b] Direct water is defined as water ingested directly as a beverage; indirect water, defined as water added in the preparation of food or beverages, was not accounted for in the estimation of bottled water intake.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-40. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: Other Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	41	26*	4*	13*	26*	33*	47*	51*	55*
1 to <3 months	67	31*	5*	22*	32*	37*	49*	69*	87*
3 to <6 months	160	33*	5*	17*	27*	36*	51*	113*	179*
6 to <12 months	287	25*	2*	5*	16*	28*	69*	98*	142*
1 to <2 years	312	14	1*	2	4	17	43*	54*	97*
2 to <3 years	256	12*	1*	1*	4*	15*	35*	62*	75*
3 to <6 years	449	8	0	1	3	11	24	28*	54*
6 to <11 years	609	9	1	1	4	13	23	33*	45*
11 to <16 years	1,116	6	0	1	2	8	18	23	41
16 to <18 years	467	6	0	1	2	6	21	27	42*
18 to <21 years	572	6	0	1	2	5	20	28	42*
≥21 years	3,555	9	0	1	3	11	25	35	53
≥65 years	834	11	1	2	7	18	25	33	42*
All ages	7,891	9	0	1	3	11	25	35	55

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-41. Consumers-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006: All Sources (mL/kg-day)

Age	Sample size	Mean	Percentile						
			10	25	50	75	90	95	99
Birth to <1 month	54	105*	15*	46*	120*	141*	189*	211*	255*
1 to <3 months	92	115*	18*	71*	119*	160*	193*	201*	241*
3 to <6 months	209	92*	8*	50*	95*	132*	163*	186*	238*
6 to <12 months	453	54	7*	16	44	84	114*	137*	183*
1 to <2 years	596	34	7*	15	26	44	68*	82*	122*
2 to <3 years	560	32	7*	15	25	43	67*	78*	123*
3 to <6 years	1,077	27	7	14	24	37	52	63	96*
6 to <11 years	1,580	22	5	11	18	28	42	52	78*
11 to <16 years	2,362	16	4	7	13	20	33	44	66
16 to <18 years	1,059	17	4	7	14	22	33	44	59
18 to <21 years	1,210	18	3	7	14	23	36	45	83
≥21 years	8,608	22	6	12	19	29	41	50	70
≥65 years	2,281	20	7	12	18	26	36	45	61
All ages	17,860	22	6	11	19	29	43	53	84

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-42. Consumer-Only[a] Estimates of Direct and Indirect[b] Water Ingestion Based on NHANES 2003–2006, Mean Confidence Intervals and Bootstrap Intervals for 90th and 95th Percentiles: All Sources (mL/kg-day)

Age	Sample size	Mean			90th percentile			95th percentile		
		Estimate	90% CI		Estimate	90% BI		Estimate	90% BI	
			Lower Bound	Upper Bound		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Birth to <1 month	54	105*	86*	125*	189*	160*	211*	211*	174*	238*
1 to <3 months	92	115*	106*	125*	193*	164*	199*	201*	188*	222*
3 to <6 months	209	92*	84*	101*	163*	143*	179*	186*	171*	201*
6 to <12 months	453	54	49	59	114*	105*	126*	137*	124*	146*
1 to <2 years	596	34	31	37	68*	62*	74*	82*	74*	100*
2 to <3 years	560	32	29	35	67*	60*	72*	78*	72*	92*
3 to <6 years	1,077	27	26	29	52	48	54	63	57	70
6 to <11 years	1,580	22	21	24	42	39	46	52	49	55
11 to <16 years	2,362	16	15	18	33	30	37	44	39	53
16 to <18 years	1,059	17	16	18	33	29	35	44	36	45
18 to <21 years	1,210	18	16	19	36	33	39	45	42	48
≥21 years	8,608	22	21	23	41	40	43	50	48	51
≥65 years	2,281	20	20	21	36	34	39	45	42	47
All ages	17,860	22	22	23	43	42	44	53	52	54

[a] Excludes individuals who did not ingest water from the source during the survey period.

[b] Direct water is defined as water ingested directly as a beverage; indirect water is defined as water added in the preparation of food or beverages. Does not include indirect consumption of bottled water.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

CI = Confidence Interval.

BI = Bootstrap Interval.

Source: U.S. EPA analysis of NHANES 2003–2006 data.

Table 3-43. Assumed Tap Water Content of Beverages in Great Britain

Beverage	% Tap Water
Cold Water	100
Home-made Beer/Cider/Lager	100
Home-made Wine	100
Other Hot Water Drinks	100
Ground/Instant Coffee:[a]	
Black	100
White	80
Half Milk	50
All Milk	0
Tea	80
Hot Milk	0
Cocoa/Other Hot Milk Drinks	0
Water-based Fruit Drink	75
Fizzy Drinks	0
Fruit Juice Type 1[b]	0
Fruit Juice Type 2[b]	75
Milk	0
Mineral Water[c]	0
Bought cider/beer/lager	0
Bought Wine	0

[a] Black—coffee with all water, milk not added; White—coffee with 80% water, 20% milk; Half Milk—coffee with 50% water, 50% milk; All Milk—coffee with all milk, water not added.

[b] Fruit juice: individuals were asked in the questionnaire if they consumed ready-made fruit juice (Type 1 above), or the variety that is diluted (Type 2).

[c] Information on volume of mineral water consumed was obtained only as "number of bottles per week." A bottle was estimated at 500 mL, and the volume was split so that 2/7 was assumed to be consumed on weekends, and 5/7 during the week.

Source: Hopkins and Ellis, 1980.

Table 3-44. Intake of Total Liquid, Total Tap Water, and Various Beverages (L/day) by the British Population

Beverage	All Individuals					Consumers-Only[a]			
	Mean Intake	Approx. Std. Error of Mean	Approx. 95% Confidence Interval for Mean	10 and 90 Percentiles	1 and 99 Percentiles	Percentage of Total Number of Individuals	Mean Intake	Approx. Std. Error of Mean	Approx. 95% Confidence Interval for Mean
Total Liquid	1.589	0.0203	1.547–1.629	0.77–2.57	0.34–4.50	100	1.589	0.0203	1.547–1.629
Total Liquid Home	1.104	0.0143	1.075–1.133	0.49–1.79	0.23–3.10	100	1.104	0.0143	1.075–1.133
Total Liquid Away	0.484	0.0152	0.454–0.514	0.00–1.15	0.00–2.89	89.9	0.539	0.0163	0.506–0.572
Total Tap Water	0.955	0.0129	0.929–0.981	0.39–1.57	0.10–2.60	99.8	0.958	0.0129	0.932–0.984
Total Tap Water Home	0.754	0.0116	0.731–0.777	0.26–1.31	0.02–2.30	99.4	0.759	0.0116	0.736–0.782
Total Tap Water Away	0.201	0.0056	0.190–0.212	0.00–0.49	0.00–0.96	79.6	0.253	0.0063	0.240–0.266
Tea	0.584	0.0122	0.560–0.608	0.01–1.19	0.00–2.03	90.9	0.643	0.0125	0.618–0.668
Coffee	0.19	0.0059	0.178–0.202	0.00–0.56	0.00–1.27	63	0.302	0.0105	0.281–0.323
Other Hot Water Drinks	0.011	0.0015	0.008–0.014	0.00–0.00	0.00–0.25	9.2	0.12	0.0133	0.093–0.147
Cold Water	0.103	0.0049	0.093–0.113	0.00–0.31	0.00–0.85	51	0.203	0.0083	0.186–0.220
Fruit Drinks	0.057	0.0027	0.052–0.062	0.00–0.19	0.00–0.49	46.2	0.123	0.0049	0.113–0.133
Non-Tap Water	0.427	0.0058	0.415–0.439	0.20–0.70	0.06–1.27	99.8	0.428	0.0058	0.416–0.440
Home-brew	0.01	0.0017	0.007–0.013	0.00–0.00	0.00–0.20	7	0.138	0.0209	0.096–0.180
Bought Alcoholic Beverages	0.206	0.0123	0.181–0.231	0.00–0.68	0.00–2.33	43.5	0.474	0.025	0.424–0.524

[a] “Consumers-only” is defined as only those individuals who reported consuming the beverage during the survey period.

Source: Hopkins and Ellis, 1980.

Table 3-45. Summary of Total Liquid and Total Tap Water Intake for Males and Females (L/day) in Great Britain

Beverage	Age Group (years)	Number		Mean Intake		Approx. Std. Error of Mean		Approx 95% Confidence Interval for Mean		10 and 90 Percentiles	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Total Liquid Intake	1 to 4	88	75	0.853	0.888	0.0557	0.066	0.742–0.964	0.756–1.020	0.38–1.51	0.39–1.48
	5 to 11	249	201	0.986	0.902	0.0296	0.0306	0.917–1.045	0.841–0.963	0.54–1.48	0.51–1.39
	12 to 17	180	169	1.401	1.198	0.0619	0.0429	1.277–1.525	1.112–1.284	0.75–2.27	0.65–1.74
	18 to 30	333	350	2.184	1.547	0.0691	0.0392	2.046–2.322	1.469–1.625	1.12–3.49	0.93–2.30
	31 to 54	512	551	2.112	1.601	0.0526	0.0215	2.007–2.217	1.558–1.694	1.15–3.27	0.95–2.36
	≥55	396	454	1.83	1.482	0.0498	0.0356	1.730–1.930	1.411–1.553	1.03–2.77	0.84–2.17
Total Tap Water Intake	1 to 4	88	75	0.477	0.464	0.0403	0.0453	0.396–0.558	0.373–0.555	0.17–0.85	0.15–0.89
	5 to 11	249	201	0.55	0.533	0.0223	0.0239	0.505–0.595	0.485–0.581	0.22–0.90	0.22–0.93
	12 to 17	180	169	0.805	0.725	0.0372	0.0328	0.731–0.8790	0.659–0.791	0.29–1.35	0.31–1.16
	18 to 30	333	350	1.006	0.991	0.0363	0.0304	0.933–1.079	0.930–1.052	0.45–1.62	0.50–1.55
	31 to 54	512	551	1.201	1.091	0.0309	0.024	1.139–1.263	1.043–1.139	0.64–1.88	0.62–1.68
	≥55	396	454	1.133	1.027	0.0347	0.0273	1.064–1.202	0.972–1.082	0.62–1.72	0.54–1.57

Source: Hopkins and Ellis, 1980.

Table 3-46. Daily Total Tap Water Intake Distribution for Canadians, by Age Group (Approx. 0.20-L increments, both sexes, combined seasons)

Amount Consumed[a] L/day	Age Group (years)					
	5 and Under		6 to 17		18 and Over	
	%	Number	%	Number	%	Number
0.00–0.21	11.1	9	2.8	7	0.5	3
0.22–0.43	17.3	14	10.0	25	1.9	12
0.44–0.65	24.8	20	13.2	33	5.9	38
0.66–0.86	9.9	8	13.6	34	8.5	54
0.87–1.07	11.1	9	14.4	36	13.1	84
1.08–1.29	11.1	9	14.8	37	14.8	94
1.30–1.50	4.9	4	9.6	24	15.3	98
1.51–1.71	6.2	5	6.8	17	12.1	77
1.72–1.93	1.2	1	2.4	6	6.9	44
1.94–2.14	1.2	1	1.2	3	5.6	36
2.15–2.36	1.2	1	4.0	10	3.4	22
2.37–2.57	-	0	0.4	1	3.1	20
2.58–2.79	-	0	2.4	6	2.7	17
2.80–3.00	-	0	2.4	6	1.4	9
3.01–3.21	-	0	0.4	1	1.1	7
3.22–3.43	-	0	-	0	0.9	6
3.44–3.64	-	0	-	0	0.8	5
3.65–3.86	-	0	-	0	-	0
>3.86	-	0	1.6	4	2.0	13
TOTAL	100.0	81	100.0	250	100.0	639

[a] Includes tap water and foods and beverages derived from tap water.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-47. Average Daily Tap Water Intake of Canadians (expressed as mL/kg body weight)

Age Group (years)	Average Daily Intake (mL/kg)		
	Females	Males	Both Sexes
<3	53	35	45
3 to 5	49	48	48
6 to 17	24	27	26
18 to 34	23	19	21
35 to 54	25	19	22
≥55	24	21	22
Total Population	24	21	22

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-48. Average Daily Total Tap Water Intake of Canadians, by Age and Season (L/day)[a]

	Age (years)						
	<3	3 to 5	6 to 17	18 to 34	35 to 54	≥55	All Ages
Average							
Summer	0.57	0.86	1.14	1.33	1.52	1.53	1.31
Winter	0.66	0.88	1.13	1.42	1.59	1.62	1.37
Summer/Winter	0.61	0.87	1.14	1.38	1.55	1.57	1.34
90th Percentile							
Summer/Winter	1.5	1.5	2.21	2.57	2.57	2.29	2.36

[a] Includes tap water and foods and beverages derived from tap water.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-49. Average Daily Total Tap Water Intake of Canadians as a Function of Level of Physical Activity at Work and in Spare Time (16 years and older, combined seasons, L/day)

	Work		Spare Time	
Activity Level[a]	Consumption[b] L/day	Number of Respondents	Consumption[b] L/day	Number of Respondents
Extremely Active	1.72	99	1.57	52
Very Active	1.47	244	1.51	151
Somewhat Active	1.47	217	1.44	302
Not Very Active	1.27	67	1.52	131
Not At All Active	1.3	16	1.35	26
Did Not State	1.3	45	1.31	26
TOTAL		688		688

[a] The levels of physical activity listed here were not defined any further by the survey report, and categorization of activity level by survey participants is assumed to be subjective.
[b] Includes tap water and foods and beverages derived from tap water.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-50. Average Daily Tap Water Intake by Canadians, Apportioned Among Various Beverages (Both sexes, by age, combined seasons, L/day)[a]

	Age Group (years)					
	<3	3 to 5	6 to 17	18 to 34	35 to 54	≥55
Total Number in Group	34	47	250	232	254	153
Water	0.14	0.31	0.42	0.39	0.38	0.38
Ice/Mix	0.01	0.01	0.02	0.04	0.03	0.02
Tea	*	0.01	0.05	0.21	0.31	0.42
Coffee	0.01	*	0.06	0.37	0.5	0.42
"Other Type of Drink"	0.21	0.34	0.34	0.2	0.14	0.11
Reconstituted Milk	0.1	0.08	0.12	0.05	0.04	0.08
Soup	0.04	0.08	0.07	0.06	0.08	0.11
Homemade Beer/Wine	*	*	0.02	0.04	0.07	0.03
Homemade Popsicles	0.01	0.03	0.03	0.01	*	*
Baby Formula, etc.	0.09	*	*	*	*	*
TOTAL	0.61	0.86	1.14	1.38	1.55	1.57

[a] Includes tap water and foods and beverages derived from tap water.
* Less than 0.01 L/day.

Source: Canadian Ministry of National Health and Welfare, 1981.

Table 3-51. Intake Rates of Total Fluids and Total Tap Water by Age Group

	Average Daily Consumption Rate (L/day)	
Age Group	Total Fluids[a]	Total Tap Water[b]
6 to 11 months	0.80	0.20
2 years	0.99	0.50
14 to 16 years	1.47	0.72
25 to 30 years	1.76	1.04
60 to 65 years	1.63	1.26

[a] Includes milk, "ready-to-use" formula, milk-based soup, carbonated soda, alcoholic beverages, canned juices, water, coffee, tea, reconstituted juices, and reconstituted soups. Does not include reconstituted infant formula.

[b] Includes water, coffee, tea, reconstituted juices, and reconstituted soups.

Source: Derived from Pennington, 1983.

Table 3-52. Mean and Standard Error for the Daily Intake of Beverages and Tap Water by Age

Age (years)	Tap Water Intake (mL)	Water-Based Drinks (mL)[a]	Soups (mL)	Total Beverage Intake[b] (mL)
All ages	662.5 ± 9.9	457.1 ± 6.7	45.9 ± 1.2	1,434.0 ± 13.7
<1	170.7 ± 64.5	8.3 ± 43.7	10.1 ± 7.9	307.0 ± 89.2
1 to 4	434.6 ± 31.4	97.9 ± 21.5	43.8 ± 3.9	743.0 ± 43.5
5 to 9	521.0 ± 26.4	116.5 ± 18.0	36.6 ± 3.2	861.0 ± 36.5
10 to 14	620.2 ± 24.7	140.0 ± 16.9	35.4 ± 3.0	1,025.0 ± 34.2
15 to 19	664.7 ± 26.0	201.5 ± 17.7	34.8 ± 3.2	1,241.0 ± 35.9
20 to 24	656.4 ± 33.9	343.1 ± 23.1	38.9 ± 4.2	1,484.0 ± 46.9
25 to 29	619.8 ± 34.6	441.6 ± 23.6	41.3 ± 4.2	1,531.0 ± 48.0
30 to 39	636.5 ± 27.2	601.0 ± 18.6	40.6 ± 3.3	1,642.0 ± 37.7
40 to 59	735.3 ± 21.1	686.5 ± 14.4	51.6 ± 2.6	1,732.0 ± 29.3
≥60	762.5 ± 23.7	561.1 ± 16.2	59.4 ± 2.9	1,547.0 ± 32.8

[a] Includes water-based drinks such as coffee, etc. Reconstituted infant formula does not appear to be included in this group.

[b] Includes tap water and water-based drinks such as coffee, tea, soups, and other drinks such as soft drinks, fruitades, and alcoholic drinks.

Source: U.S. EPA, 1984.

Table 3-53. Average Total Tap Water Intake Rate by Sex, Age, and Geographic Area

Group/Subgroup	Number of Respondents	Average Total Tap Water Intake,[a,b] L/day
Total group	5,258	1.39
Sex		
Males	3,892	1.40
Females	1,366	1.35
Age, years		
21 to 44	291	1.30
45 to 64	1,991	1.48
65 to 84	2,976	1.33
Geographic area		
Atlanta	207	1.39
Connecticut	844	1.37
Detroit	429	1.33
Iowa	743	1.61
New Jersey	1,542	1.27
New Mexico	165	1.49
New Orleans	112	1.61
San Francisco	621	1.36
Seattle	316	1.44
Utah	279	1.35

[a] Standard deviations not reported in Cantor et al. (1987).

[b] Total tap water defined as all water and beverages derived from tap water.

Source: Cantor et al., 1987.

Table 3-54. Frequency Distribution of Total Tap Water Intake Rates[a]

Consumption Rate (L/day)	Frequency[b] (%)	Cumulative Frequency[b] (%)
≤0.80	20.6	20.6
0.81–1.12	21.3	41.9
1.13–1.44	20.5	62.4
1.45–1.95	19.5	81.9
≥1.96	18.1	100.0

[a] Represents consumption of tap water and beverages derived from tap water in a "typical" winter week.

[b] Extracted from Table 3 in the article by Cantor et al. (1987).

Source: Cantor et al., 1987.

Table 3-55. Total Tap Water Intake (mL/day) for Both Sexes Combined[a]

Age (years)	Number of Observations	Mean	SD	SE of Mean	Percentile Distribution								
					1	5	10	25	50	75	90	95	99
<0.5	182	272	247	18	*	0	0	80	240	332	640	800	*
0.5 to 0.9	221	328	265	18	*	0	0	117	268	480	688	764	*
1 to 3	1,498	646	390	10	33	169	240	374	567	820	1,162	1,419	1,899
4 to 6	1,702	742	406	10	68	204	303	459	660	972	1,302	1,520	1,932
7 to 10	2,405	787	417	9	68	241	318	484	731	1,016	1,338	1,556	1,998
11 to 14	2,803	925	521	10	76	244	360	561	838	1,196	1,621	1,924	2,503
15 to 19	2,998	999	593	11	55	239	348	587	897	1,294	1,763	2,134	2,871
20 to 44	7,171	1,255	709	8	105	337	483	766	1,144	1,610	2,121	2,559	3,634
45 to 64	4,560	1,546	723	11	335	591	745	1,057	1,439	1,898	2,451	2,870	3,994
65 to 74	1,663	1,500	660	16	301	611	766	1,044	1,394	1,873	2,333	2,693	3,479
≥75	878	1,381	600	20	279	568	728	961	1,302	1,706	2,170	2,476	3,087
Infants (ages <1)	403	302	258	13	0	0	0	113	240	424	649	775	1,102
Children (ages 1 to 10)	5,605	736	410	5	56	192	286	442	665	960	1,294	1,516	1,954
Teens (ages 11 to 19)	5,801	965	562	7	67	240	353	574	867	1,246	1,701	2,026	2,748
Adults (ages 20 to 64)	11,731	1,366	728	7	148	416	559	870	1,252	1,737	2,268	2,707	3,780
Adults (ages ≥65)	2,541	1,459	643	13	299	598	751	1,019	1,367	1,806	2,287	2,636	3,338
All	26,081	1,193	702	4	80	286	423	690	1,081	1,561	2,092	2,477	3,415

[a] Total tap water is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."
* Value not reported due to insufficient number of observations.
SD = Standard deviation.
SE = Standard error.

Source: Ershow and Cantor, 1989.

Table 3-56. Total Tap Water Intake (mL/kg-day) for Both Sexes Combined[a]

Age (years)	Number of Observations: Actual Count	Number of Observations: Weighted Count	Mean	SD	SE of Mean	Percentile Distribution: 1	5	10	25	50	75	90	95	99
<0.5	182	201.2	52.4	53.2	3.9	*	0	0	14.8	37.8	66.1	128.3	155.6	*
0.5 to 0.9	221	243.2	36.2	29.2	2	*	0	0	15.3	32.2	48.1	69.4	102.9	*
1 to 3	1,498	1,687.7	46.8	28.1	0.7	2.7	11.8	17.8	27.2	41.4	60.4	82.1	101.6	140.6
4 to 6	1,702	1,923.9	37.9	21.8	0.5	3.4	10.3	14.9	21.9	33.3	48.7	69.3	81.1	103.4
7 to 10	2,405	2,742.4	26.9	15.3	0.3	2.2	7.4	10.3	16	24	35.5	47.3	55.2	70.5
11 to 14	2,803	3,146.9	20.2	11.6	0.2	1.5	4.9	7.5	11.9	18.1	26.2	35.7	41.9	55
15 to 19	2,998	3,677.9	16.4	9.6	0.2	1	3.9	5.7	9.6	14.8	21.5	29	35	46.3
20 to 44	7,171	13,444.5	18.6	10.7	0.1	1.6	4.9	7.1	11.2	16.8	23.7	32.2	38.4	53.4
45 to 64	4,560	8,300.4	22	10.8	0.2	4.4	8	10.3	14.7	20.2	27.2	35.5	42.1	57.8
65 to 74	1,663	2,740.2	21.9	9.9	0.2	4.6	8.7	10.9	15.1	20.2	27.2	35.2	40.6	51.6
≥75	878	1,401.8	21.6	9.5	0.3	3.8	8.8	10.7	15	20.5	27.1	33.9	38.6	47.2
Infants (ages <1)	403	444.3	43.5	42.5	2.1	0	0	0	15.3	35.3	54.7	101.8	126.5	220.5
Children (ages 1 to 10)	5,605	6,354.1	35.5	22.9	0.3	2.7	8.3	12.5	19.6	30.5	46.0	64.4	79.4	113.9
Teens (ages 11 to 19)	5,801	6,824.9	18.2	10.8	0.1	1.2	4.3	6.5	10.6	16.3	23.6	32.3	38.9	52.6
Adults (ages 20 to 64)	11,731	21,744.9	19.9	10.8	0.1	2.2	5.9	8.0	12.4	18.2	25.3	33.7	40.0	54.8
Adults (ages ≥65)	2,541	4,142.0	21.8	9.8	0.2	4.5	8.7	10.9	15.0	20.3	27.1	34.7	40.0	51.3
All	26,081	39,510.2	22.6	15.4	0.1	1.7	5.8	8.2	13.0	19.4	28.0	39.8	50.0	79.8

[a] Total tap water is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."
* Value not reported due to insufficient number of observations.
SD = Standard deviation.
SE = Standard error.

Source: Ershow and Cantor, 1989.

Table 3-57. Summary of Tap Water Intake by Age				
Age Group	Intake (mL/day)		Intake (mL/kg-day)	
	Mean	10^{th}–90^{th} Percentiles	Mean	10^{th}–90^{th} Percentiles
Infants (<1 year)	302	0–649	43.5	0–100
Children (1 to 10 years)	736	286–1,294	35.5	12.5–64.4
Teens (11 to 19 years)	965	353–1,701	18.2	6.5–32.3
Adults (20 to 64 years)	1,366	559–2,268	19.9	8.0–33.7
Adults (≥65 years)	1,459	751–2,287	21.8	10.9–34.7
All ages	1,193	423–2,092	22.6	8.2–39.8

Source: Ershow and Cantor, 1989.

Table 3-58. Total Tap Water Intake (as % of total water intake) by Broad Age Category[a,b]										
Age (years)	Mean	Percentile Distribution								
		1	5	10	25	50	75	90	95	99
<1	26	0	0	0	12	22	37	55	62	82
1 to 10	45	6	19	24	34	45	57	67	72	81
11 to 19	47	6	18	24	35	47	59	69	74	83
20 to 64	59	12	27	35	49	61	72	79	83	90
≥65	65	25	41	47	58	67	74	81	84	90

[a] Does not include pregnant women, lactating women, or breast-fed children.
[b] Total tap water is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."
0 = Less than 0.5%.

Source: Ershow and Cantor, 1989.

Table 3-59. General Dietary Sources of Tap Water for Both Sexes[a,b]									
		% of Tap Water							
Age (years)	Source	Mean	Standard Deviation	5	25	50	75	95	99
<1	Food[c]	11	24	0	0	0	10	70	100
	Drinking Water	69	37	0	39	87	100	100	100
	Other Beverages	20	33	0	0	0	22	100	100
	All Sources	100							
1 to 10	Food[c]	15	16	0	5	10	19	44	100
	Drinking Water	65	25	0	52	70	84	96	100
	Other Beverages	20	21	0	0	15	32	63	93
	All Sources	100							
11 to 19	Food[c]	13	15	0	3	8	17	38	100
	Drinking Water	65	25	0	52	70	85	98	100
	Other Beverages	22	23	0	0	16	34	68	96
	All Sources	100							
20 to 64	Food[c]	8	10	0	2	5	11	25	49
	Drinking Water	47	26	0	29	48	67	91	100
	Other Beverages	45	26	0	25	44	63	91	100
	All Sources	100							
≥65	Food[c]	8	9	0	2	5	11	23	38
	Drinking Water	50	23	0	36	52	66	87	99
	Other Beverages	42	23	3	27	40	57	85	100
	All Sources	100							
All	Food[c]	10	13	0	2	6	13	31	64
	Drinking Water	54	27	0	36	56	75	95	100
	Other Beverages	36	27	0	14	34	55	87	100
	All Sources	100							

[a] Does not include pregnant women, lactating women, or breast-fed children.
[b] Individual values may not add to totals due to rounding.
[c] Food category includes soups.
0 = Less than 0.5%.

Source: Ershow and Cantor, 1989.

Table 3-60. Summary Statistics for Best-Fit Lognormal Distributions for Water Intake Rates[a]

Group (Age in Years)	In Total Fluid Intake Rate μ	σ	R^2
<1	6.979	0.291	0.996
1 to <11	7.182	0.340	0.953
11 to <20	7.490	0.347	0.966
20 to <65	7.563	0.400	0.977
≥ 65	7.583	0.360	0.988
All ages	7.487	0.405	0.984
Simulated balanced population	7.492	0.407	1.000
Group (Age in Years)	**In Total Fluid Intake Rate μ**	**σ**	**R^2**
<1	5.587	0.615	0.970
1 to <11	6.429	0.498	0.984
11 to <20	6.667	0.535	0.986
20 to <65	7.023	0.489	0.956
≥ 65	7.088	0.476	0.978
All ages	6.870	0.530	0.978
Simulated balanced population	6.864	0.575	0.995

[a] These values (mL/day) were used in the following equations to estimate the quantiles and averages for total tap water intake shown in Table 3-61.
97.5 percentile intake rate = $\exp[\mu + (1.96 \times \sigma)]$
75 percentile intake rate = $\exp[\mu + (0.6745 \times \sigma)]$
50 percentile intake rate = $\exp[\mu]$
25 percentile intake rate = $\exp[\mu - (0.6745 \times \sigma)]$
2.5 percentile intake rate = $\exp[\mu - (1.96 \times \sigma)]$
Mean intake rate – $\exp[\mu + 0.5 \times \sigma^2)]$

Source: Roseberry and Burmaster, 1992.

Table 3-61. Estimated Quantiles and Means for Total Tap Water Intake Rates (mL/day)[a]

Age Group (years)	Percentile 2.5	25	50	75	97.5	Arithmetic Average
<1	80	176	267	404	891	323
1 to <11	233	443	620	867	1,644	701
11 to <20	275	548	786	1,128	2,243	907
20 to <65	430	807	1,122	1,561	2,926	1,265
≥ 65	471	869	1,198	1,651	3,044	1,341
All ages	341	674	963	1,377	2,721	1,108
Simulated Balanced Population	310	649	957	1,411	2,954	1,129

[a] Total tap water is defined as "all water from the household tap consumed directly as a beverage or used to prepare foods and beverages."

Source: Roseberry and Burmaster, 1992.

Table 3-62 . Water Ingested (mL/day)[a] from Water by Itself and Water Added to Other Beverages and Foods

Category		6 Weeks (N = 124)	3 Months (N = 120)	6 Months (N = 99)	9 Months (N = 77)
Water by Itself	Range	0–355	0–355	0–266	0–473
	Per capita mean[b] ± SD	30 ± 89	30 ± 59	30 ± 59	89 ± 89
	Consumer-only mean[c]	89	89	118	118
	Percent consuming[d]	28	24	42	66
Water Added to Formula-Powdered Concentrate	Range	0–1,242	0–1,242	0–1,124	0–1,064
	Per capita mean ± SD	177 ± 296	266 ± 384	266 ± 355	207 ± 325
	Consumer-only mean	473	621	562	562
	Percent consuming	39	42	48	36
Liquid Concentrate	Range	0–621	0–680	0–710	0–532
	Per capita mean ± SD	89 ± 148	237 ± 207	148 ± 207	59 ± 148
	Consumer-only mean	355	384	414	325
	Percent consuming	23	30	35	21
All Concentrated Formula	Range	0–1,242	0–1,242	0–1,123	0–1,064
	Per capita mean ± SD	266 ± 296	384 ± 355	414 ± 325	266 ± 296
	Consumer-only mean	444	562	532	503
	Percent consuming	60	68	81	56
Water Added to Juices and Other Beverages	Range	0–118	0–710	0–473	0–887
	Per capita mean ± SD	<30 ± 30	30 ± 89	30 ± 89	59 ± 148
	Consumer-only mean	89	207	148	207
	Percent consuming	3	9	18	32
Water Added to Powdered Baby Foods and Cereals	Range	0–30	0–177	0–266	0–177
	Per capita mean ± SD	<30 ± 30	<30 ± 30	59 ± 59	30 ± 59
	Consumer-only mean	30	59	89	89
	Percent consuming	2	17	64	43
Water Added to Other Foods (Soups, Jell-o, Puddings)	Range	-	0–118	0–118	0–355
	Per capita mean ± SD	-	30 ± 30	<30 ± 30	30 ± 59
	Consumer-only mean	-	89	59	118
	Percent consuming	0	2	8	29
ALL SOURCES OF WATER	Range	0–1,242	0–1,419	0–1,123	0–1,745
	Per capita mean ± SD	296 ± 325	414 ± 414	473 ± 325	444 ± 355
	Consumer-only mean	414	562	503	473
	Percent consuming	68	77	94	97

[a] Converted from ounces/day; 1 fluid ounce = 29.57 mL.
[b] Mean intake among entire sample.
[c] Mean intake for only those ingesting water from the particular category.
[d] Percentage of infants receiving water from that individual source.
N = Number of observations.
SD = Standard Deviation.
\- Indicates there is insufficient sample size to estimate means.

Source: Levy et al., 1995.

Table 3-63. Mean Per Capita Drinking Water Intake Based on USDA, CSFII Data from 1989–1991 (mL/day)

Sex and Age (years)	Plain Drinking Water	Coffee	Tea	Fruit Drinks and Ades[a]	Total
Males and Females:					
<1	194	0	<0.5	17	211.5
1 to 2	333	<0.5	9	85	427.5
3 to 5	409	2	26	100	537
≤5	359	1	17	86	463
Males:					
6 to 11	537	2	44	114	697
12 to 19	725	12	95	104	936
20 to 29	842	168	136	101	1,247
30 to 39	793	407	136	50	1,386
40 to 49	745	534	149	53	1,481
50 to 59	755	551	168	51	1,525
60 to 69	946	506	115	34	1,601
70 to 79	824	430	115	45	1,414
≥80	747	326	165	57	1,295
≥20	809	408	139	60	1,416
Females:					
6 to 11	476	1	40	86	603
12 to 19	604	21	87	87	799
20 to 29	739	154	120	61	1,074
30 to 39	732	317	136	59	1,244
40 to 49	781	412	174	36	1,403
50 to 59	819	438	137	37	1,431
60 to 69	829	429	124	36	1,418
70 to 79	772	324	161	34	1,291
≥80	856	275	149	28	1,308
≥20	774	327	141	46	1,288
All individuals	711	260	114	65	1,150

[a] Includes regular and low calorie fruit drinks, punches, and ades, including those made from powdered mix and frozen concentrate. Excludes fruit juices and carbonated drinks.

Source: USDA, 1995.

Table 3-64. Number of Respondents That Consumed Tap Water at a Specified Daily Frequency

Population Group	Total *N*	None	Number of Glasses in a Day					
			1–2	3–5	6–9	10–19	20+	DK
Overall	4,663	1,334	1,225	1,253	500	151	31	138
Sex								
Male	2,163	604	582	569	216	87	25	65
Female	2,498	728	643	684	284	64	6	73
Refused	2	2	-	-	-	-	-	-
Age (years)								
1 to 4	263	114	96	40	7	1	0	5
5 to 11	348	90	127	86	15	7	2	20
12 to 17	326	86	109	88	22	7	-	11
18 to 64	2,972	908	751	769	334	115	26	54
>64	670	117	127	243	112	20	2	42
Race								
White	3,774	1,048	1,024	1,026	416	123	25	92
Black	463	147	113	129	38	9	1	21
Asian	77	25	18	23	6	1	-	4
Some Others	96	36	18	22	6	7	2	5
Hispanic	193	63	42	40	28	10	2	7
Refused	60	15	10	13	6	1	1	9
Hispanic								
No	4,244	1,202	1,134	1,162	451	129	26	116
Yes	347	116	80	73	41	18	4	13
DK	26	5	6	7	4	3	-	1
Refused	46	11	5	11	4	1	1	8
Employment								
Full-time	2,017	637	525	497	218	72	18	40
Part-time	379	90	94	120	50	13	7	5
Not Employed	1,309	313	275	413	188	49	3	54
Refused	32	6	4	11	1	2	1	4
Education								
<High School	399	89	95	118	51	14	2	28
High School Graduate	1,253	364	315	330	132	52	13	37
<College	895	258	197	275	118	31	5	9
College Graduate	650	195	157	181	82	19	4	6
Post Graduate	445	127	109	113	62	16	3	12
Census Region								
Northeast	1,048	351	262	266	95	32	7	28
Midwest	1,036	243	285	308	127	26	9	33
South	1,601	450	437	408	165	62	11	57
West	978	290	241	271	113	31	4	20
Day of Week								
Weekday	3,156	864	840	862	334	96	27	106
Weekend	1,507	470	385	391	166	55	4	32
Season								
Winter	1,264	398	321	336	128	45	5	26
Spring	1,181	337	282	339	127	33	10	40
Summer	1,275	352	323	344	155	41	9	40
Fall	943	247	299	234	90	32	7	32
Asthma								
No	4,287	1,232	1,137	1,155	459	134	29	115
Yes	341	96	83	91	40	16	1	13
DK	35	6	5	7	1	1	1	10
Angina								
No	4,500	1,308	1,195	1,206	470	143	29	123
Yes	125	18	25	40	27	6	1	6
DK	38	8	5	7	3	2	1	9
Bronchitis/Emphysema								
No	4,424	1,280	1,161	1,189	474	142	29	124
Yes	203	48	55	58	24	9	1	5
DK	36	6	9	6	2	-	1	9

- = Missing data.
DK = Don't know.
N = Sample size.
Refused = Respondent refused to answer.

Source: U.S. EPA, 1996.

Table 3-65. Number of Respondents That Consumed Juice Reconstituted with Tap Water at a Specified Daily Frequency

Population Group	Total *N*	Number of Glasses in a Day						
		None	1–2	3–5	6–9	10–19	20+	DK
Overall	4,663	1,877	1,418	933	241	73	21	66
Sex								
Male	2,163	897	590	451	124	35	17	33
Female	2,498	980	826	482	117	38	4	33
Refused	2	-	2	-	-	-	-	-
Age (years)								
1 to 4	263	126	71	48	11	4	1	2
5 to 11	348	123	140	58	12	2	1	11
12 to 17	326	112	118	63	18	7	1	4
18 to 64	2,972	1,277	817	614	155	46	16	30
>64	670	206	252	133	43	12	2	14
Race								
White	3,774	1,479	1,168	774	216	57	16	44
Black	463	200	142	83	15	9	1	7
Asian	77	33	27	15	1	-	-	0
Some Others	96	46	19	24	2	1	3	1
Hispanic	193	95	51	30	5	5	1	5
Refused	60	24	11	7	2	1	-	9
Hispanic								
No	4,244	1,681	1,318	863	226	64	17	49
Yes	347	165	87	61	14	7	4	7
DK	26	11	6	5	-	1	-	3
Refused	46	20	7	4	1	1	-	7
Employment								
Full-time	2,017	871	559	412	103	32	9	20
Part-time	379	156	102	88	19	7	2	5
Not Employed	1,309	479	426	265	75	20	7	21
Refused	32	15	4	4	2	1	-	3
Education								
<High School	399	146	131	82	25	7	2	4
High School Graduate	1,253	520	355	254	68	21	7	17
<College	895	367	253	192	47	18	5	11
College Graduate	650	274	201	125	31	7	1	5
Post Graduate	445	182	130	92	26	5	3	4
Census Region								
Northeast	1,048	440	297	220	51	13	4	15
Midwest	1,036	396	337	200	63	17	4	14
South	1,601	593	516	332	84	26	10	28
West	978	448	268	181	43	17	3	9
Day of Week								
Weekday	3,156	1,261	969	616	162	51	11	46
Weekend	1,507	616	449	307	79	22	10	20
Season								
Winter	1,264	529	382	245	66	23	4	10
Spring	1,181	473	382	215	54	19	8	17
Summer	1,275	490	389	263	68	18	6	28
Fall	943	385	265	210	53	13	3	11
Asthma								
No	4,287	1,734	1,313	853	216	69	20	55
Yes	341	130	102	74	25	3	1	5
DK	35	13	3	6	-	1	-	6
Angina								
No	4,500	1,834	1,362	900	231	67	20	59
Yes	125	31	53	25	7	5	1	1
DK	38	12	3	8	3	1	-	6
Bronchitis/Emphysema								
No	4,424	1,782	1,361	882	230	65	21	57
Yes	203	84	53	44	10	6	-	3
DK	36	11	4	7	1	2	-	6

- = Missing data.
DK = Don't know.
N = Sample size.
Refused = Respondent refused to answer.

Source: U.S. EPA, 1996.

Table 3-66. Mean and (standard error) Water and Drink Consumption (mL/kg-day) by Race/Ethnicity

Race/Ethnic Group	*N*	Plain Tap Water	Milk and Milk Drinks	Reconstituted Formula	RTF Formula	Baby Food	Juices and Carbonated Drinks	Non-Carbonated Drinks	Other	Total[a]
Black non-Hispanic	121	21 (1.7)	24 (4.6)	35 (6.0)	4 (2.0)	8 (1.6)	2 (0.7)	14 (1.3)	21 (1.7)	129 (5.7)
White non-Hispanic	620	13 (0.8)	23 (1.2)	29 (2.7)	8 (1.5)	10 (1.2)	1 (0.2)	11 (0.7)	18 (0.8)	113 (2.6)
Hispanic	146	15 (1.2)	23 (2.4)	38 (7.3)	12 (4.0)	10 (1.4)	1 (0.3)	10 (1.6)	16 (1.4)	123 (5.2)
Other	59	21 (2.4)	19 (3.7)	31 (9.1)	19 (11.2)	7 (4.0)	1 (0.5)	8 (2.0)	19 (3.2)	124 (10.6)

[a] Totals may be slightly different from the sums of all categories due to rounding.
N = Number of observations.
RTF = Ready-to-feed.
Note: Standard Error shown in parentheses.

Source: Heller et al., 2000.

Table 3-67. Plain Tap Water and Total Water Consumption by Age, Sex, Region, Urbanicity, and Poverty Category

		Plain Tap Water (mL/kg-day)		Total Water (mL/kg-day)	
Variable	*N*	Mean	SE	Mean	SE
Age					
<12 months	296	11	1.0	130	4.6
12 to 24 months	650	18	0.8	108	1.7
Sex					
Male	475	15	1.0	116	4.1
Female	471	15	0.8	119	3.2
Region					
Northeast	175	13	1.4	121	6.3
Midwest	197	14	1.0	120	3.1
South	352	15	1.3	113	3.7
West	222	17	1.1	119	4.6
Urbanicity					
Urban	305	16	1.5	123	3.5
Suburban	446	13	0.9	117	3.1
Rural	195	15	1.2	109	3.9
Poverty category[a]					
0–1.30	289	19	1.5	128	2.6
1.31–3.50	424	14	1.0	117	4.2
>3.50	233	12	1.3	109	3.5
Total	946	15	0.6	118	2.3

[a] Poverty category represents family's annual incomes of 0–1.30, 1.31–3.50, and greater than 3.50 times the federal poverty level.

N = Number of observations.

SE = Standard Error.

Source: Heller et al., 2000.

Table 3-68. Intake of Water from Various Sources in 2- to 13-Year-Old Participants of the DONALD Study, 1985-1999

Water Intake from	Boys and girls 2 to 3 years *N* = 858[b]	Boys and girls 4 to 8 years *N* = 1,795[b]	Boys 9 to 13 years *N* = 541[b]	Girls 9 to 13 years *N* = 542[b]
	Mean			
Water in Food (mL/day)[a]	365 (33)[c]	487 (36)	673 (36)	634 (38)
Beverages (mL/day)[a]	614 (55)	693 (51)	969 (51)	823 (49)
Milk (mL/day)[a]	191 (17)	177 (13)	203 (11)	144 (9)
Mineral water (mL/day)[a]	130 (12)	179 (13)	282 (15)	242 (15)
Tap water (mL/day)[a]	45 (4)	36 (3)	62 (3)	56 (3)
Juice (mL/day)[a]	114 (10)	122 (0)	133 (7)	138 (8)
Soft drinks (mL/day)[a]	57 (5)	111 (8)	203 (11)	155 (9)
Coffee/tea (mL/day)[a]	77 (7)	69 (5)	87 (4)	87 (5)
	Mean ± SD			
Total water intake[a,d] (mL/day)	1,114 ± 289	1,363 ± 333	1,891 ± 428	1,676 ± 386
Total water intake[a,d] (mL/kg-day)	78 ± 22	61 ± 13	49 ± 11	43 ± 10
Total water intake[a,d] (mL/kcal-day)	1.1 ± 0.3	0.9 ± 0.2	1.0 ± 0.2	1.0 ± 0.2

[a] Converted from g/day, g/kg-day, or g/kcal-day; 1 g = 1 mL.
[b] *N* = Number of records.
[c] Percent of total water shown in parentheses.
[d] Total water = water in food + beverages + oxidation.
SD = Standard deviation.

Source: Sichert-Hellert et al., 2001.

Table 3-69. Mean (±standard error) Fluid Intake (mL/kg-day) by Children Aged 1 to 10 Years, NHANES III, 1988–1994

	Total Sample (*N* = 7,925)	Sample with Temperature Information (*N* = 3,869)	Sample without Temperature Information (*N* = 4,056)
Total fluid	84 ± 1.0	84 ± 1.0	85 ± 1.4
Plain water	27 ± 0.8	27 ± 1.0	26 ± 1.1
Milk	18 ± 0.3	18 ± 0.6	18 ± 0.4
Carbonated drinks	6 ± 0.2	5 ± 0.3	6 ± 0.3
Juice	12 ± 0.3	11 ± 0.6	12 ± 0.4

N = Number of observations.

Source: Sohn et al., 2001.

Table 3-70. Estimated Mean (±standard error) Amount of Total Fluid and Plain Water Intake Among Children[a] Aged 1 to 10 Years by Age, Sex, Race/Ethnicity, Poverty Income Ratio, Region, and Urbanicity (NHANES III, 1988–1994)

	N	Total Fluid		Plain Water	
		mL/day	mL/kg-day	mL/day	mL/kg-day
Age (years)					
1	578	1,393 ± 31	124 ± 2.9	298 ± 19	26 ± 1.8
2	579	1,446 ± 31	107 ± 2.3	430 ± 26	32 ± 1.9
3	502	1,548 ± 75	100 ± 4.6	482 ± 27	31 ± 1.8
4	511	1,601 ± 41	91 ± 2.8	517 ± 23	29 ± 1.3
5	465	1,670 ± 54	84 ± 2.3	525 ± 36	26 ± 1.7
6	255	1,855 ± 125	81 ± 4.9	718 ± 118	31 ± 4.7
7	235	1,808 ± 66	71 ± 2.3	674 ± 46	26 ± 1.9
8	247	1,792 ± 37	61 ± 1.8	626 ± 37	21 ± 1.2
9	254	2,113 ± 78	65 ± 2.1	878 ± 59	26 ± 1.4
10	243	2,051 ± 97	58 ± 2.4	867 ± 74	24 ± 2.0
Sex					
Male	1,974	1,802 ± 30	86 ± 1.8	636 ± 32	29 ± 1.3
Female	1,895	1,664 ± 24	81 ± 1.5	579 ± 26	26 ± 1.0
Race/ethnicity					
White	736	1,653 ± 26	79 ± 1.8	552 ± 34	24 ± 0.3
Black	1,122	1,859 ± 42	88 ± 1.8	795 ± 36	36 ± 1.5
Mexican American	1,728	1,817 ± 25	89 ± 1.7	633 ± 23	29 ± 1.1
Other	283	1,813 ± 47	90 ± 4.2	565 ± 39	26 ± 1.7
Poverty/income ratio[b]					
Low	1,868	1,828 ± 32	93 ± 2.6	662 ± 27	32 ± 1.3
Medium	1,204	1,690 ± 31	80 ± 1.6	604 ± 35	26 ± 1.4
High	379	1,668 ± 54	76 ± 2.5	533 ± 41	22 ± 1.7
Region[c,d]					
Northeast	679	1,735 ± 31	87 ± 2.3	568 ± 52	26 ± 2.1
Midwest	699	1,734 ± 45	84 ± 1.5	640 ± 54	29 ± 1.8
South	869	1,739 ± 31	83 ± 2.2	613 ± 24	28 ± 1.3
West	1,622	737 ± 25	81 ± 1.7	624 ± 44	27 ± 1.9
Urban/rural[d]					
Urban	3,358	1,736 ± 18	84 ± 1.0	609 ± 29	27 ± 1.1
Rural	511	1,737 ± 19	84 ± 4.3	608 ± 20	28 ± 1.2
Total	3,869	1,737 ± 15	84 ± 1.1	609 ± 24	27 ± 1.0

[a] Children for whom temperature data were obtained.

[b] Based on ratio of household income to federal poverty threshold. Low: ≤1.300; medium: 1.301–3.500; high: ≥3.501.

[c] All variables except for Region and Urban/rural showed statistically significant differences for both total fluid and plain water intake by Bonferroni multiple comparison method.

[d] Northeast = Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont;
Midwest = Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin;
South = Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia;
West = Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

N = Number of observations.

Source: Sohn et al., 2001.

Table 3-71. Tap Water Intake in Breast-Fed and Formula-Fed Infants and Mixed-Fed Young Children at Different Age Points

Age	N[a]	Tap Water Intake[b] (mL/day)					Tap Water Intake[b] (mL/kg-day)											
		Total					Total						From Household[c]			From Manufacturing[d]		
		Mean	SD	Median	p95	Max	Mean	SD	Median	p95	Max	%[e]	Mean	SD	%[f]	Mean	SD	%[f]
Breast-fed																		
1 year, total	300	130	180	50	525	1,172	17	24**	6	65	150	17	15	23**	85	2.4	4.7**	15
3 months	111	67	167	0	493	746	10	25**	0	74	125	10	10	25**	97	0.3	1.9**	3
6 months	124	136	150	68	479	634	18	20**	8	5`8	85	18	14	19**	79	3.8	6.3*	21
9 months	47	254	218	207	656	1,172	30	27**	23	77	150	28	26	27**	87	3.7	3.4	13
12 months	18	144	170	85	649	649	15	18**	9	66	66	19	13	18**	86	2.2	2.1	14
Formula-fed																		
1 year, total	758	441	244	440	828	1,603	53	33	49	115	200	51	49	33	92	4.0	8.0	8
3 months	78	662	154	673	874	994	107	23	107	147	159	93	103	28	97	3.4	17.9	3
6 months	141	500	178	519	757	888	63	23	65	99	109	64	59	25	92	4.8	8.0	8
9 months	242	434	236	406	839	1,579	49	27	45	94	200	50	44	27	91	4.5	6.3	9
12 months	297	360	256	335	789	1,603	37	26	32	83	175	39	33	25	91	3.3	3.7	9
Mixed-fed																		
1 to 3 years, total	904	241	243	175	676	2,441	19	20	14	56	203	24	15	20	78	3.9	5.5	22
18 months	277	280	264	205	828	1,881	25	23	18	70	183	28	22	23	88	3.0	4.1	12
24 months	292	232	263	158	630	2,441	18	21	12	49	203	23	15	21	80	3.7	5.0	20
36 months	335	217	199	164	578	1,544	14	13	11	36	103	22	9	12	66	4.9	6.6	34

[a] Numbers of 3-day diet records.
[b] Total tap water = tap water from the household and tap water from food manufacturing. Converted from g/day and g/kg-day; 1 g = 1 mL.
[c] Tap water from household = tap water from the household tap consumed directly as a beverage or used to prepare foods and beverages.
[d] Tap water from food = manufacturing tap water from the industrial food production used for the preparation of foods (bread, butter/margarine, tinned fruit, vegetables and legumes, ready to serve meals, commercial weaning food) and mixed beverages (lemonade, soft drinks).
[e] Mean as a percentage of total water.
[f] Mean as a percentage of total tap water.
* Significantly different from formula-fed infants, $p < 0.05$.
** Significantly different from formula-fed infants, $p < 0.0001$.
SD = Standard Deviation.
p95 = 95th percentile.

Source: Hilbig et al., 2002.

Table 3-72. Percentage of Subjects Consuming Beverages and Mean Daily Beverage Intakes (mL/day) for Children with Returned Questionnaires

Age at Questionnaire	6 Months	9 Months	12 Months	16 Months	20 Months	24 Months	6 to 24 Months[a]
Actual Age (Months)	6.29 ± 0.35	9.28 ± 0.35	12.36 ± 0.46	16.31 ± 0.49	20.46 ± 0.57	24.41 ± 0.53	-
N[b]	677	681	659	641	632	605	585[c]
Human Milk[d]	30	19	11	5	3	0	-
Infant Formula[e]							
%[d]	68	69	29	4	2	0	67[g]
mL/day[f]	798 ± 234	615 ± 328	160 ± 275	12 ± 77	9 ± 83	-	207 ± 112
Cows' Milk[e]							
%[d]	5	25	79	91	93	97	67[g]
mL/day[f]	30 ± 145	136 ± 278	470 ± 310	467 ± 251	402 ± 237	358 ± 225	355 ± 163
Formula and Cows' Milk[e]							
%[d]	70	81	88	92	94	98	67[g]
mL/day[f]	828 ± 186	751 ± 213	630 ± 245	479 ± 248	411 ± 237	358 ± 228	562 ± 154
Juice and Juice Drinks							
%[d]	55	73	89	94	95	93	99[h]
mL/day[f]	65 ± 95	103 ± 112	169 ± 151	228 ± 166	269 ± 189	228 ± 172	183 ± 103
Water							
%[d]	36	59	75	87	90	94	99[h]
mL/day[f]	27 ± 47	53 ± 71	92 ± 109	124 ± 118	142 ± 127	145 ± 148	109 ± 74
Other Beverages[i]							
%[d]	1	9	23	42	62	86	80[h]
mL/day[f]	3 ± 18	6 ± 27	27 ± 71	53 ± 109	83 ± 121	89 ± 133	44 ± 59
Total Beverages mL/day[e,f,j]	934 ± 219	917 ± 245	926 ± 293	887 ± 310	908 ± 310	819 ± 299	920 ± 207

[a] Cumulative number of children and percentage of children consuming beverage and beverage intakes for the 6- through 24-month period.
[b] Number of children with returned questionnaires at each time period.
[c] Number of children with cumulative intakes for 6- through 24-month period.
[d] Percentage of children consuming beverage.
[e] Children are not included when consuming human milk.
[f] Mean standard deviation of beverage intake. Converted from ounces/day; 1 fluid ounce = 29.57 mL.
[g] Percentage of children consuming beverage during 6- through 24-month period. Children who consumed human milk are not included.
[h] Percentage of children consuming beverage during 6- through 24-month period.
[i] Other beverages include non-juice beverages (e.g., carbonated beverages, Kool-Aid).
[j] Total beverages includes all beverages except human milk.
\- Indicates there are insufficient data.

Source: Marshall et al., 2003a.

Table 3-73. Mean (±Standard Deviation) Daily Beverage Intakes Reported on Beverage Frequency Questionnaire and 3-Day Food and Beverage Diaries

Beverage	Age											
	6 months (*N* = 240)			12 months (*N* = 192)			3 years (*N* = 129)			5 years (*N* = 112)		
	Questionnaire	Diary		Questionnaire	Diary		Questionnaire	Diary		Questionnaire	Diary	
	mL/day[a]		%[b]	mL/day[a]		[b]	mL/day[a]		[b]	mL/day[a]		[b]
Human milk	204 ± 373	195 ± 358	28.0	9 ± 21	56 ± 225	12.6	NA[c]	NA	-	NA	NA	-
Infant formula	609 ± 387	603 ± 364	85.8	180 ± 290	139 ± 251	37.0	NA	NA	-	NA	NA	-
Cows' milk	24 ± 124	24 ± 124	6.7	429 ± 349	408 ± 331	90.4	316 ± 216	358 ± 216	100	319 ± 198	325 ± 177	98.2
Juice/juice drinks	56 ± 124	33 ± 59	57.5	151 ± 136	106 ± 101	92.2	192 ± 169	198 ± 169	96.9	189 ± 169	180 ± 163	95.5
Liquid soft drinks	6 ± 68	0 ± 0	1.3	9 ± 30	3 ± 15	20.9	62 ± 71	74 ± 101	74.2	74 ± 95	101 ± 121	82.1
Powdered soft drinks	0 ± 18	0 ± 0	0.4	12 ± 47	3 ± 18	10.5	62 ± 115	47 ± 101	51.2	74 ± 124	47 ± 95	52.7
Water	44 ± 80	30 ± 53	61.7	127 ± 136	80 ± 109	84.9	177 ± 204	136 ± 177	95.3	240 ± 242	169 ± 183	99.1
Total	940 ± 319	896 ± 195	100	905 ± 387	804 ± 284	100	795 ± 355	816 ± 299	100	896 ± 399	819 ± 302	100

[a] Mean standard deviation of all subjects. Converted from ounces/day; 1 fluid ounce = 29.57 mL.
[b] Percent of subjects consuming beverage on either questionnaire or diary.
[c] NA = not applicable.
N = Number of observations.
\- Indicates there are insufficient data to calculate percentage.

Source: Marshall et al., 2003b.

Table 3-74. Consumption of Beverages by Infants and Toddlers (feeding infants and toddlers study)

Beverage Category	4 to 6 Months (*N* = 862)		7 to 8 Months (*N* = 483)		9 to 11 Months (*N* = 679)		12 to 14 Months (*N* = 374)		15 to 18 Months (*N* = 308)		19 to 24 Months (*N* = 316)	
	Consumers[a]	Mean ± SD mL/day[b]	Consumers[a]	Mean ± SD mL/day[b]	Consumers[a]	Mean ± SD mL/day[b]	Consumers[a]	Mean ± SD mL/day[b]	Consumers[a]	Mean ± SD mL/day[b]	Consumers[a]	Mean ± SD mL/day[b]
Total Milks[c]	100	778 ± 257	100	692 ± 257	99.7	659 ± 284	98.2	618 ± 293	94.2	580 ± 305	93.4	532 ± 281
100% Juice[d]	21.3	121 ± 89	45.6	145 ± 109	55.3	160 ± 127	56.2	186 ± 145	57.8	275 ± 189	61.6	281 ± 189
Fruit Drinks[e]	1.6	101 ± 77	7.1	98 ± 77	12.4	157 ± 139	29.1	231 ± 186	38.6	260 ± 231	42.6	305 ± 308
Carbonated	0.1	86 ± 0	1.1	6 ± 9	1.7	89 ± 92	4.5	115 ± 83	11.2	157 ± 106	11.9	163 ± 172
Water	33.7	163 ± 231	56.1	174 ± 219	66.9	210 ± 234	72.2	302 ± 316	74.0	313 ± 260	77.0	337 ± 245
Other[f]	1.4	201 ± 192	2.2	201 ± 219	3.5	169 ± 166	6.6	251 ± 378	12.2	198 ± 231	11.2	166 ± 248
Total beverages	100	863 ± 254	100	866 ± 310	100	911 ± 361	100	1,017 ± 399	100	1,079 ± 399	100	1,097 ± 482

Age (months)

[a] Weighted percentages, adjusted for over sampling, non-response, and under-representation of some racial and ethnic groups.
[b] Amounts consumed only by those children who had a beverage from this beverage category. Converted from ounces/day; 1 fluid ounce = 29.57 mL.
[c] Includes human milk, infant formula, cows' milk, soy milk, and goats' milk.
[d] Fruit or vegetable juices with no added sweeteners.
[e] Includes beverages with less than 100% juice and often with added sweeteners; some were fortified with one or more nutrients.
[f] "Other" beverages category included tea, cocoa, and similar dry milk beverages, and electrolyte replacement beverages for infants.
N = Number of observations.
SD = Standard Deviation.

Source: Skinner et al., 2004.

Table 3-75. Per Capita Estimates of Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	69	21*	19*	22*	39*	33*	46*	44*	38*	46*
Lactating	40	21*	15*	28*	53*	44*	55*	55*	52*	57*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,166	19	19	20	35	35	36	36	46	47

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-76. Per Capita Estimates of Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	70	1,318*	1,199*	1,436*	2,336*	1,851*	3,690*	2,674*	2,167*	3,690*
Lactating	41	1,806*	1,374*	2,238*	3,021*	2,722*	3,794*	3,767*	3,452*	3,803*
Non-pregnant, Non-lactating Aged 15 to 44	2,221	1,243	1,193	1,292	2,336	2,222	2,488	2,937	2,774	3,211

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-77. Per Capita Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	69	13*	11*	14*	31*	28*	46*	43*	33*	46*
Lactating	40	21*	15*	28*	53*	44*	55*	55*	52*	57*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,166	14	14	15	31	30	32	38	36	39

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% B.I. = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-78. Per Capita Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	70	819*	669*	969*	1,815*	1,479*	2,808*	2,503*	2,167*	3,690*
Lactating	41	1,379*	1,021*	1,737*	2,872*	2,722*	3,452*	3,434*	2,987*	3,803*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,221	916	882	951	1,953	1,854	2,065	2,575	2,403	2,908

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-79. Estimates of Consumers Only Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	69	21*	19*	22*	39*	33*	46*	44*	38*	46*
Lactating	40	28*	19*	38*	53*	44*	57*	57*	52*	58*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,149	19	19	20	35	34	37	46	42	48

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-80. Estimates of Consumers-Only Direct and Indirect Water Intake from All Sources by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	70	1,318*	1,199*	1,436*	2,336*	1,851*	3,690*	2,674*	2,167*	3,690*
Lactating	41	1,806*	1,374*	2,238*	3,021*	2,722*	3,794*	3,767*	3,452*	3,803*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,203	1,252	1,202	1,303	2,338	2,256	2,404	2,941	2,834	3,179

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-81. Consumers-Only Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/kg-day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	65	14*	12*	15*	33*	29*	46*	43*	33*	46*
Lactating	33	26*	18*	18*	54*	44*	55*	55*	53*	57*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,028	15	14	16	32	31	33	38	36	42

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-82. Consumers-Only Estimated Direct and Indirect Community Water Ingestion by Pregnant, Lactating, and Childbearing Age Women (mL/day)

		Mean			90th Percentile			95th Percentile		
			90% CI			90% BI			90% BI	
Women Categories	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Pregnant	65	872*	728*	1,016*	1,844*	1,776*	3,690*	2,589*	2,167*	3,690*
Lactating	34	1,665*	1,181*	2,148*	2,959*	2,722*	3,452*	3,588*	2,987*	4,026*
Non-pregnant, Non-lactating Ages 15 to 44 years	2,077	976	937	1,014	2,013	1,893	2,065	2,614	2,475	2,873

NOTE: Source of data: 1994–1996, 1998 USDA CSFII; estimates are based on 2-day averages; interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of the variance; all estimates exclude commercial and biological water.

90% CI = 90% confidence intervals for estimated means; 90% BI = 90% Bootstrap intervals for percentile estimates using bootstrap method with 1,000 replications.

* The sample size does not meet minimum reporting requirements to make statistically reliable estimates as described in the *Third Report on Nutrition Monitoring in the United States*, 1994–1996 (LSRO, 1995).

Source: Kahn and Stralka, 2008 (Based on CSFII 1994–1996 and 1998).

Table 3-83. Total Fluid Intake of Women 15 to 49 Years Old

Reproductive Status[a]	Mean	Standard Deviation	Percentile Distribution						
			5	10	25	50	75	90	95
mL/day									
Control	1,940	686	995	1,172	1,467	1,835	2,305	2,831	3,186
Pregnant	2,076	743	1,085	1,236	1,553	1,928	2,444	3,028	3,475
Lactating	2,242	658	1,185	1,434	1,833	2,164	2,658	3,169	3,353
mL/kg-day									
Control	32.3	12.3	15.8	18.5	23.8	30.5	38.7	48.4	55.4
Pregnant	32.1	11.8	16.4	17.8	17.8	30.5	40.4	48.9	53.5
Lactating	37.0	11.6	19.6	21.8	21.8	35.1	45.0	53.7	59.2

[a] Number of observations: non-pregnant, non-lactating controls (N = 6,201); pregnant (N = 188); lactating (N = 77).

Source: Ershow et al., 1991.

Table 3-84. Total Tap Water Intake of Women 15 to 49 Years Old

Reproductive Status[a]	Mean	Standard Deviation	Percentile Distribution 5	10	25	50	75	90	95
mL/day									
Control	1,157	635	310	453	709	1,065	1,503	1,983	2,310
Pregnant	1,189	699	274	419	713	1,063	1,501	2,191	2,424
Lactating	1,310	591	430	612	855	1,330	1,693	1,945	2,191
mL/kg-day									
Control	19.1	10.8	5.2	7.5	11.7	17.3	24.4	33.1	39.1
Pregnant	18.3	10.4	4.9	5.9	10.7	16.4	23.8	34.5	39.6
Lactating	21.4	9.8	7.4	9.8	14.8	20.5	26.8	35.1	37.4
Fraction of daily fluid intake that is tap water (%)									
Control	57.2	18.0	24.6	32.2	45.9	59.0	70.7	79.0	83.2
Pregnant	54.1	18.2	21.2	27.9	42.9	54.8	67.6	76.6	83.2
Lactating	57.0	15.8	27.4	38.0	49.5	58.1	65.9	76.4	80.5

[a] Number of observations: non-pregnant, non-lactating controls (*N* = 6,201); pregnant (*N* = 188); lactating (*N* = 77).

Source: Ershow et al., 1991.

Table 3-85. Total Fluid (mL/Day) Derived from Various Dietary Sources by Women Aged 15 to 49 Years[a]

Sources	Control Women Mean[b]	Control Women Percentile 50	Control Women Percentile 95	Pregnant Women Mean[b]	Pregnant Women Percentile 50	Pregnant Women Percentile 95	Lactating Women Mean[b]	Lactating Women Percentile 50	Lactating Women Percentile 95
Drinking Water	583	480	1,440	695	640	1,760	677	560	1,600
Milk and Milk Drinks	162	107	523	308	273	749	306	285	820
Other Dairy Products	23	8	93	24	9	93	36	27	113
Meats, Poultry, Fish, Eggs	126	114	263	121	104	252	133	117	256
Legumes, Nuts, and Seeds	13	0	77	18	0	88	15	0	72
Grains and Grain Products	90	65	257	98	69	246	119	82	387
Citrus and Non-citrus Fruit Juices	57	0	234	69	0	280	64	0	219
Fruits, Potatoes, Vegetables, Tomatoes	198	171	459	212	185	486	245	197	582
Fats, Oils, Dressings, Sugars, Sweets	9	3	41	9	3	40	10	6	50
Tea	148	0	630	132	0	617	253	77	848
Coffee and Coffee Substitutes	291	159	1,045	197	0	955	205	80	955
Carbonated Soft Drinks[c]	174	110	590	130	73	464	117	57	440
Non-carbonated Soft Drinks[c]	38	0	222	48	0	257	38	0	222
Beer	17	0	110	7	0	0	17	0	147
Wine Spirits, Liqueurs, Mixed Drinks	10	0	66	5	0	25	6	0	59
All Sources	1,940	NA	NA	2,076	NA	NA	2,242	NA	NA

[a] Number of observations: non-pregnant, non-lactating controls (*N* = 6,201); pregnant (*N* = 188); lactating (*N* = 77).

[b] Individual means may not add to all-sources total due to rounding.

[c] Includes regular, low-calorie, and non-calorie soft drinks.

NA: Not appropriate to sum the columns for the 50th and 95th percentiles of intake.

Source: Ershow et al., 1991.

Table 3-86. Total Tap Water and Bottled Water Intake by Pregnant Women (L/day)

Variables	Cold Tap Water		Bottled Water	
	N	Mean (SD)	*N*	Mean (SD)
Demographics				
Home	2,293	1.3 (1.2)	[a]	[a]
Work	2,295	0.4 (0.6)	[a]	[a]
Total	2,293	1.7 (1.4)	2,284	0.6 (0.9)
Geographic Region				
Site 1	1,019	1.8 (1.4)	1,016	0.5 (0.9)
Site 2	864	1.9 (1.4)	862	0.4 (0.7)
Site 3	410	1.1 (1.3)	406	1.1 (1.2)
Season				
Winter	587	1.6 (1.3)	584	0.6 (1.0)
Spring	622	1.7 (1.4)	622	0.6 (1.0)
Summer	566	1.8 (1.6)	560	0.6 (0.9)
Fall	518	1.8 (1.5)	518	0.5 (0.9)
Age at LMP[b]				
17 to 25	852	1.6 (1.4)	848	0.6 (1.0)
26 to 30	714	1.8 (1.5)	710	0.6 (1.0)
31 to 35	539	1.7 (1.3)	538	0.5 (0.8)
≥36	188	1.8 (1.4)	188	0.5 (0.9)
Education				
≤High school	691	1.5 (1.5)	687	0.6 (1.0)
Some college	498	1.7 (1.5)	496	0.6 (1.0)
≥4-year college	1,103	1.8 (1.3)	1,100	0.5 (0.9)
Race/ethnicity				
White, non-Hispanic	1,276	1.8 (1.4)	1,273	0.5 (0.9)
Black, non-Hispanic	727	1.6 (1.5)	722	0.6 (0.9)
Hispanic, any race	204	1.1 (1.3)	202	1.1 (1.2)
Other	84	1.9 (1.5)	85	0.5 (0.9)
Marital Status				
Single, never married	719	1.6 (1.5)	713	0.6 (1.0)
Married	1,497	1.8 (1.4)	1,494	0.5 (0.9)
Other	76	1.7 (1.9)	76	0.5 (0.9)
Annual Income ($)				
≤40,000	967	1.6 (1.5)	962	0.6 (1.0)
40,000–80,000	730	1.8 (1.4)	730	0.5 (0.9)
>80,000	501	1.7 (1.3)	499	0.5 (0.9)
Employment				
No	681	1.7 (1.5)	679	0.5 (0.9)
Yes	1,611	1.7 (1.4)	1,604	0.6 (0.9)
BMI				
Low	268	1.6 (1.3)	267	0.6 (1.0)
Normal	1,128	1.7 (1.4)	1,123	0.5 (0.9)
Overweight	288	1.7 (1.5)	288	0.6 (0.9)
Obese	542	1.8 (1.6)	540	0.6 (1.0)

Table 3-86. Total Tap Water and Bottled Water Intake by Pregnant Women (L/day) (continued)

Variables	Cold Tap Water		Bottled Water	
	N	Mean (SD)	*N*	Mean (SD)
Diabetes				
No diabetes	2,221	1.7 (1.4)	2,213	0.6 (0.9)
Regular diabetes	17	2.6 (2.1)	17	0.4 (0.8)
Gestational diabetes	55	1.6 (1.6)	54	0.6 (1.0)
Nausea during pregnancy				
No	387	1.6 (1.4)	385	0.6 (1.0)
Yes	1,904	1.7 (1.4)	1,897	0.6 (0.9)
Pregnancy history				
No prior pregnancy	691	1.7 (1.4)	685	0.6 (1.0)
Prior pregnancy with no SAB[c]	1,064	1.7 (1.4)	1,063	0.5 (0.9)
Prior pregnancy with SAB	538	1.8 (1.5)	536	0.6 (1.0)
Caffeine				
0 mg/day	578	1.8 (1.5)	577	0.6 (1.0)
1–150 mg/day	522	1.6 (1.3)	522	0.5 (0.8)
151–300 mg/day	433	1.6 (1.4)	433	0.6 (0.9)
>300 mg/day	760	1.7 (1.5)	752	0.6 (1.0)
Vitamin use				
No	180	1.4 (1.4)	176	0.5 (0.8)
Yes	2,113	1.7 (1.4)	2,108	0.6 (0.9)
Smoking				
Non-smoker	2,164	1.7 (1.4)	2,155	0.6 (0.9)
<10 cigarettes/day	84	1.8 (1.5)	84	0.8 (1.3)
≥10 cigarettes/day	45	1.8 (1.6)	45	0.4(0.7)
Alcohol use				
No	2,257	1.7 (1.4)	2,247	0.6 (0.9)
Yes	36	1.6 (1.2)	37	0.6 (0.8)
Recreational exercise				
No	1,061	1.5 (1.4)	1,054	0.6 (0.9)
Yes	1,232	1.8 (1.4)	1,230	0.6 (1.0)
Illicit drug use				
No	2,024	1.7 (1.4)	2,017	0.6 (0.9)
Yes	268	1.7 (1.5)	266	0.6 (1.0)

[a] Data are not reported in the source document.
[b] LMP = Age of Last Menstrual Period.
[c] SAB = Spontaneous abortion.
N = Number of observations.
SD = Standard deviation.

Source: Forssen et al., 2007.

Table 3-87. Percentage of Mean Water Intake Consumed as Unfiltered and Filtered Tap Water by Pregnant Women

Variables		Cold Unfiltered Tap Water	Cold Filtered Tap Water	Bottled Water
	N	%	%	%
Total	2,280	52	19	28
Geographic Region				
Site 1	1,014	46	28	26
Site 2	860	67	13	19
Site 3	406	37	10	53
Season				
Winter	583	52	19	29
Spring	621	53	19	28
Summer	559	50	20	29
Fall	517	54	19	26
Age at LMP[a]				
≤25	845	55	11	33
26–30	709	49	22	28
31–35	538	51	27	22
≥36	188	53	22	25
Education				
≤High school	685	56	8	34
Some college	495	53	16	30
≥4-year college	1,099	49	27	23
Race/ethnicity				
White, non-Hispanic	1,272	50	26	23
Black, non-Hispanic	720	60	9	30
Hispanic, any race	202	37	9	54
Other	84	48	27	25
Marital Status				
Single, never married	711	57	9	33
Married	1,492	50	25	25
Other	76	57	9	34
Annual Income ($)				
≤40,000	960	56	11	33
40,000–80,000	728	51	24	24
>80,000	499	45	29	25
Employment				
No	678	52	21	27
Yes	1,601	52	19	29
BMI				
Low	266	50	21	29
Normal	1,121	51	22	27

Table 3-87. Percentage of Mean Water Intake Consumed as Unfiltered and Filtered Tap Water by Pregnant Women (continued)

Variables		Cold Unfiltered Tap Water	Cold Filtered Tap Water	Bottled Water
	N	%	%	%
Overweight	287	53	18	28
Obese	540	56	14	29
Diabetes				
No diabetes	2,209	52	19	28
Regular diabetes	17	69	15	16
Gestational diabetes	54	50	22	27
Nausea during pregnancy				
No	385	54	18	28
Yes	1,893	52	20	28
Pregnancy history				
No prior pregnancy	685	48	21	31
Prior pregnancy with no SAB[b]	1,060	54	18	27
Prior pregnancy with SAB	535	53	20	26
Caffeine				
0 mg/day	577	50	22	27
1–150 mg/day	520	53	17	29
151–300 mg/day	432	52	17	30
>300 mg/day	751	53	19	27
Vitamin use				
No	176	57	8	34
Yes	2,104	52	20	28
Smoking				
Non-smoker	2,151	51	20	28
<10 cigarettes/day	84	60	10	28
≥10 cigarettes/day	45	66	7	22
Alcohol use				
No	2,244	52	19	28
Yes	36	58	19	23
Recreational exercise				
No	1,053	54	14	31
Yes	1,227	51	24	26
Illicit drug use				
No	2,013	51	20	28
Yes	266	56	12	31

[a] LMP = Age of Last Menstrual Period.
[b] SAB = spontaneous abortion.
BMI = body mass index.

Source: Forssen et al., 2007.

Table 3-88. Water Intake at Various Activity Levels (L/hour)[a]						
Room Temperature[b] (°F)	Activity Level					
	High (0.15 hp/man)[c]		Medium (0.10 hp/man)[c]		Low (0.05 hp/man)[c]	
	N[d]	Intake	N	Intake	N	Intake
100	-	-	-	-	15	0.653 (0.75)
95	18	0.540 (0.31)	12	0.345 (0.59)	6	0.50 (0.31)
90	7	0.286 (0.26)	7	0.385 (0.26)	16	0.23 (0.20)
85	7	0.218 (0.36)	16	0.213 (0.20)	-	-
80	16	0.222 (0.14)	-	-	-	-

[a] Data expressed as mean intake with standard deviation in parentheses.
[b] Humidity = 80%; air velocity = 60 ft/minute.
[c] The symbol "hp" refers to horsepower.
[d] Number of subjects with continuous data.
\- Data not reported in the source document.

Source: McNall and Schlegel, 1968.

Table 3-89. Planning Factors for Individual Tap Water Consumption		
Environmental Condition	Recommended Planning Factor (gal/day)[a]	Recommended Planning Factor (L/day)[a,b]
Hot	3.0[c]	11.4
Temperate	1.5[d]	5.7
Cold	2.0[e]	7.6

[a] Based on a mix of activities among the workforce as follows: 15% light work; 65% medium work; 20% heavy work. These factors apply to the conventional battlefield where no nuclear, biological, or chemical weapons are used.
[b] Converted from gal/day to L/day.
[c] This assumes 1 quart/12-hour rest period/man for perspiration losses and 1 quart/day-man for urination plus 6 quarts/12-hours light work/man, 9 quarts/12-hours moderate work/man, and 12 quarts/12-hours heavy work/man.
[d] This assumes 1 quart/12-hour rest period/man for perspiration losses and 1 quart/day/man for urination plus 1 quart/12-hours light work/man, 3 quarts/12-hours moderate work/man, and 6 quarts/12-hours heavy work/man.
[e] This assumes 1 quart/12-hour rest period/man for perspiration losses, 1 quart/day/man for urination, and 2 quarts/day/man for respiration losses plus 1 quart/12-hours light work/man, 3 quarts/12-hours moderate work/man, and 6 quarts/6-hours heavy work/man.

Source: U.S. Army, 1983.

Table 3-90. Pool Water Ingestion by Swimmers

Study Group	Number of Participants	Average Water Ingestion Rate (mL/45-minute interval)	Average Water Ingestion Rate (mL/hour)[a]
Children <18 years old	41	37	49
Males <18 years old	20	45	60
Females <18 years old	21	30	43
Adults (>18 years)	12	16	21
Men	4	22	29
Women	8	12	16

[a] Converted from mL/45-minute interval.

Source: Dufour et al., 2006.

Table 3-91. Arithmetic Mean (Maximum) Number of Dives per Diver and Volume of Water Ingested (mL/dive)

Divers and Locations	% of Divers	# of Dives	Volume of Water Ingested (mL)
Occupational Divers (*N* = 35)			
Open sea	57	24 (151)	8.7 (25)
Coastal water, USD <1 km	23	3.2 (36)	9.7 (25)
Coastal water, USD >1 km	20	1.8 (16)	8.3 (25)
Coastal water, USD unknown	51	16 (200)	12 (100)
Open sea and coastal combined	-	-	9.8 (100)
Freshwater, USD <1 km	37	8.3 (76)	5.5 (25)
Freshwater, USD >1 km	37	16 (200)	5.5 (25)
Freshwater, no USD	37	16 (200)	4.8 (25)
Freshwater, USD unknown	77	45 (200)	6.0 (25)
All freshwater combined	-	-	5.7 (25)
Sports Divers—ordinary mask (*N* = 482)			
Open sea			
Coastal water	26	2.1 (120)	7.7 (100)
Open sea and coastal combined	78	14 (114)	9.9 (190)
Fresh recreational water	-	-	9.0 (190)
Canals and rivers	85	22 (159)	13 (190)
City canals	11	0.65 (62)	3.4 (100)
Canals, rivers, city canals combined	1.5	0.031 (4)	2.8 (100)
Swimming pools	-	-	3.2 (100)
	65	17 (134)	20 (190)
Sports Divers—full face mask (*N* = 482)			
Open sea			
Coastal water	0.21	0.012 (6)	0.43 (2.8)
Fresh recreational water	1.0	0.10 (34)	1.3 (15)
Canals and rivers	27	0.44 (80)	1.3 (15)
City canals	1.2	0.098 (13)	0.47 (2.8)
All surface water combined	0.41	0.010 (3)	0.31 (2.8)
Swimming pools	-	-	0.81 (25)
	2.3	0.21 (40)	13 (190)

N = Number of divers.
USD = Upstream sewage discharge.

Source: Schijven and de Roda Husman, 2006.

Table 3-92. Exposure Parameters for Swimmers in Swimming Pools, Freshwater, and Seawater						
Parameter	Adults				Children <15 years	
	Men		Women			
	Mean	95% UCI	Mean	95% UCI	Mean	95% UCI
Swimming Duration (min)						
Swimming Pool	68	180	67	170	81	200
Freshwater	54	200	54	220	79	270
Seawater	45	160	41	180	65	240
Volume Water Swallowed (mL)						
Swimming Pool	34	170	23	110	51	200
Freshwater	27	140	18	86	37	170
Seawater	27	140	18	90	31	140

UCL = Upper confidence interval.

Source: Schets et al., 2011.

Table 3-93. Estimated Water Ingestion During Water Recreation Activities (mL/hr)								
Activity	Surface Water Study				Swimming Pool Study			
	N	Median	Mean	UCL	N	Median	Mean	UCL
Limited Contact Scenarios								
Boating	316	2.1	3.7	11.2	0	-	-	-
Canoeing	766				76			
no capsize		2.2	3.8	11.4		2.1	3.6	11.0
with capsize		3.6	6.0	19.9		3.9	6.6	22.4
all activities		2.3	3.9	11.8		2.6	4.4	14.1
Fishing	600	2.0	3.6	10.8	121	2.0	3.5	10.6
Kayaking	801				104			
no capsize		2.2	3.8	11.4		2.1	3.6	10.9
with capsize		2.9	5.0	16.5		4.8	7.9	26.8
all activities		2.3	3.8	11.6		3.1	5.2	17.0
Rowing	222				0			
no capsize		2.3	3.9	11.8		-	-	-
with capsize		2.0	3.5	10.6		-	-	-
all activities		2.3	3.9	11.8		-	-	-
Wading/splashing	0	-	-	-	112	2.2	3.7	1.0
Walking	0	-	-	-	23	2.0	3.5	1.0
Full Contact Scenarios								
Immersion	0	-	-	-	112	3.2	5.1	15.3
Swimming	0	-	-	-	114	6.0	10.0	34.8
TOTAL	2,705				662			

N = Number of participants.
UCL = Upper confidence limit (i.e. mean +1.96 × standard deviation).
- = No data.

Source: Dorevitch et al. , 2011.

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4. NON-DIETARY INGESTION FACTORS

4.1. INTRODUCTION

Adults and children have the potential for exposure to toxic substances through non-dietary ingestion pathways other than soil and dust ingestion (e.g., ingesting pesticide residues that have been transferred from treated surfaces to the hands or objects that are mouthed). Adults mouth objects such as cigarettes, pens and pencils, or their hands. Young children mouth objects, surfaces, or their fingers as they explore their environment. Mouthing behavior includes all activities in which objects, including fingers, are touched by the mouth or put into the mouth—except for eating and drinking—and includes licking, sucking, chewing, and biting (Groot et al., 1998). In addition, the sequence of events can be important, such as when a handwashing occurs relative to contact with soil and hand-to-mouth contact. Videotaped observations of children's mouthing behavior demonstrate the intermittent nature of hand-to-mouth and object-to-mouth behaviors in terms of the number of contacts recorded per unit of time (Ko et al., 2007).

Adult and children's mouthing behavior can potentially result in ingestion of toxic substances (Lepow et al., 1975). Only one study was located that provided data on mouthing frequency or duration for adults, but Cannella et al. (2006) indicated that adults with developmental disabilities frequently exhibit excessive hand-mouthing behavior. In a large non-random sample of children born in Iowa, parents reported non-nutritive sucking behaviors to be very common in infancy, and to continue for a substantial proportion of children up to the 3rd and 4th birthdays (Warren et al., 2000). Hand-to-mouth behavior has been observed in both preterm and full-term infants (Rochat et al., 1988; Blass et al., 1989; Takaya et al., 2003). Infants are born with a sucking reflex for breast-feeding, and within a few months, they begin to use sucking or mouthing as a means to explore their surroundings. Sucking also becomes a means of comfort when a child is tired or upset. In addition, teething normally causes substantial mouthing behavior (i.e., sucking or chewing) to alleviate discomfort in the gums (Groot et al., 1998).

There are three general approaches to gather data on children's mouthing behavior: real-time hand recording, in which trained observers manually record information (Davis et al., 1995); video-transcription, in which trained videographers tape a child's activities and subsequently extract the pertinent data manually or with computer software (Zartarian et al., 1998, 1997a, b; Black et al., 2005); and questionnaire, or survey response, techniques (Stanek et al., 1998). With real-time hand recording, observations made by trained professionals—rather than parents—may offer the advantage of consistency in interpreting visible behaviors and may be less subjective than observations made by someone who maintains a caregiving relationship to the child. On the other hand, young children's behavior may be influenced by the presence of unfamiliar people (Davis et al., 1995). Groot et al. (1998) indicated that parent observers perceived that deviating from their usual care giving behavior by observing and recording mouthing behavior appeared to have influenced their children's behavior. With video-transcription methodology, an assumption is made that the presence of the videographer or camera does not influence the child's behavior. This assumption may result in minimal biases introduced when filming newborns, or when the camera and videographer are not visible to the child. However, if the children being studied are older than newborns and can see the camera or videographer, biases may be introduced. Ferguson et al. (2006) described apprehension caused by videotaping as well as situations where a child's awareness of the videotaping crew caused "play-acting" to occur, or parents indicated that the child was behaving differently during the taping session, although children tend to ignore the presence of the camera after some time has passed. Another possible source of measurement error may be introduced when children's movements or positions cause their mouthing not to be captured by the camera. Data transcription errors can bias results in either the negative or positive direction. Finally, measurement error can occur if situations arise in which caregivers are absent during videotaping and researchers must stop videotaping and intervene to prevent risky behaviors (Zartarian et al., 1995). Meanwhile, survey response studies rely on responses to questions about a child's mouthing behavior posed to parents or caregivers. Measurement errors from these studies could occur for a number of different reasons, including language/dialect differences between interviewers and respondents, question wording problems and lack of definitions for terms used in questions, differences in respondents' interpretation of questions, and recall/memory effects.

Some researchers express mouthing behavior as the frequency of occurrence (e.g., contacts per hour or contacts per minute). Others describe the duration of specific mouthing events, expressed in units of seconds or minutes. This chapter does not address issues related to contaminant transfer from thumbs, fingers, or objects or surfaces, into the mouth, and subsequent ingestion. Examples of how to use mouthing frequency and duration data can be found in a U.S. Environmental Protection Agency (U.S. EPA) Office of Pesticide Programs guidance document for conducting residential exposure assessments (U.S. EPA, 2009). This guidance document provides a standard method for estimating potential dose among toddlers from incidental ingestion of pesticide residues from previously treated turf. This scenario assumes that pesticide residues are transferred to the skin of toddlers playing on treated yards and are subsequently ingested as a result of hand-to-mouth transfer. A second scenario assumes that pesticide residues are transferred to a child's toy and are subsequently ingested as a result of object-to-mouth transfer. Neither scenario includes residues ingested as a result of soil ingestion.

The recommendations for mouthing frequency and duration for children only are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values for children are based on key studies identified by the U.S. EPA for this factor. Although some studies in Sections 4.3.1 and 4.4.1 are classified as key, they were not directly used to provide the recommendations. They are included as key because they were used by Xue et al. (2007) or Xue et al. (2010) in meta-analyses, which are the primary sources of the recommendations provided in this chapter for hand-to-mouth and object-to-mouth frequency, respectively. Following the recommendations, key and relevant studies on mouthing frequency (see Section 4.3) and duration (see Section 4.4) are summarized and the methodologies used in the key and relevant studies are described. Information on the prevalence of mouthing behavior is presented in Section 4.5.

4.2. RECOMMENDATIONS

The key studies described in Section 4.3 and Section 4.4 were used to develop recommended values for mouthing frequency and duration, respectively, among children. Only one relevant study was located that provided data on mouthing frequency or duration for adults. The recommended hand-to-mouth frequencies are based on data from Xue et al. (2007). Xue et al. (2007) conducted a secondary analysis of data from several of the studies summarized in this chapter, as well as data from unpublished studies. Xue et al. (2007) provided data for the age groups in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005) and categorized the data according to indoor and outdoor contacts. The recommendations for frequency of object-to-mouth contact are based on data from Xue et al. (2010). Xue et al. (2010) conducted a secondary analysis of data from several of the studies summarized in this chapter, as well as data from an unpublished study. Recommendations for duration of object-to-mouth contacts are based on data from Juberg et al. (2001), Greene (2002), and Beamer et al. (2008). Recommendations on duration of object-to-mouth contacts pre-dated the U.S. EPA's (2005) guidance on age groups. For cases in which age groups of children in the key studies did not correspond exactly to U.S. EPA's recommended age groups, the closest age group was used.

Table 4-1 shows recommended mouthing frequencies, expressed in units of contacts per hour, between either any part of the hand (including fingers and thumbs) and the mouth or between an object or surface and the mouth. Recommendations for hand-to-mouth duration are not provided since the algorithm to estimate exposures from this pathway is not time dependent. Table 4-2 presents the confidence ratings for the recommended values. The overall confidence rating is low for both frequency and duration of hand-to-mouth and object-to-mouth contact.

Table 4-1. Summary of Recommended Values for Mouthing Frequency and Duration

Age Group	Hand-to-Mouth Indoor Frequency (contacts/hour) Mean	Hand-to-Mouth Indoor Frequency (contacts/hour) 95th percentile	Hand-to-Mouth Outdoor Frequency (contacts/hour) Mean	Hand-to-Mouth Outdoor Frequency (contacts/hour) 95th percentile	Source
Birth to <1 month	-	-	-	-	Xue et al., 2007
1 to <3 months	-	-	-	-	
3 to <6 months	28	65	-	-	
6 to <12 months	19	52	15	47	
1 to <2 years	20	63	14	42	
2 to <3 years	13	37	5	20	
3 to <6 years	15	54	9	36	
6 to <11 years	7	21	3	12	
11 to <16 years	-	-	-	-	
16 to <21 years	-	-	-	-	
Object-to-Mouth	Indoor Frequency (contacts/hour) Mean	Indoor Frequency (contacts/hour) 95th percentile	Outdoor Frequency (contacts/hour) Mean	Outdoor Frequency (contacts/hour) 95th percentile	
Birth to <1 month	-	-	-	-	Xue et al., 2010
1 to <3 months	-	-	-	-	
3 to <6 months	11	32	-	-	
6 to <12 months	20	38	-	-	
1 to <2 years	14	34	8.8	21	
2 to <3 years	9.9	24	8.1	40	
3 to <6 years	10	39	8.3	30	
6 to <11 years	1.1	3.2	1.9	9.1	
11 to <16 years	-	-	-	-	
16 to <21 years	-	-	-	-	
	Mean Duration (minutes/hour)		95th percentile Duration (minutes/hour)		
Birth to <1 month	-		-		Juberg et al., 2001; Greene, 2002; Beamer et al., 2008
1 to <3 months	-		-		
3 to <6 months	11[a]		26[b]		
6 to <12 months	9[c]		19[d]		
1 to <2 years	7[e]		22[e]		
2 to <3 years	10[f]		11[g]		
3 to <6 years	-		-		
6 to <11 years	-		-		
11 to <16 years	-		-		
16 to <21 years	-		-		

[a] Mean calculated from Juberg et al., 2001(0 to 18 months) and Greene, 2002 (3 to 12 months).
[b] Calculated 95th percentile from Greene, 2002 (3 to 12 months).
[c] Mean calculated from Juberg et al., 2001 (0 to 18 months), Greene, 2002 (3 to 12 months), and Beamer et al., 2008 (6 to 13 months).
[d] Calculated 95th percentile from Greene, 2002 (3 to 12 months) and Beamer et al., 2008 (6 to 13 months).
[e] Mean and 95th percentile from Greene, 2002 (12 to 24 months).
[f] Mean calculated from Juberg et al., 2001 (19 to 36 months), Greene, 2002 (24 to 36 months), and Beamer et al., 2008 (20 to 26 months).
[g] Calculated 95th percentile from Greene, 2002 (24 to 36 months) and Beamer et al., 2008 (20 to 26 months).
\- = No data.

Table 4-2. Confidence in Mouthing Frequency and Duration Recommendations

General Assessment Factor	Rationale	Rating
Soundness		Low
Adequacy of Approach	The approaches for data collection and analysis used were adequate for providing estimates of children's mouthing frequencies and durations. Sample sizes were very small relative to the population of interest. Xue et al., (2007) and (2010) meta-analysis of secondary data was considered to be of suitable utility for the purposes for developing recommendations.	
Minimal (or defined) Bias	Bias in either direction likely exists in both frequency and duration estimates; the magnitude of bias is unknown.	
Applicability and Utility		Low
Exposure Factor of Interest	Key studies for older children focused on mouthing behavior while the infant studies were designed to research developmental issues.	
Representativeness	Most key studies were of samples of U.S. children, but, due to the small sample sizes and small number of locations under study, the study subjects may not be representative of the overall U.S. child population.	
Currency	The studies were conducted over a wide range of dates. However, the currency of the data is not expected to affect mouthing behavior recommendations.	
Data Collection Period	Extremely short data collection periods may not represent behaviors over longer time periods.	
Clarity and Completeness		Low
Accessibility	The journal articles are in the public domain, but, in many cases, primary data were unavailable.	
Reproducibility	Data collection methodologies were capable of providing results that were reproducible within a certain range.	
Quality Assurance	Several of the key studies applied and documented quality assurance/quality control measures.	
Variability and Uncertainty		Low
Variability in Population	The key studies characterized inter-individual variability to a limited extent, and they did not characterize intra-individual variability over diurnal or longer term time frames.	
Description of Uncertainty	The study authors typically did not attempt to quantify uncertainties inherent in data collection methodology (such as the influence of observers on behavior), although some described these uncertainties qualitatively. The study authors typically did attempt to quantify uncertainties in data analysis methodologies (if video-transcription methods were used). Uncertainties arising from short data collection periods typically were unaddressed either qualitatively or quantitatively.	
Evaluation and Review		Medium
Peer Review	All key studies appear in peer-review journals.	
Number and Agreement of Studies	Several key studies were available for both frequency and duration, but data were not available for all age groups. The results of studies from different researchers are generally in agreement.	
Overall rating		**Low**

4.3. NON-DIETARY INGESTION—MOUTHING FREQUENCY STUDIES

4.3.1. Key Studies of Mouthing Frequency

4.3.1.1. *Zartarian et al. (1997a)—Quantifying Videotaped Activity Patterns: Video Translation Software and Training Technologies/Zartarian et al. (1997b)—Quantified Dermal Activity Data from a Four-Child Pilot Field Study/Zartarian et al. (1998)—Quantified Mouthing Activity Data from a Four-Child Pilot Field Study*

Zartarian et al. (1998, 1997a, b) conducted a pilot study of the video-transcription methodology to investigate the applicability of using videotaping for gathering information related to children's activities, dermal exposures, and mouthing behaviors. The researchers had conducted studies using the real-time hand recording methodology. These studies demonstrated poor inter-observer reliability and observer fatigue when working for long periods of time. This prompted the investigation into using videotaping with transcription of the children's activities at a point in time after the videotaped observations occurred.

Four Mexican American farm worker children in the Salinas Valley of California each were videotaped with a hand-held video camera during their waking hours, excluding time spent in the bathroom, over one day in September 1993. The boys were 2 years 10 months old and 3 years 9 months old; the girls were 2 years and 5 months old, and 4 years and 2 months old. Time of videotaping was 6.0 hours for the younger girl, 6.6 hours for the older girl, 8.4 hours for the younger boy and 10.1 hours for the older boy. The videotaping gathered information on detailed micro-activity patterns of children to be used to evaluate software for videotaped activities and translation training methods. The researchers reported measures taken to assess inter-observer reliability and several problems with the video-transcription process.

The hourly data showed that non-dietary object mouthing occurred in 30 of the 31 hours of tape time, with one child eating during the hour in which no non-dietary object mouthing occurred. Mean object-to-mouth contacts for the four children were reported to be 11 contacts per hour (median = 9 contacts per hour), with an average per child range of 1 to 29 contacts per hour (Zartarian et al., 1998). Objects mouthed included bedding/towels, clothes, dirt, grass/vegetation, hard surfaces, hard toys, paper/card, plush toy, and skin (Zartarian et al., 1998). Average hand-to-mouth contacts for the four children were 13 contacts per hour (averaging the sum of left hand and right hand-to-mouth contacts and averaging across children, from Zartarian et al. [1997b]), with the average per child ranging from 9 to 19 contacts per hour.

This study's primary purpose was to develop and evaluate the video-transcription methodology; a secondary purpose was collection of mouthing behavior data. The sample of children studied was very small and not likely to be representative of the national population. As with other video-transcription studies, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

4.3.1.2. *Reed et al. (1999)—Quantification of Children's Hand and Mouthing Activities through a Videotaping Methodology*

In this study, Reed et al. (1999) used a video-transcription methodology to quantify the frequency and type of children's hand and mouth contacts, as well as a survey response methodology, and compared the videotaped behaviors with parents' perceptions of those behaviors. Twenty children ages 3 to 6 years old selected randomly at a daycare center in New Brunswick, NJ, and 10 children ages 2 to 5 years old at residences in Newark and Jersey City, NJ who were not selected randomly, were studied (sex not specified). For the video-transcription methodology, inter-observer reliability tests were performed during observer training and at four points during the two years of the study. The researchers compared the results of videotaping the ten children in the residences with their parents' reports of the children's daily activities. Mouthing behaviors studied included hand-to-mouth and hand bringing object-to-mouth.

Table 4-3 presents the video-transcription mouthing contact frequency results. The authors analyzed parents' responses on frequencies of their children's mouthing behaviors and compared those responses with the children's videotaped behaviors, which revealed certain discrepancies: Parents' reported hand-to-mouth contact of "almost never" corresponded to overall somewhat lower videotaped hand-to-mouth frequencies than those of children whose parents reported "sometimes," but there was little correspondence between parents' reports of object-to-mouth frequency and videotaped behavior.

The advantages of this study were that it compared the results of video-transcription with the survey response methodology results and that it described quality assurance steps taken to assure reliability of transcribed videotape data. However, only a small number of children were studied, some were not selected for observation randomly, and the sample of children studied may not be representative of either the locations studied or the national population. Because of the children's ages, the presence of unfamiliar persons following the children with a video camera may influence the video-transcription results. The parents' survey responses also may be influenced by recall/memory effects and other limitations of survey methodologies.

4.3.1.3. *Freeman et al. (2001)—Quantitative Analysis of Children's Micro-Activity Patterns: The Minnesota Children's Pesticide Exposure Study*

Freeman et al. (2001) conducted a survey response and video-transcription study of some of the respondents in a phased study of children's pesticide exposures in the summer and early fall of 1997. A probability-based sample of 168 families with children ages 3 to <14 years old in urban (Minneapolis/St. Paul) and non-urban (Rice and Goodhue Counties) areas of Minnesota answered questions about children's mouthing of paint chips, food-eating without utensils, eating of food dropped on the floor, mouthing of non-food items, and mouthing of thumbs and fingers. For the survey response portion of the study, parents provided the responses for children ages 3 and 4 years and collaborated with or assisted older children with their responses. Of the 168 families responding to the survey, 102 were available, selected, and agreed to measurements of pesticide exposure. Of these 102 families, 19 agreed to videotaping of the study children's activities for a period of 4 consecutive hours.

Based on the survey responses for 168 children, the 3-year olds had significantly more positive responses for all reported behavior compared to the other age groups. The authors stated that they did not know whether parent reporting of 3-year olds' behavior influenced the responses given. Table 4-4 shows the percentage of children, grouped by age, who were reported to exhibit non-food related mouthing behaviors. Table 4-5 presents the mean and median number of mouthing contacts by age for the 19 videotaped children. Among the four age categories of these children, object-to-mouth activities were significantly greater for the 3- and 4-year olds than any other age group, with a median of 3 and a mean of 6 contacts per hour ($p = 0.002$, Kruskal Wallis test comparison across four age groups). Hand-to-mouth contacts had a median of 3.5 and mean of 4 contacts per hour for the three 3- and 4-year olds observed, median of 2.5 and mean of 8 contacts per hour for the seven 5- and 6-year olds observed, median of 3 and mean of 5 contacts per hour for the four 7- and 8-year olds observed, and median of 2 and mean of 4 for the five 10-, 11-, and 12-year olds observed. Sex differences were observed for some of the activities, with boys spending significantly more time outdoors than girls. Hand-to-mouth and object-to-mouth activities were less frequent outdoors than indoors for both boys and girls.

For the 19 children in the video-transcription portion of the study, inter-observer reliability checks and quality control checks were performed on randomly sampled tapes. For four children's tapes, comparison of the manual video-transcription with a computerized transcription method (Zartarian et al., 1995) also was performed; no significant differences were found in the frequency of events recorded using the two techniques. The frequency of six behaviors (hand-to-mouth, hand-to-object, object-to-mouth, hand-to-smooth surface, hand-to-textured surface, and hand-to-clothing) was recorded. The amount of time each child spent indoors, outdoors, and in contact with soil or grass, as well as whether the child was barefoot was also recorded. For the four children whose tapes were analyzed with the computerized transcription method, which calculates event durations, the authors stated that most hand-to-mouth and object-to-mouth activities were observed during periods of lower physical activity, such as television viewing.

An advantage to this study is that it included results from two separate methodologies, and included quality assurance steps taken to assure reliability of transcribed videotape data. However, the children in this study may not be representative of all children in the United States. Variation in who provided the survey responses (sometimes parents only, sometimes children with parents) may have influenced the responses given. Children studied using the video-transcription methodology were not chosen randomly from the survey response group. The presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.3.1.4. *Tulve et al. (2002)—Frequency of Mouthing Behavior in Young Children*

Tulve et al. (2002) coded the unpublished Davis et al. (1995) data for location (indoor and outdoor) and activity type (quiet or active) and analyzed the subset of the data that consisted of indoor mouthing behavior during quiet activity (72 children, ranging in age from 11 to 60 months). A total of one hundred eighty-six 15-minute observation periods were included in the study, with the number of observation periods per child ranging from 1 to 6. Tulve et al. (2002) used the Davis et al. (1995) data from which the children were selected randomly based on date of birth through a combination of birth certificate records and random digit dialing of residential telephone numbers.

Results of the data analyses indicated that there was no association between mouthing frequency and sex, but a clear association between mouthing frequency and age was observed. The analysis indicated that children ≤24 months had the highest frequency of mouthing behavior (81 events/hour) and that children >24 months had the lowest (42 events/hour) (see Table 4-6). Both groups of children were observed to mouth toys and hands more frequently than household surfaces or body parts other than hands.

An advantage of this study is that the randomized design may mean that the children studied were relatively representative of young children living in the study area, although they may not be representative of the U.S. population. Due to the ages of the children studied, the observers' use of headphones and manual recording of mouthing behavior on observation sheets may have influenced the children's behavior.

4.3.1.5. *AuYeung et al. (2004)—Young Children's Mouthing Behavior: An Observational Study via Videotaping in a Primarily Outdoor Residential Setting*

AuYeung et al. (2004) used a video-transcription methodology to study a group of 38 children (20 females and 18 males; ages 1 to 6 years), 37 of whom were selected randomly via a telephone screening survey of a 300 to 400 square mile portion of the San Francisco, CA peninsula, along with one child selected by convenience because of time constraints. Families who lived in a residence with a lawn and whose annual income was >$35,000 were asked to participate. Videotaping took place between August 1998 and May 1999 for approximately two hours per child. Videotaping by one researcher was supplemented with field notes taken by a second researcher who also was present during taping. Most of the videotaping took place during outdoor play, however, data were included for several children (one child <2 years old and eight children >2 years old) who had more than 15 minutes of indoor play during their videotaping sessions.

The videotapes were translated into American Standard Code for Information Interchange (ASCII) computer files using Virtual Timing Device™ software described in Zartarian et al. (1997a). Both frequency and duration (see Section 4.4.2.5 of this chapter) were analyzed. Between 5% and 10% of the data files translated were randomly chosen for quality control checks for inter-observer agreement. Ferguson et al. (2006) described quality control aspects of the study in detail.

For analysis, the mouthing contacts were divided into indoor and outdoor locations and 16 object/surface categories. Mouthing frequency was analyzed by age and sex separately and in combination. Mouthing contacts were defined as contact with the lips, inside of the mouth, and/or the tongue; dietary contacts were ignored. Table 4-7 shows mouthing frequencies for indoor locations. For the one child observed that was ≤24 months of age, the total mouthing frequency was 84.8 contacts/hour; for children >24 months, the median indoor mouthing frequency was 19.5 contacts/hour. Outdoor median mouthing frequencies (see Table 4-8) were very similar for children ≤24 months of age (13.9 contacts/hour) and >24 months (14.6 contacts/hour).

Non-parametric tests, such as the Wilcoxon rank sum test, were used for the data analyses. Both age and sex were found to be associated with differences in mouthing behavior. Girls had significantly higher frequencies of mouthing contacts with the hands and non-dietary objects than boys ($p = 0.01$ and $p = 0.008$, respectively).

This study provides distributions of outdoor mouthing frequencies with a variety of objects and surfaces. Although indoor mouthing data also were included in this study, the results were based on a small number of children ($N = 9$) and a limited amount of indoor play. The sample of children may be representative of certain socioeconomic strata in the study area, but it is not likely to be representative of the national population. Because of the children's ages, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.3.1.6. *Black et al. (2005)—Children's Mouthing and Food-Handling Behavior in an Agricultural Community on the U.S./Mexico Border*

Black et al. (2005) studied mouthing behavior of children in a Mexican-American community along the Rio Grande River in Texas, during the spring and summer of 2000, using a survey response and a video-transcription methodology. A companion study of this community (Shalat et al., 2003) identified 870 occupied households during the April 2000 U.S. Census and contacted 643 of these via in-person interview to determine the presence of children under the age of 3 years. Of the 643 contacted, 91 had at least one child under the age of 3 years (Shalat et al., 2003). Of these 91 households, the mouthing and food-handling behavior of 52 children (26 boys and 26 girls) from 29 homes was videotaped, and the children's parents answered questions about children's hygiene, mouthing and food-handling activities (Black et al., 2005). The study was of children ages 7 to 53 months, grouped into four age categories: infants (7 to 12 months), 1-year olds (13 to 24 months), 2-year olds (25 to 36 months), and preschoolers (37 to 53 months).

The survey asked questions about children's ages, sexes, reported hand-washing, mouthing and food-handling behavior (N = 52), and activities (N = 49). Parental reports of thumb/finger placement in the mouth showed decreases with age. The researchers attempted to videotape each child for 4 hours. The children were followed by the videographers through the house and yard, except for times when they were napping or using the bathroom. Virtual Timing Device™ software, mentioned earlier, was used to analyze the videotapes.

Based on the results of videotaping, most of the children (49 of 52) spent the majority of their time indoors. Of the 39 children who spent time both indoors and outdoors, all three behaviors (hand-to-mouth, object-to-mouth and food handling) were more frequent and longer while the child was indoors. Hand-to-mouth activity was recorded during videotaping for all but one child, a 30 month old girl.

For the four age groups, the mean hourly hand-to-mouth frequency ranged from 11.9 (2-year olds) to 22.1 (preschoolers), and the mean hourly object-to-mouth frequency ranged from 7.8 (2-year olds) to 24.4 (infants). No significant linear trends were seen with age or sex for hand-to-mouth hourly frequency. A significant linear trend was observed for hourly object-to-mouth frequency, which decreased as age increased (adjusted $R^2 = 0.179$; $p = 0.003$). Table 4-9 shows the results of this study.

Because parental survey reports were not strongly correlated with videotaped hand or object mouthing, the authors suggested that future research might include alternative methods of asking about mouthing behavior to improve the correlation of questionnaire data with videotaped observations.

One advantage of this study is that it compared survey responses with videotaped information on mouthing behavior. A limitation is that the sample was fairly small and was from a limited area (mid-Rio Grande Valley) and is not likely to be representative of the national population. Because of the children's ages, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.3.1.7. *Xue et al. (2007)—A Meta-Analysis of Children's Hand-to-Mouth Frequency Data for Estimating Non-Dietary Ingestion Exposure*

Xue et al. (2007) gathered hand-to-mouth frequency data from nine available studies representing 429 subjects and more than 2,000 hours of behavior observation (Zartarian et al., 1998; Reed et al., 1999; Leckie et al., 2000; Freeman et al., 2001; Greene, 2002; Tulve et al., 2002; Hore, 2003; Black et al., 2005, Beamer et al., 2008). Two of these studies (i.e., Leckie et al., 2000; Hore, 2003) are unpublished data sets and are not summarized in this chapter. The remaining seven studies are summarized elsewhere in this chapter. Xue et al. (2007) conducted a meta-analysis to study differences in hand-to-mouth behavior. The purpose of the analysis was to

1. examine differences across studies by age (using the new U.S. EPA recommended age groupings [U.S. EPA, 2005]), sex, and indoor/outdoor location;
2. fit variability distributions to the available hand-to-mouth frequency data for use in one-dimensional Monte Carlo exposure assessments;
3. fit uncertainty distributions to the available hand-to-mouth frequency data for use in two-dimensional Monte Carlo exposure assessments; and
4. assess hand-to-mouth frequency data needs using the new U.S. EPA recommended age groupings (U.S. EPA, 2005).

The data were sorted into age groupings. Visual inspection of the data and statistical methods (i.e., method of moments and maximum likelihood estimation) were used, and goodness-of-fit tests were applied to verify the selection among lognormal, Weibull, and normal distributions (Xue et al., 2007). Analyses to study inter- and intra-individual variability of indoor and outdoor hand-to-mouth frequency were conducted. It was found that age and location (indoor vs. outdoor) were important factors contributing to hand-to-mouth frequency, but study and sex were not (Xue et al., 2007). Distributions of hand-to-mouth frequencies were developed for both indoor and outdoor activities. Table 4-10 presents distributions for indoor settings while Table 4-11 presents distributions for outdoor settings. Hand-to-mouth frequencies decreased for both indoor and outdoor activity as age increased, and they were higher indoors than outdoors for all age groups (Xue et al., 2007).

A strength of this study is that it is the first effort to fit hand-to-mouth distributions of children in different locations while using U.S. EPA's recommended age groups. Limitations of the studies used in this meta-analysis apply to the results from the meta-analysis as well; the uncertainty analysis in this study does not account for uncertainties arising out of differences in approaches used in the various studies used in the meta-analysis.

4.3.1.8. *Beamer et al. (2008)—Quantified Activity Pattern Data from 6 to 27-Month-Old Farmworker Children for Use in Exposure Assessment*

Beamer et al. (2008) conducted a follow-up to the pilot study performed by Zartarian et al. (1997a, b, 1998), described in Sections 4.3.1.1 and 4.4.2.2. For this study, a convenience sample of 23 children residing in the farm worker community of Salinas Valley, CA, was enrolled. Participants were 6- to 13-month-old infants or 20- to 26-month-old toddlers. Two researchers videotaped each child's activities for a minimum of 4 hours and kept a detailed written log of locations visited and objects and surfaces contacted by the child. A questionnaire was administered to an adult in the household to acquire demographic data, housing and cleaning characteristics, eating patterns, and other information pertinent to the child's potential pesticide exposure.

Table 4-12 presents the distribution of object/surface contact frequency for infants and toddlers in events/hour. The mean hand-to-mouth frequency was 18.4 events/hour. The mean mouthing frequency of non-dietary objects was 29.2 events/hour. Table 4-13 presents the distributions for the mouthing frequency and duration of non-dietary objects, and it highlights the differences between infants and toddlers. Toddlers had higher mouthing frequencies with non-dietary items associated with pica (i.e., paper) while infants had higher mouthing frequencies with other non-dietary objects. In addition, boys had higher mouthing frequencies than girls. The advantage of this study is that it included both infants and toddlers. Differences between the two age groups, as well as sex differences, could be observed. As with other video-transcription studies, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

4.3.1.9. *Xue et al. (2010)—A Meta-Analysis of Children's Object-to-Mouth Frequency Data for Estimating Non-Dietary Ingestion Exposure*

Xue et al. (2010) gathered object-to-mouth frequency data from 7 available studies representing 438 subjects and approximately 1,500 hours of behavior observation. The studies used in this analysis included six published studies that were also individually summarized in this chapter (Reed et al., 1999; Freeman et al., 2001; Greene, 2002; Tulve et al., 2002; AuYeung et al., 2004, Beamer et al., 2008) as well as one unpublished data set (Hore, 2003). These data were used to conduct a meta-analysis to study differences in object-to-mouth behavior. The purpose of the analysis was to

1. "examine differences across studies by age (using the new U.S. EPA recommended age groupings [U.S. EPA, 2005]), sex, and indoor/outdoor location;
2. fit variability distributions to the available object to-mouth frequency data for use in one dimensional Monte Carlo exposure assessments;
3. fit uncertainty distributions to the available object-to-mouth frequency data for use in two dimensional Monte Carlo exposure assessments; and
4. assess object-to-mouth frequency data needs using the new U.S. EPA recommended age groupings (U.S. EPA, 2005)."

The data were sorted into age groupings. Visual inspection of the data and statistical methods (i.e., method of moments and maximum likelihood estimation) were used, and goodness-of-fit tests were applied to verify the selection among lognormal, Weibull, and normal distributions (Xue et al., 2010). Analyses to study inter- and intra-individual variability of indoor and outdoor object-to-mouth frequency were conducted. It was found that age, location (indoor vs. outdoor), and study were important factors contributing to object-to-mouth frequency, but study and sex were not (Xue et al., 2010). Distributions of object-to-mouth frequencies were developed for both indoor and outdoor activities. Table 4-14 presents distributions for indoor settings while Table 4-15 presents distributions for outdoor settings. Object-to-mouth frequencies decreased for both indoor and outdoor activity as age increased (i.e., after age <6 to 12 months for indoor activity; and after <3 to 6 years for outdoor activity), and were higher indoors than outdoors for all age groups (Xue et al., 2010).

A strength of this study is that it is the first effort to fit object-to-mouth distributions of children in different locations while using U.S. EPA's recommended age groups. Limitations of the studies used in this meta-analysis apply to the results from the meta-analysis as well; the uncertainty analysis in this study does not account for uncertainties arising out of differences in approaches used in the various studies used in the meta-analysis.

4.3.2. Relevant Studies of Mouthing Frequency

4.3.2.1. *Davis et al. (1995)—Soil Ingestion in Children with Pica: Final Report*

In 1992, under a Cooperative Agreement with U.S. EPA, the Fred Hutchinson Cancer Research Center conducted a survey response and real-time hand recording study of mouthing behavior data. The study included 92 children (46 males, 46 females) ranging in age from <12 months to 60 months, from Richland, Kennewick, and Pasco, WA. The children were selected randomly based on date of birth through a combination of birth certificate records and random digit dialing of residential telephone numbers. For each child, data were collected in one 7-day period during January to April, 1992. Eligibility included residence within the city limits, residence duration >1 month, and at least one parent or guardian who spoke English. Most of the adults who responded to the survey reported their marital status as being married (90%), their race as Caucasian (89%), their household income in the >$30,000 range (56%), or their housing status as single-family home occupants (69%).

The survey asked questions about thumb-sucking and frequency questions about pacifier use, placing fingers, hands and feet in the mouth, and mouthing of furniture, railings, window sills, floor, dirt, sand, grass, rocks, mud, clothes, toys, crayons, pens, and other items. Table 4-16 shows the survey responses for the 92 study children. For most of the children in the study, the mouthing behavior real-time hand recording data were collected simultaneously by parents and by trained observers who described and quantified the mouthing behavior of the children in their home environment. The observers recorded mouth and tongue contacts with hands, other body parts, natural objects, surfaces, and toys every 15 seconds during 15-minute observation periods spread over 4 days. Parents and trained observers wore headphones that indicated elapsed time (Davis et al., 1995). If all attempted observation periods were successful, each child would have a total of sixteen 15-minute observation periods with sixty 15-second intervals per 15-minute observation period, or nine hundred sixty 15-second intervals in all. The number of successful intervals of observation ranged from 0 to 840 per child. Comparisons of the inter-observer reliability between the trained observers and parents showed

> "a high degree of correlation between the overall degree of both mouth and tongue activity recorded by parents and observers. For total mouth activity, there was a significant correlation between the rankings obtained according to parents and observers, and parents were able to identify the same individuals as observers as being most and least oral in 60% of the cases" (Davis et al., 1995).

One advantage of this study is the simultaneous observations by both, parents and trained observers, that allow comparisons regarding the consistency of the recorded observations. The random nature in which the population was selected may provide a representative population of the study area, within certain limitations, but not of the national population. In addition, this study was considered relevant because the data were not analyzed for deriving estimates of mouthing contact. These data were analyzed by Tulve et al., 2002 (see Section 4.3.1.4). Simultaneous collection of food, medication, fecal, and urine samples that occurred as part of the overall study (not described in this summary) may have contributed a degree of deviation from normal routines within the households during the 7 days of data collection and may have influenced children's usual behaviors. Wearing of headphones by parents and trained observers during mouthing observations, presence of non-family-member observers, and parents' roles as observers as well as caregivers also may have influenced the results; the authors state "Having the child play naturally while being observed was challenging. Usually the first day of observation was the most difficult in this respect, and by the third or fourth day of observation the child generally paid little attention to the observers."

4.3.2.2. *Lew and Butterworth (1997)—The Development of Hand-Mouth Coordination in 2- to 5-Month-Old Infants: Similarities with Reaching and Grasping*

Lew and Butterworth (1997) studied 14 infants (10 males, 4 females; mostly first borns) in Stirling, United Kingdom, in 1990 using a video-transcription methodology. Attempts were made to study each infant within 1 week of the infant's 2-, 3-, 4-, and 5-month birthdays. After becoming accustomed to the testing laboratory, and with their mothers present, infants were placed in semi-reclining seats and filmed during an experimental protocol in which researchers placed various objects into the infants' hands. Infants were observed for two baseline periods of 2 minutes each. The researchers coded all contacts to the face and mouth that occurred during baseline periods (prior to and after the object handling period) as well as contacts occurring during the object handling period. Hand-to-mouth contacts included contacts that landed directly in or on the mouth as well as those in which the hand landed on the face first and then moved to the mouth. The researchers assessed inter-observer agreement using a rater not involved with the study, for a random proportion (approximately 10%) of the movements documented during the object handling period, and reported inter-observer agreement of 0.90 using Cohen's kappa for the location of contacts. The frequency of contacts ranged between zero and one contact per minute.

The advantages of this study were that use of video cameras could be expected to have minimal effect on infant behavior for infants of these ages, and the researchers performed tests of inter-observer reliability. A disadvantage is that the study included baseline observation periods of only 2 minutes' duration, during which spontaneous hand-to-mouth movements could be observed. The extent to which these infants' behavior is representative of other infants of these ages is unknown.

4.3.2.3. *Tudella et al. (2000)—The Effect of Oral-Gustatory, Tactile-Bucal, and Tactile-Manual Stimulation on the Behavior of the Hands in Newborns*

Tudella et al. (2000) studied the frequency of hand-to-mouth contact, as well as other behaviors, in 24 full-term Brazilian newborns (10 to 14 days old) using a video-transcription methodology. Infants were in an alert state, in their homes in silent and previously heated rooms in a supine position and had been fed between 1 and 1 1/2 hours before testing. Infants were studied for a 4-minute baseline period without stimuli before experimental stimuli were administered. Results from the four-minute baseline period, without stimuli, indicated that the mean frequency of hand-to-mouth contact (defined as right hand or left hand touching the lips or entering the buccal cavity, either with or without rhythmic jaw movements) was almost 3 right hand contacts and slightly more than 1.5 left hand contacts, for a total hand-to-mouth contact frequency of about 4 contacts in the 4-minute period. The researchers performed inter-observer reliability tests on the videotape data and reported an inter-coder Index of Concordance of 93%.

The advantages of this study were that use of video cameras could be expected to have virtually no effect on newborns' behavior, and inter-observer reliability tests were performed. However, the study data may not represent newborn hand-to-mouth contact during non-alert periods such as sleep. The extent to which these infants' behavior is representative of other full-term 10- to 14-day-old infants' behavior is unknown.

4.3.2.4. *Ko et al. (2007)—Relationships of Video Assessments of Touching and Mouthing Behaviors During Outdoor Play in Urban Residential Yards to Parental Perceptions of Child Behaviors and Blood Lead Levels*

Ko et al. (2007) compared parent survey responses with results from a video-transcription study of children's mouthing behavior in outdoor settings, as part of a study of relationships between children's mouthing behavior and other variables with blood lead levels. A convenience sample of 37 children (51% males, 49% females) 14 to 69 months old was recruited via an urban health center and direct contacts in the surrounding area, apparently in Chicago, IL. Participating children were primarily Hispanic (89%). The mouth area was defined as within 1 inch of the mouth, including the lips. Items passing beyond the lips were defined as in the mouth. Placement of an object or food item in the mouth along with part of the hand was counted as both hand and food or hand and object in mouth. Mouthing behaviors included hand-to-mouth area both with and without food, hand-in-mouth with or without food, and object-in-mouth including food, drinks, toys, or other objects.

Survey responses for the 37 children who also were videotaped included parents reporting children's inserting hand, toys, or objects in mouth when playing outside, and inserting dirt, stones, or sticks in mouth. Video-transcription results of outdoor play for these 37 children indicated 0 to 27 hand-in-mouth and 3 to 69 object-in-mouth touches per hour for the 13 children reported to frequently insert hand, toys, or objects in mouth when playing outside; 0 to 67 hand-in-mouth, and 7 to 40 object-in-mouth touches per hour for the 10 children reported to "sometimes" perform this behavior; 0 to 30 hand-in-mouth and 0 to 125 object in mouth touches per hour for the 12 children reported to "hardly ever" perform this behavior, and 1 to 8 hand-in-mouth and 3 to 6 object-in-mouth touches per hour for the 2 children reported to "never" perform this behavior.

Videotaping was attempted for 2 hours per child over two or more play sessions, with videographers trying to avoid interacting with the children. Children played with their usual toys and partners, and no instructions were given to parents regarding their supervision of the children's play. The authors stated that during some portion of the videotape time, children's hands and mouths were out of camera view. Videotape transcription was performed manually, according to a modified version of the protocol used in the Reed et al. (1999) study. Inter-observer reliability between three video-transcribers was checked with seven 30-minute video segments.

One strength of this study is its comparison of survey responses with results from the video-transcription methodology. A limitation is that the non-randomly selected sample of children studied is unlikely to be representative of the national population. Comparing results from this study with results from other video-transcription studies may be problematic because of inclusion of food handling with hand-to-mouth and object-to-mouth frequency counts. Due to the children's ages, their behavior may have differed from normal patterns because of the presence of strangers who videotaped them.

4.3.2.5. *Nicas and Best (2008)—A Study Quantifying the Hand-to-Face Contact Rate and Its Potential Application to Predicting Respiratory Tract Infection*

Nicas and Best (2008) conducted an observational study on adults (five women and five men; ages not specified), in which individuals were videotaped while performing office-type work for a 3-hour period. The videotapes were viewed by the investigators, who counted the number of hand-to-face touches the subjects made while they worked on a laptop computer, read, or wrote. Following the observations, the sample mean and standard deviation were computed for the number of times each subject touched his or her eyes, nostrils, and lips. For the three combinations of touch frequencies (i.e., lips-eyes, lips-nostrils, eyes-nostrils), Spearman rank correlation coefficients were computed and tests of the hypothesis that the rank correlation coefficients exceeded zero were performed.

Table 4-17 shows the frequency of hand-to-face contacts with the eyes, nostrils, and lips of the subjects, and the sum of these counts. There was considerable inter-individual variability among the subjects. During the 3-hour continuous study period, the total number of hand contacts with the eyes, lips and nostrils ranged from 3 to 104 for individual subjects, with a mean of 47. The mean per hour contact rate was 15.7. There was a positive correlation between the number of hand contacts with lips and eyes and with lips and nostrils (subjects who touched their lips frequently also touched their eyes and nostrils frequently). The Spearman rank correlation coefficients for contacts between different facial targets were 0.76 for the lips and eyes; 0.66 for the lips and nostrils, and 0.44 for the eyes and nostrils.

The study's primary purpose was to quantify hand-to-face contacts in order to determine the application of this contact rate in predicting respiratory tract infection. The authors developed an algebraic model for estimating the dose of pathogens transferred to target facial membranes during a defined exposure period. The advantage of this study is that it determined the frequency of hand-to-face contacts for adults. A limitation of the study is that there were very few subjects (five women and five men) who may not have been representative of the U.S. population. In addition, as with other video-transcription studies, the presence of videographers and a video camera may have influenced the subjects' behaviors.

4.4. NON-DIETARY INGESTION—MOUTHING DURATION STUDIES

4.4.1. Key Mouthing Duration Studies

4.4.1.1. *Juberg et al. (2001)—An Observational Study of Object Mouthing Behavior by Young Children*

Juberg et al. (2001) studied 385 children ages 0 to 36 months in western New York State, with parents collecting real-time hand-recording mouthing behavior data, primarily in the children's own home environments. The study consisted of an initial pilot study conducted in February 1998, a second phase conducted in April 1998, and a third phase conducted at an unspecified later time. The study's sample was drawn from families identified in a child play research center database or whose children attended a child care facility in the same general area; some geographic variation within the local area was obtained by selecting families with different zip codes in the different study phases. The pilot phase had 30 children who participated out of 150 surveys distributed; the second phase had 187 children out of approximately 300 surveys distributed, and the third phase had 168 participants out of 300 surveys distributed.

Parents were asked to observe their child's mouthing of objects only; hand-to-mouth behavior was not included. Data were collected on a single day (pilot and second phases) or 5 days (third phase); parents recorded the insertion of objects into the mouth by noting the "time in" and "time out" and the researchers summed the recorded data to tabulate total times spent mouthing the various objects during the days of observation. Thus, the study data were presented as minutes per day of object mouthing time. Mouthed items were classified as pacifiers, teethers, plastic toys, or other objects.

Table 4-18 shows the results of the combined pilot and second phase data. For both age groups, mouthing time for pacifiers greatly exceeded mouthing time for non-pacifiers, with the difference more acute for the older age group than for the younger age group. Histograms of the observed data show a peak in the low end of the distribution (0 to 100 minutes per day) and a rapid decline at longer durations.

A third phase of the study focused on children between the ages of 3 and 18 months and included only non-pacifier objects. Subjects were observed for 5 non-consecutive days over a 2-month period. A total of 168 participants returned surveys for at least one day, providing a total of 793 person-days of data. The data yielded a mean non-pacifier object mouthing duration of 36 minutes per day; the mean was the same when calculated on the basis of 793 person-days of data as on the basis of 168 daily average mouthing times.

One advantage of this study is the large sample size (385 children); however, the children apparently were not selected randomly, although some effort was made to obtain local geographic variation among study participants. There is no description of the socioeconomic status or racial and ethnic identities of the study participants. The authors do not describe the methodology parents used to record mouthing event durations (e.g., using stopwatches, analog or digital clocks, or guesses). The authors stated that using mouthing event duration units of minutes rather than seconds may have yielded observations rounded to the nearest minute.

4.4.1.2. *Greene (2002)—A Mouthing Observation Study of Children Under Six Years of Age*

The U.S. Consumer Product Safety Commission conducted a survey response and real-time hand recording study between December 1999 and February 2001 to quantify the cumulative time per day that young children spend awake, not eating, and mouthing objects. "Mouthing" was defined as children sucking, chewing, or otherwise putting an object on their lips or into their mouth. Participants were recruited via a random digit dialing telephone survey in urban and nearby rural areas of Houston, TX and Chicago, IL. Of the 115,289 households surveyed, 1,745 households had a child under the age of 6 years and were willing to participate. In the initial phase of the study, 491 children ages 3 to 81 months participated. Parents were instructed to use watches with second hands or to count seconds to estimate mouthing event durations. Parents also were to record mouthing frequency and types of objects mouthed. Parents collected data in four separate, non-consecutive 15-minute observation periods. Initially, parents were called back by the researchers and asked to provide their data over the telephone. Of the 491 children, 43 children (8.8%) had at least one 15-minute observation period with mouthing event durations recorded as exceeding 15 minutes. Due to this data quality problem, the researchers excluded the parent observation data from further analysis.

In a second phase, trained observers used stopwatches to record the mouthing behaviors and mouthing event durations of the subset of 109 of these children ages 3 to 36 months and an additional 60 children (total in second phase, 169), on 2 hours of each of 2 days. The observations were done at different times of the day at the child's home and/or child care facility. Table 4-19 shows the prevalence of observed mouthing among the 169 children in the second phase. All children were observed to mouth during the 4 hours of observation time; 99% mouthed parts of their anatomy. Pacifiers were mouthed by 27% in an age-declining pattern ranging from 47% of children less than 12 months old to 10% of the 2- to <3-year olds.

Table 4-20 provides the average mouthing time by object category and age in minutes per hour. The average mouthing time for all objects ranged from 5.3 to 10.5 minutes per hour, with the highest mouthing time corresponding to children <1 year of age and the lowest to the 2 to <3 years of age category. Among the objects mouthed, pacifiers represented about one third of the total mouthing time, with 3.4 minutes per hour for the youngest children, 2.6 minutes per hour for the children between 1 and 2 years and 1.8 minutes per hour for children 2 to <3 years old. The next largest single item category was anatomy. In this category, children under 1 year of age spent 2.4 minutes per hour mouthing fingers and thumbs; this behavior declined with age to 1.2 minutes per hour for children 2 to <3 years old.

Of the 169 children in the second phase, data were usable on the time awake and not eating (or "exposure time") for only 109; data for the remaining 60 children were missing. Thus, in order to develop extrapolated estimates of daily mouthing time for the 109 children, from the 2 hours of observation per day for two days, the researchers developed a statistical model that accounted for the children's demographic characteristics, that estimated exposure times for the 60 children with missing data, and then computed statistics for the extrapolated daily mouthing times for all 169 children, using a "bootstrap" procedure. Using this method, the estimated mean daily mouthing time of objects other than pacifiers ranged from 37 minutes/day to 70 minutes/day with the lowest number corresponding to the 2 to <3-year-old children and the largest number corresponding to the 3 to <12-month-old children.

The 551 child participants were 55% males, 45% females. The study's sample was drawn in an attempt to duplicate the overall U.S. demographic characteristics with respect to race, ethnicity, socioeconomic status and urban/suburban/rural settings. The sample families' reported annual incomes were generally higher than those of the overall U.S. population.

This study's strength was that it consisted of a randomly selected sample of children from both urban and non-urban areas in two different geographic areas within the United States. However, the observers' presence and use of a stopwatch to time mouthing durations may have affected the children's behavior.

4.4.1.3. *Beamer et al. (2008)—Quantified Activity Pattern Data from 6- to 27-Month-Old Farmworker Children for Use in Exposure Assessment*

Beamer et al. (2008) conducted a follow-up to the pilot study performed by Zartarian et al. (1998, 1997a, b), described in Sections 4.3.1.1 and 4.4.2.2. For this study, a convenience sample of 23 children residing in the farm worker community of Salinas Valley, CA was enrolled. Participants were 6- to 13-month-old infants or 20- to 26-month-old toddlers. Two researchers videotaped each child's activities for a minimum of 4 hours, and kept a detailed written log of locations visited and objects and surfaces contacted by the child. A questionnaire was administered to an adult in the household to acquire demographic data, housing and cleaning characteristics, eating patterns, and other information pertinent to the child's potential pesticide exposure.

Table 4-21 presents the object/surface hourly contact duration in minutes/hour. The mean hourly mouthing duration for hands and non-dietary objects was 1.4 and 3.5 minutes/hour, respectively. Infants had higher hourly mouthing duration with toys and all non-dietary objects than toddlers. Girls had higher contact durations than boys.

The advantage of this study is that it included both infants and toddlers. Differences between the two age groups, as well as sex differences, could be observed. As with other video-transcription studies, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

4.4.2. Relevant Mouthing Duration Studies

4.4.2.1. *Barr et al. (1994)—Effects of Intra-Oral Sucrose on Crying, Mouthing, and Hand-Mouth Contact in Newborn and Six-Week-Old Infants*

Barr et al. (1994) studied hand-to-mouth contact, as well as other behaviors, in 15 newborn (eight males, seven females) and fifteen 5- to 7-week old (eight males, seven females) full-term Canadian infants using a video-transcription methodology. The newborns were 2- to 3-days old, were in a quiet, temperature-controlled room at the hospital, were in a supine position and had been fed between 2 1/2 and 3 1/2 hours before testing. Barr et al. (1994) analyzed a 1-minute baseline period, with no experimental stimuli, immediately before a sustained crying episode lasting 15 seconds. For the newborns, reported durations of hand-to-mouth contact during 10-second intervals of the 1-minute baseline period were in the range of 0 to 2%. The 5- to 7-week old infants apparently were studied at primary care pediatric facilities when they were in bassinets inclined at an angle of 10 degrees. For these slightly older infants, the baseline periods analyzed were less than 20 seconds in length, but Barr et al. (1994) reported similarly low mean percentages of the 10-second intervals (approximately 1% of the time with hand-to-mouth contact). Hand-to-mouth contact was defined as "any part of the hand touching the lips and/or the inside of the mouth." The researchers performed inter-observer reliability tests on the videotape data and reported a mean inter-observer reliability of 0.78 by Cohen's kappa.

The advantages of this study were that use of video cameras could be expected to have virtually no effect on newborns' or five to seven week old infants' behavior, and that inter-observer reliability tests were performed. The study data did not represent newborn or 5- to 7-week-old infant hand-to-mouth contact during periods in which infants of these ages were in a sleeping or other non-alert state, and data may only represent behavior immediately prior to a state of distress (sustained crying episode). The extent to which these infants' behavior is representative of other full-term infants of these ages is unknown.

4.4.2.2. *Zartarian et al. (1997a)—Quantifying Videotaped Activity Patterns: Video Translation Software and Training Technologies/Zartarian et al. (1997b)—Quantified Dermal Activity Data from a Four-Child Pilot Field Study/Zartarian et al. (1998)—Quantified Mouthing Activity Data from a Four-Child Pilot Field Study*

As described in Section 4.3.1.1, Zartarian et al. (1998, 1997a, b) conducted a pilot study of the video-transcription methodology to investigate the applicability of using videotaping for gathering information related to children's activities, dermal exposures and mouthing behaviors. The researchers had conducted studies using the real-time hand recording methodology. These studies demonstrated poor inter-observer reliability and observer fatigue when attempted for long periods of time. This prompted the investigation into using videotaping with transcription of the children's activities at a point in time after the videotaped observations occurred.

Four Mexican-American farm worker children in the Salinas Valley of California each were videotaped with a hand-held videocamera during their waking hours, excluding time spent in the bathroom, over 1 day in September 1993. The boys were 2 years 10 months old and 3 years 9 months old; the girls were 2 years 5 months old and 4 years 2 months old. Time of videotaping was 6.0 hours for the younger girl, 6.6 hours for the older girl, 8.4 hours for the younger boy and 10.1 hours for the older boy. The videotaping gathered information on detailed micro-activity patterns of children to be used to evaluate software for videotaped activities and translation training methods.

The four children mouthed non-dietary objects an average of 4.35% (range 1.41 to 7.67%) of the total observation time, excluding the time during which the children were out of the camera's view (Zartarian et al., 1998). Objects mouthed included bedding/towels, clothes, dirt, grass/vegetation, hard surfaces, hard toys, paper/card, plush toy, and skin (Zartarian et al., 1998). Frequency distributions for the four children's non-dietary object contact durations were reported to be similar in shape. Reported hand-to-mouth contact presumably is a subset of the object-to-mouth contacts described in Zartarian et al. (1997a), and is described in Zartarian et al. (1997b). The four children mouthed their hands an average of 2.35% (range 1.0 to 4.4%) of observation time (Zartarian et al., 1997b). The researchers reported measures taken to assess inter-observer reliability and several problems with the video-transcription process.

This study's primary purpose was to develop and evaluate the video-transcription methodology; a secondary purpose was collection of mouthing behavior data. The sample of children studied was very small and not likely to be representative of the national population. Thus, U.S. EPA did not judge it to be suitable for consideration as a key study of children's mouthing behavior. As with other video-transcription studies, the presence of non-family member videographers and a video camera may have influenced the children's behavior.

4.4.2.3. *Groot et al. (1998)—Mouthing Behavior of Young Children: An Observational Study*

In this study, Groot et al. (1998) examined the mouthing behavior of 42 Dutch children (21 boys and 21 girls) between the ages of 3 and 36 months in late July and August 1998. Parent observations were made of children in 36 families. Parents were asked to observe their children 10 times per day for 15-minute intervals (i.e., 150 minutes total per day) for two days and measure mouthing times with a stopwatch. In this study, *mouthing* was defined as "all activities in which objects are touched by mouth or put into the mouth except for eating and drinking. This term includes licking as well as sucking, chewing and biting."

For the study, a distinction was made between toys meant for mouthing (e.g., pacifiers, teething rings) and those not meant for mouthing. Inter- and intra-observer reliability was measured by trained observers who co-observed a portion of observation periods in three families and who co-observed and repeatedly observed some video transcriptions made of one child. Another quality assurance procedure performed for the extrapolated total mouthing time data was to select 12 times per hour randomly during the entire waking period of four children during 1 day, in which the researchers recorded activities and total mouthing times.

Although the sample size was relatively small, the results provided estimates of mouthing times, other than pacifier use, during 1 day. The results were extrapolated to the entire day based on the 150 minutes of observation per day, and the mean value for each child for the 2 days of observations was interpreted as the estimate for that child. Table 4-22 shows summary statistics. The standard deviation in all four age categories except the 3- to 6-month old children exceeded the estimated mean. The 3 to 6 month children (N = 5) were estimated to have mean non-pacifier mouthing durations of 36.9 minutes per day, with toys as the most frequently mouthed product category, while the 6 to 12 month children (N = 14) were estimated to have 44 minutes per day (fingers most frequently mouthed). The 12- to 18-month olds' (N = 12) estimated mean non-pacifier mouthing time was 16.4 minutes per day, with fingers most frequently mouthed, and 18- to 36-month olds' (N = 11) estimated mean non-pacifier mouthing time was 9.3 minutes per day (fingers most frequently mouthed).

One strength of this study is that the researchers recognized that observing children might affect their behavior and emphasized to the parents the importance of making observations under conditions that were as normal as possible. In spite of these efforts, many parents perceived that their children's behavior was affected by being observed and that observation interfered with caregiving responsibilities such as comforting children when they were upset. Other limitations included a small sample size that was not representative of the Dutch population and that also may not be representative of U.S. children. Technical problems with the stopwatches affected at least 14 of 36 parents' data.

4.4.2.4. *Smith and Norris (2003)—Reducing the Risk of Choking Hazards: Mouthing Behavior of Children Aged 1 Month to 5 Years/Norris and Smith (2002)—Research Into the Mouthing Behavior of Children up to 5 Years Old*

Smith and Norris (2003) conducted a real-time hand recording study of mouthing behavior among 236 children (111 males, 125 females) in the United Kingdom (exact locations not specified) who were from 1 month to 5 years old. Children were observed at home by parents, who used stopwatches to record the time that mouthing began, the type of mouthing, the type of object being mouthed, and the time that mouthing ceased. Children were observed for a total of 5 hours over a 2-week period; the observation time consisted of twenty 15-minute periods spread over different times and days during the child's waking hours. Parents also recorded the times each child was awake and not eating meals so that the researchers could extrapolate estimates of total daily mouthing time from the shorter observation periods. Mouthing was defined as licking/lip touching, sucking/trying to bite and biting or chewing, with a description of each category, together with pictures, given to parents as guidance for what to record.

Table 4-23 shows the results of the study. While no overall pattern could be found in the different age groups tested, a Kruskal-Wallis test on the data for all items mouthed indicated that there was a significant difference between the age groups. Across all age groups and types of items, licking and sucking accounted for 64% of all mouthing behavior. Pacifiers and fingers exhibited less variety on mouthing behavior (principally sucking), while other items had a higher frequency of licking, biting, or other mouthing.

The researchers randomly selected 25 of the 236 children for a single 15-minute observation of each child (total observation time across all children: 375 minutes), to compare the mouthing frequency and duration data obtained according to the real-time hand recording and the video-transcription methodologies, as well as the reliability of parent observations versus those made by trained professionals. For this group of 25 children, the total number of mouthing behavior events recorded by video (160) exceeded those recorded by parents (114) and trained observers (110). Similarly, the total duration recorded by video (24 minutes and 15 seconds) exceeded that recorded by observers (parents and trained observers both recorded identical totals of 19 minutes and 44 seconds). The mean and standard deviation of observed mouthing time were both lower when recorded by video versus real-time hand recording. The maximum observed mouthing time also was lower (6 minutes and 7 seconds by video vs. 9 minutes and 43 seconds for both parents and trained observers).

The strengths of this study were its comparison of three types of observation (i.e., parents, trained observers, and videotaping), and its detailed reporting of mouthing behaviors by type, object/item mouthed, and age group. However, the children studied may not be representative of U.S. children. In addition, the study design or approach made the data less applicable for exposure assessment purposes (e.g., data on mouthing behavior that was intended to be used in reducing the risk of choking hazards).

4.4.2.5. *AuYeung et al. (2004)—Young Children's Mouthing Behavior: An Observational Study via Videotaping in a Primarily Outdoor Residential Setting*

As described in Section 4.3.1.5, AuYeung et al. (2004) used a video-transcription methodology to study a group of 38 children (20 females and 18 males; ages 1 to 6 years), 37 of whom were selected randomly via a telephone screening survey of a 300- to 400-square-mile portion of the San Francisco, CA peninsula, along with one child selected by convenience because of time constraints. Families who lived in a residence with a lawn and whose annual income was >$35,000 were asked to participate. Videotaping took place between August 1998 and May 1999 for approximately 2 hours per child. Videotaping by one researcher was supplemented with field notes taken by a second researcher who was also present during taping. Most of the videotaping took place during outdoor play, however, data were included for several children (one child <2 years old and 8 children >2 years old) who had more than 15 minutes of indoor play during their videotaping sessions.

The videotapes were translated into ASCII computer files using VirtualTimingDevice™ software described in Zartarian et al. (1997a). Both frequency (see Section 4.3.1.5 of this chapter) and duration were analyzed. Between 5 and 10% of the translated data files were randomly chosen for quality control checks for inter-observer agreement. Ferguson et al. (2006) described quality control aspects of the study in detail.

For analysis, the mouthing contacts were divided into indoor and outdoor locations and 16 object/surface categories. Mouthing durations were analyzed by age and sex separately and in combination. *Mouthing contacts* were defined as contact with the lips, inside of the mouth, and/or the tongue; dietary contacts were ignored. Table 4-24 shows mouthing durations (outdoor locations). For the children in all age groups, the median duration of each mouthing contact was 1 to 2 seconds, confirming the observations of other researchers that children's mouthing contacts are of very short duration. For the one child observed that was ≤24 months, the total indoor mouthing duration was 11.1 minutes/hour; for children >24 months, the median indoor mouthing duration was 0.9 minutes/hour (see Table 4-25). For outdoor environments, median contact durations for these age groups decreased to 0.8 and 0.6 minutes/hour, respectively (see Table 4-26).

Non-parametric tests, such as the Wilcoxon rank sum test, were used for the data analyses. Both age and sex were found to be associated with differences in mouthing behavior. Girls' hand-to-mouth contact durations were significantly shorter than for boys ($p = 0.04$).

This study provides distributions of outdoor mouthing durations with various objects and surfaces. Although indoor mouthing data were also included in this study, the results were based on a small number of children ($N = 9$) and a limited amount of indoor play. The sample of children may be representative of certain socioeconomic strata in the study area, but is not likely to be representative of the national population. Because of the children's ages, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

4.5. MOUTHING PREVALENCE STUDIES

4.5.1. Stanek et al. (1998)—Prevalence of Soil Mouthing/Ingestion Among Healthy Children Aged 1 to 6

Stanek et al. (1998) characterized the prevalence of mouthing behavior among healthy children based on a survey response study of parents or guardians of 533 children (289 females, 244 males) ages 1 to 6 years old. Study participants were attendees at scheduled well-child visits at three clinics in western Massachusetts in August through October, 1992. Participants were questioned about the frequency of 28 mouthing behaviors of the children over the preceding month in addition to exposure time (e.g., time outdoors, play in sand or dirt) and children's characteristics (e.g., teething).

Table 4-27 presents the prevalence of reported non-food ingestion/mouthing behaviors by child's age as the percentage of children whose parents reported the behavior in the preceding month. The table includes a column of data for the 3 to <6 year age category; this column was calculated by U.S. EPA as a weighted mean value of the individual data for 3-, 4-, and 5-year olds in order to conform to the standardized age categories used in this handbook. Among all the age groups, 1-year olds had the highest reported daily sucking of fingers/thumb; the proportion dropped for 2-year olds, but rose slightly for 3- and 4-year olds and declined again after age 4. A similar pattern was reported for more than weekly finger/thumb sucking, while more than monthly finger/thumb sucking showed a very slight increase for 6-year olds. Reported pacifier use was highest for 1-year olds and declined with age for daily and more than weekly use; for more than monthly use of a pacifier several 6-year olds were reported to use pacifiers, which altered the age-declining pattern for the daily and more than weekly reported pacifier use. A pattern similar to pacifier use existed with reported mouthing of teething toys, with highest reported use for 1-year olds, a decline with age until age 6 when reported use for daily, more than weekly, and more than monthly use of teething toys increased.

The authors developed an outdoor mouthing rate for each child as the sum of rates for responses to four questions on mouthing specific outdoor objects. Survey responses were converted to mouthing rates per week, using values of 0, 0.25, 1, and 7 for responses of never, monthly, weekly, and daily ingestion. Reported outdoor soil mouthing behavior prevalence was found to be higher than reported indoor dust mouthing prevalence, but both behaviors had the highest reported prevalence among 1-year old children and decreased for children 2 years and older. The investigators conducted principal component analyses on responses to four questions relating to ingestion/mouthing of outdoor objects in an attempt to characterize variability. Outdoor ingestion/mouthing rates constructed from the survey responses were that children 1-year old were reported to mouth or ingest outdoor objects 4.73 times per week while 2- to 6-year olds were reported to mouth or ingest outdoor objects 0.44 times per week. The authors developed regression models to identify factors related to high outdoor mouthing rates. The authors found that children who were reported to play in sand or dirt had higher outdoor object ingestion/mouthing rates.

A strength of this study is that it was a large sample obtained in an area with urban and semi-urban residents within various socioeconomic categories and with varying racial and ethnic identities. However, difficulties with parents' recall of past events may have caused either over-estimates or under-estimates of the behaviors studied.

4.5.2. Warren et al. (2000)—Non-Nutritive Sucking Behaviors in Preschool Children: A Longitudinal Study

Warren et al. (2000) conducted a survey response study of a non-random cohort of children born in certain Iowa hospitals from early 1992 to early 1995 as part of a study of children's fluoride exposure. For this longitudinal study of children's non-nutritive sucking behaviors, 1,374 mothers were recruited at the time of their newborns' birth, and more than 600 were active in the study until the children were at least 3 years old. Survey questions on non-nutritive sucking behaviors were administered to the mothers when the children were 6 weeks, and 3, 6, 9, 12, 16, and 24 months old, and then yearly after age 24 months. Questions were posed regarding the child's sucking behavior during the previous 3 to 12 months.

The authors reported that nearly all children sucked non-nutritive items, including pacifiers, thumbs or other fingers, and/or other objects, at some point in their early years. The parent-reported sucking behavior prevalence peaked at 91% for 3 month old children. At 2 years of age, a majority (53%) retained a sucking habit, while 29% retained the habit at age 3 years and 21% at age 4 years. Parent-reported pacifier use was 28% for 1-year olds, 25% for 2-year olds, and 10% for 3-year olds. The authors cautioned against generalizing the results to other children because of study design limitations.

Strengths of this study were its longitudinal design and the large sample size. A limitation is that the non-random selection of original study participants and the self-selected nature of the cohort of survey respondents who participated over time means that the results may not be representative of other U.S. children of these ages.

4.6. REFERENCES FOR CHAPTER 4

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Table 4-3. New Jersey Children's Mouthing Frequency (contacts/hour) from Video-Transcription

Category	Minimum	Mean	Median	90th Percentile	Maximum
Hand to mouth	0.4	9.5	8.5	20.1	25.7
Object to mouth	0	16.3	3.6	77.1	86.2

Source: Reed et al., 1999.

Table 4-4. Survey-Reported Percent of 168 Minnesota Children Exhibiting Behavior, by Age

Age Group (years)	Thumbs/Fingers in Mouth	Toes in Mouth	Non-Food Items in Mouth
3	71	29	71
4	63	0	31
5	33	-	20
6	30	-	29
7	28	-	28
8	33	-	40
9	43	-	38
10	38	-	38
11	33	-	48
12	33	-	17

\- = No data.

Source: Freeman et al., 2001.

Table 4-5. Video-Transcription Median (Mean) Observed Mouthing in 19 Minnesota Children (contacts/hour), by Age

Age Group (years)	*N*	Object to Mouth[a]	Hand to Mouth
3 to 4	3	3 (6)	3.5 (4)
5 to 6	7	0 (1)	2.5 (8)
7 to 8	4	0 (1)	3 (5)
10 to 12	5	0 (1)	2 (4)

[a] Kruskal Wallis test comparison across four age groups, $p = 0.002$.

N = Number of observations.

Source: Freeman et al., 2001.

Table 4-6. Variability in Objects Mouthed by Washington State Children (contacts/hour)

Variable	All Subjects				≤24 Months				>24 Months			
	N[a]	Mean[b]	Median	95% CI[c]	*N*[a]	Mean[b]	Median	95% CI[c]	*N*[a]	Mean[b]	Median	95% CI[c]
Mouth to body	186	8	2	2−3	69	10	4	3−6	117	7	1	0.8−1.3
Mouth to hand	186	16	11	9−14	69	18	12	9−16	117	16	9	7−12
Mouth to surface	186	4	1	0.8−1.2	69	7	5	3−8	117	2	1	0.9−1.1
Mouth to toy	186	27	18	14−23	69	45	39	31−48	117	17	9	7−12
Total events	186	56	44	36−52	69	81	73	60−88	117	42	31	25−39

[a] Number of observations.
[b] Arithmetic mean.
[c] The 95% confidence intervals (CI) apply to median. Values were calculated in logs and converted to original units.

Source: Tulve et al., 2002.

Table 4-7. Indoor Mouthing Frequency (Contacts per contacts/hour), Video-Transcription of 9 Children, by Age

Age Group	*N*	Statistic	Hand	Total Non-Dietary[a]
13 to 84 months	9	Mean	20.5	29.6
		Median	14.8	22.1
		Range	2.5−70.4	3.2−82.2
≤24 months	1	-	73.5	84.8
>24 months	8	Mean	13.9	22.7
		Median	13.3	19.5
		Range	2.2−34.1	2.8−51.3

[a] Object/surface categories mouthed indoors included: clothes/towels, hands, metal, paper/wrapper, plastic, skin, toys, and wood.

N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-8. Outdoor Mouthing Frequency (Contacts per contacts/hour), Video-Transcription of 38 Children, by Age

Age Group	*N*	Statistic	Hand	Total Non-Dietary[a]
13 to 84 months	38	Mean	11.7	18.3
		5th percentile	0.4	0.8
		25th percentile	4.4	9.2
		50th percentile	8.4	14.5
		75th percentile	14.8	22.4
		95th percentile	31.5	51.7
		99th percentile	47.6	56.6
≤24 months	8	Mean	13.0	20.4
		Median	7.0	13.9
		Range	1.3−47.7	6.2−56.4
>24 months	30	Mean	11.3	17.7
		5th percentile	0.2	0.6
		25th percentile	4.7	7.6
		50th percentile	8.6	14.6
		75th percentile	14.8	22.4
		95th percentile	27.7	43.8
		99th percentile	39.5	53.0

[a] Object/surface categories mouthed outdoors included: animal, clothes/towels, fabric, hands, metal, non-dietary water, paper/wrapper, plastic, skin, toys, vegetation/grass, and wood.

N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-9. Videotaped Mouthing Activity of Texas Children, Median Frequency (Mean ± SD), by Age

Age	*N*	Hand to Mouth (contact/hour)	Object to Mouth (contact/hour)
		Median (Mean ± SD) Frequency	Median (Mean ± SD) Frequency
7 to 12 months	13	14 (19.8 ± 14.5)	18.1 (24.4 ± 11.6)
13 to 24 months	12	13.3 (15.8 ± 8.7)	8.4 (9.8 ± 6.3)
25 to 36 months	18	9.9 (11.9 ± 9.3)	5.5 (7.8 ± 5.8)
37 to 53 months	9	19.4 (22.1 ± 22.1)	8.4 (10.1 ± 12.4)

N = Number of subjects.
SD = Standard deviation.

Source: Black et al., 2005.

Table 4-10. Indoor Hand-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies, by Age

Age Group	Weibull Scale Parameter	Weibull Shape Parameter	Chi-Square	*N*	Mean	SD	Percentile				
							5	25	50	75	95
3 to <6 months	1.28	30.19	fail	23	28.0	21.7	3.0	8.0	23.0	48.0	65.0
6 to <12 months	1.02	19.01	pass	119	18.9	17.4	1.0	6.6	14.0	26.4	52.0
1 to <2 years	0.91	18.79	fail	245	19.6	19.6	0.1	6.0	14.0	27.0	63.0
2 to <3 years	0.76	11.04	fail	161	12.7	14.2	0.1	2.9	9.0	17.0	37.0
3 to <6 years	0.75	12.59	pass	169	14.7	18.4	0.1	3.7	9.0	20.0	54.0
6 to <11 years	1.36	7.34	pass	14	6.7	5.5	1.7	2.4	5.7	10.2	20.6

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2007.

Table 4-11. Outdoor Hand-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies, by Age

Age Group	Weibull Scale Parameter	Weibull Shape Parameter	Chi-Square	*N*	Mean	SD	Percentile				
							5	25	50	75	95
6 to <12 months	1.39	15.98	pass	10	14.5	12.3	2.4	7.6	11.6	16.0	46.7
1 to <2 years	0.98	13.76	pass	32	13.9	13.6	1.1	4.2	8.0	19.2	42.2
2 to <3 years	0.56	3.41	fail	46	5.3	8.1	0.1	0.1	2.6	7.0	20.0
3 to <6 years	0.55	5.53	fail	55	8.5	10.7	0.1	0.1	5.6	11.0	36.0
6 to <11 years	0.49	1.47	fail	15	2.9	4.3	0.1	0.1	0.5	4.7	11.9

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2007.

Table 4-12. Object/Surface to Mouth Contact Frequency for Infants and Toddlers (events/hour) (*N* = 23)

Object/Surface	Range	Mean	Percentiles					
			5th	25th	50th	75th	95th	99th
Animal	-	-	-	-	-	-	-	-
Body	0.0−5.0	1.5	0.0	0.4	0.8	2.4	4.0	4.8
Clothes/towel	0.3−13.6	5.4	1.1	2.6	3.6	6.9	13.2	13.5
Fabric	0.0−5.7	1.1	0.0	0.0	0.3	2.2	3.3	5.2
Floor	0.0−1.3	0.2	0.0	0.0	0.0	0.4	1.0	1.2
Food	2.3−68.3	28.9	11.1	17.8	28.2	34.8	53.7	65.2
Footwear	0.0−8.9	0.7	0.0	0.0	0.0	0.0	5.7	8.3
Hand/mouth	2.0−62.1	18.4	6.6	10.0	15.2	22.8	44.7	58.6
Metal	0.0−2.1	0.3	0.0	0.0	0.0	0.1	1.3	1.9
Non-dietary water	-	-	-	-	-	-	-	-
Paper/wrapper	0.0−13.6	2.1	0.0	0.3	0.8	2.1	7.2	12.2
Plastic	0.0−14.3	2.0	0.0	0.4	1.4	2.3	5.1	12.3
Rock/brick	-	-	-	-	-	-	-	-
Toy	0.3−48.4	14.7	1.9	6.8	12.5	20.6	34.9	45.6
Vegetation	0.0−18.2	0.8	0.0	0.0	0.0	0.0	0.0	14.2
Wood	0.0−3.9	0.5	0.0	0.0	0.0	0.5	1.8	3.4
Non-dietary object[a]	6.2−82.3	29.2	8.1	15.9	27.2	38.0	64.0	78.8
All objects/surfaces	24.4−145.9	76.5	28.7	58.7	77.4	94.5	123.1	141.2

[a] All object designations except for food and hand/mouth represent non-dietary objects.
- No mouth contact with these objects/surfaces occurred.

Source: Beamer et al., 2008.

Table 4-13. Distributions Mouthing Frequency and Duration for Non-Dietary Objects with Significant Differences ($p < 0.05$) Between Infants and Toddlers

Object/Surface	Infant (6 to 13 months) Mouthing Frequency (contacts/hour)									Infant (6 to 13 months) Mouthing Duration (minutes/hour)							
	N	Range	Mean	5th	25th	50th	75th	95th	99th	Range	Mean	5th	25th	50th	75th	95th	99th
Clothes/towel	13	2−13.3	6.8	2.7	4.8	6.3	7.2	12.7	12.1	-	-	-	-	-	-	-	-
Paper/wrapper	13	0.0−7.2	1.1	0.0	0.2	0.7	0.8	4.3	6.6	0.0−0.7	0.1	0.0	0.0	0.0	0.1	0.4	0.6
Toy	13	6.5−48.4	21.1	7.3	14.4	20.2	25.5	40.8	46.9	0.7−17.9	3.6	0.8	1.2	1.7	2.8	11.6	16.6
Non-dietary object/surface	13	14−82.3	37.8	20.0	28.3	35.2	38.6	72.8	64.0	1.1−18.4	4.5	1.2	2.2	2.8	4.1	12.6	17.2
	Toddler (20−26 months) Mouthing Frequency (contacts/hour)									Toddler (20−26 months) Mouthing Duration (minutes/hour)							
	N	Range	Mean	5th	25th	50th	75th	95th	99th	Range	Mean	5th	25th	50th	75th	95th	99th
Clothes/towel	10	0.3−13.6	3.5	0.6	2.0	2.6	3.6	9.1	12.7	-	-	-	-	-	-	-	-
Paper/wrapper	10	0.3−12.6	6.3	1.0	2.8	5.4	9.6	12.5	12.6	0.0−0.8	0.2	0.0	0.0	0.1	0.2	0.6	0.7
Toy	10	0.3−13.6	3.5	0.6	2.0	2.6	3.6	9.1	12.7	0.0−6.8	1.5	0.1	0.2	0.5	0.7	6.1	6.6
Other non-dietary object/surface[a]	10	6.2−41.2	18.0	7.0	9.4	15.9	22.0	35.2	40.5	0.3−6.9	2.1	0.4	0.7	1.3	1.8	6.3	6.7

[a] Excludes "clothes/towel," "paper/wrapper," and "toys;" includes all other non-dietary objects/surfaces shown in Table 4-12.
\- No significant difference between infants and toddlers for this object/surface category.

Source: Beamer et al., 2008 supplemental data.

Table 4-14. Indoor Object-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies, by Age

Age Group	Weibull Scale Parameter	Weibull Shape Parameter	Chi-Square	*N*	Mean	SD	Percentile				
							5th	25th	50th	75th	95th
3 to <6 months	9.83	0.74	pass	19	11.2	10.0	0.1	1.7	9.3	17.3	31.8
6 to <12 months	22.72	1.66	pass	82	20.3	12.5	3.3	11.3	19.0	28.0	37.9
1 to <2 years	15.54	1.39	pass	137	14.2	10.2	2.0	6.5	12.3	19.0	34.0
2 to <3 years	10.75	1.36	pass	95	9.9	7.0	1.7	4.2	8.7	14.5	24.4
3 to <6 years	6.90	0.58	pass	167	10.1	14.8	0.1	1.0	5.0	13.0	39.0
6 to <11 years	1.04	0.85	pass	14	1.1	1.1	0.1	0.1	0.9	1.985	3.2

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2010.

Table 4-15. Outdoor Object-to-Mouth Frequency (contacts/hour) Weibull Distributions from Various Studies, by Age

Age Group (years)	Weibull Scale Parameter	Weibull Shape Parameter	Chi-Square	*N*	Mean	SD	Percentile				
							5th	25th	50th	75th	95th
1 to <2	8.58	0.93	pass	21	8.8	8.8	0.1	3.8	6.0	10.8	21.3
2 to <3	6.15	0.64	pass	29	8.1	10.5	0.1	1.5	4.6	11.0	40.0
3 to <6	5.38	0.55	pass	53	8.3	12.4	0.1	0.1	5.0	10.6	30.3
6 to <11	1.10	0.55	fail	29	1.9	2.8	0.1	0.1	0.8	2.0	9.1

N = Number of subjects.
SD = Standard deviation.

Source: Xue et al., 2010.

Table 4-16. Survey-Reported Mouthing Behaviors for 92 Washington State Children

Behavior	Never		Seldom		Occasionally		Frequently		Always		Unknown	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Hand/foot in mouth	4	4	27	30	23	25	31	34	4	4	3	3
Pacifier	74	81	6	7	2	2	9	10	1	1	0	0
Mouth on object	14	15	30	33	25	27	19	21	1	1	3	3
Non-food in mouth	5	5	25	27	33	36	24	26	5	5	0	0
Eat dirt/sand	37	40	39	43	11	12	4	4	1	1	0	0

N = Number of subjects.

Source: Davis et al., 1995.

Table 4-17. Number of Hand Contacts Observed in Adults During a Continuous 3-Hour Period

Subject	Eye	Lip	Nostril	Total
1	0	0	3	3
2	4	2	1	7
3	2	12	4	18
4	1	1	20	22
5	10	22	15	47
6	13	33	8	54
7	17	15	27	59
8	6	31	28	65
9	9	52	30	91
10	12	72	20	104
Mean	7.4	24	16	47
Standard Deviation	5.7	24	11	35

Source: Nicas and Best, 2008.

Table 4-18. Estimated Daily Mean Mouthing Times of New York State Children, for Pacifiers and Other Objects

	Age 0 to 18 Months		Age 19 to 36 Months	
Object Type	All Children	Only Children Who Mouthed Object[a]	All Children	Only Children Who Mouthed Object[a]
	Minutes/Day	Minutes/Day	Minutes/Day	Minutes/Day
Pacifier	108 (N = 107)	221 (N = 52)	126 (N = 110)	462 (N = 52)
Teether	6 (N = 107)	20 (N = 34)	0 (N = 110)	30 (N = 1)
Plastic toy	17 (N = 107)	28 (N = 66)	2 (N = 110)	11 (N = 21)
Other objects	9 (N = 107)	22 (N = 46)	2 (N = 110)	15 (N = 18)

[a] Refers to means calculated for the subset of the sample children who mouthed the object stated (zeroes are eliminated from the calculation of the mean).

N = Number of children.

Source: Juberg et al., 2001.

Table 4-19. Percent of Houston-Area and Chicago-Area Children Observed Mouthing, by Category and Child's Age

Object Category	All Ages	<1 Year	1 to 2 Years	2 to 3 Years
All objects	100	100	100	100
Pacifier	27	43	27	10
Non-pacifier	100	100	100	100
Soft plastic food content item	28	13	30	41
Anatomy	99	100	97	100
Non-soft plastic toy, teether, and rattle	91	94	91	86
Other items	98	98	97	98

Source: Greene, 2002.

Table 4-20. Estimates of Mouthing Time for Various Objects for Infants and Toddlers (minutes/hour), by Age				
Age Group	Mean (SD)	Median	95th Percentile	99th Percentile
All Items[a]				
3 to <12 months	10.5 (7.3)	9.6	26.2	39.8
12 to <24 months	7.3 (6.8)	5.5	22.0	28.8
24 to <36 months	5.3 (8.2)	2.4	15.6	47.8
Non-Pacifier[b]				
3 to <12 months	7.1 (3.6)	6.9	13.1	14.4
12 to <24 months	4.7 (3.7)	3.6	12.8	18.9
24 to <36 months	3.5 (3.6)	2.3	12.8	15.6
All Soft Plastic Item[c]				
3 to <12 months	0.5 (0.6)	0.1	1.8	2.5
12 to <24 months	0.4 (0.4)	0.2	1.3	1.9
24 to <36 months	0.4 (0.6)	0.1	1.6	2.9
Soft Plastic Item Not Food Contact				
3 to <12 months	0.4 (0.6)	0.1	1.8	2.0
12 to <24 months	0.3 (0.4)	0.1	1.1	1.5
24 to <36 months	0.2 (0.4)	0.0	1.3	1.8
Soft Plastic Toy, Teether, and Rattle				
3 to <12 months	0.3 (0.5)	0.1	1.8	2.0
12 to <24 months	0.2 (0.3)	0.0	0.9	1.3
24 to <36 months	0.1 (0.2)	0.0	0.2	1.6
Soft Plastic Toy				
3 to <12 months	0.1 (0.3)	0.0	0.7	1.1
12 to <24 months	0.2 (0.3)	0.0	0.9	1.3
24 to <36 months	0.1 (0.2)	0.0	0.2	1.6
Soft Plastic Teether and Rattle				
3 to <12 months	0.2 (0.4)	0.0	1.0	2.0
12 to <24 months	0.0 (0.1)	0.0	0.1	0.6
24 to <36 months	0.0 (0.1)	0.0	0.0	1.0
Other Soft Plastic Item				
3 to <12 months	0.1 (0.2)	0.0	0.8	1.0
12 to <24 months	0.1 (0.1)	0.0	0.4	0.6
24 to <36 months	0.1 (0.3)	0.0	0.5	1.4
Soft Plastic Food Contact Item				
3 to <12 months	0.0 (0.2)	0.0	0.3	0.9
12 to <24 months	0.1 (0.2)	0.0	0.7	1.2
24 to <36 months	0.2 (0.4)	0.0	1.2	1.9
Anatomy				
3 to <12 months	2.4 (2.8)	1.5	10.1	12.2
12 to <24 months	1.7 (2.7)	0.8	8.3	14.8
24 to <36 months	1.2 (2.3)	0.4	5.1	13.6

Table 4-20. Estimates of Mouthing Time for Various Objects for Infants and Toddlers (minutes/hour), by Age (continued)

Age Group	Mean (SD)	Median	95th Percentile	99th Percentile
Non-Soft Plastic Toy, Teether, and Rattle				
3 to <12 months	1.8 (1.8)	1.3	6.5	7.7
12 to <24 months	0.6 (0.8)	0.3	1.8	4.6
24 to <36 months	0.2 (0.4)	0.1	0.9	2.3
Other Item				
3 to <12 months	2.5 (2.1)	2.1	7.8	8.1
12 to <24 months	2.1 (2.0)	1.4	6.6	9.0
24 to <36 months	1.7 (2.6)	0.7	7.1	14.3
Pacifier				
3 to <12 months	3.4 (6.9)	0.0	19.5	37.3
12 to <24 months	2.6 (6.5)	0.0	19.9	28.6
24 to <36 months	1.8 (7.9)	0.0	4.8	46.3

[a] Object category “all items” is subdivided into pacifiers and non-pacifiers.

[b] Object category “non-pacifiers” is subdivided into all soft plastic items, anatomy (which includes hair, skin, fingers and hands), non-soft plastic toys/teethers/rattles, and other items.

[c] Object category “all soft plastic items” is subdivided into food contact items, non-food contact items (toys, teethers, and rattles) and other soft plastic.

SD = Standard deviation.

Source: Greene, 2002.

Table 4-21. Object/Surface to Hands and Mouth Contact Duration for Infants and Toddlers (minutes/hour) (*N* = 23)

Object/Surface	Range	Mean	Percentiles					
			5th	25th	50th	75th	95th	99th
Animal	-	-	-	-	-	-	-	-
Body	0.0−0.3	0.1	0.0	0.0	0.0	0.1	0.3	0.3
Clothe/towel	0.0−0.9	0.3	0.0	0.1	0.2	0.4	0.7	0.9
Fabric	0.0−0.2	0.0	0.0	0.0	0.0	0.1	0.2	0.2
Floor	0.0−0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Food	0.3−15.0	4.7	0.4	1.8	3.8	6.6	10.9	14.1
Footwear	0.0−1.4	0.1	0.0	0.0	0.0	0.0	0.3	1.1
Hand/mouth	0.2−5.4	1.4	0.4	0.5	1.2	1.8	3.7	5.0
Metal	0.0−0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.2
Non-dietary water	-	-	-	-	-	-	-	-
Paper/wrapper	0.0−0.8	0.1	0.0	0.0	0.0	0.1	0.7	0.8
Plastic	0.0−0.6	0.1	0.0	0.0	0.1	0.1	0.5	0.6
Rock/brick	-	-	-	-	-	-	-	-
Toys	0.0−17.9	2.7	0.1	0.6	1.2	2.8	7.4	15.6
Vegetation	0.0−0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Wood	0.0−0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.3
Non-dietary object[a]	0.3−18.4	3.5	0.5	1.2	2.2	3.9	8.5	16.3
All objects/surfaces	2.2−33.6	9.6	2.4	5.1	8.8	12.0	17.1	30.0

[a] All object designations except for food and hand/mouth represent non-dietary objects.
\- No mouth contact with these objects/surfaces occurred.

Source: Beamer et al., 2008.

Table 4-22. Mouthing Times of Dutch Children Extrapolated to Total Time While Awake, Without Pacifier (minutes/day), by Age

Age Group	*N*	Mean	SD	Minimum	Maximum
3 to 6 months	5	36.9	19.1	14.5	67
6 to 12 months	14	44	44.7	2.4	171.5
12 to 18 months	12	16.4	18.2	0	53.2
18 to 36 months	11	9.3	9.8	0	30.9

Note: The object most mouthed in all age groups was the fingers, except for the 6 to 12 month group, which mostly mouthed toys.
N = Number of children.
SD = Standard deviation.

Source: Groot et al., 1998.

Table 4-23. Estimated Mean Daily Mouthing Duration by Age Group for Pacifiers, Fingers, Toys, and Other Objects (hours:minutes:seconds)

Item Mouthed	Age Group											
	1 to 3 months	3 to 6 months	6 to 9 months	9 to 12 months	12 to 15 months	15 to 18 months	18 to 21 Months	21 to 24 months	2 years	3 years	4 years	5 years
N =	9	14	15	17	16	14	16	12	39	31	29	24
Dummy (pacifier)	0:47:13	0:27:45	0:14:36	0:41:39	1:00:15	0:25:22	1:09:02	0:25:12	0:32:55	0:48:42	0:16:40	0:00:20
Finger	0:18:22	0:49:03	0:16:54	0:14:07	0:08:24	0:10:07	0:18:40	0:35:34	0:29:43	0:34:42	0:19:26	0:44:06
Toy	0:00:14	0:28:20	0:39:10	0:23:04	0:15:18	0:16:34	0:11:07	0:15:46	0:12:23	0:11:37	0:03:11	0:01:53
Other object	0:05:14	0:12:29	0:24:30	0:16:25	0:12:02	0:23:01	0:19:49	0:12:53	0:21:46	0:15:16	0:10:44	0:10:00
Not recorded	0:00:45	0:00:24	0:00:00	0:00:01	0:00:02	0:00:08	0:00:11	0:14:13	0:02:40	0:00:01	0:00:05	0:02:58
Total (all objects)	1:11:48	1:57:41	1:35:11	1:35:16	1:36:01	0:15:13	1:58:49	1:43:39	1:39:27	1:50:19	0:50:05	0:59:17

N = Number of children in sample.

Source: Smith and Norris, 2003.

Table 4-24. Outdoor Median Mouthing Duration (seconds/contact), Video-Transcription of 38 Children, by Age

Age Group	*N*	Statistic	Hand	Total Non-Dietary[a]
13 to 84 months	38	Mean	3.5	3.4
		5th percentile	0	0
		25th percentile	1	1
		50th percentile	1	1
		75th percentile	2	3
		95th percentile	12	11
		99th percentile	41.6	40
≤24 months	8	Mean	9	7
		Median	3	2
		Range	0 to 136	0 to 136
>24 months	30	Mean	2	2.4
		5th percentile	0	0
		25th percentile	1	1
		50th percentile	1	1
		75th percentile	2	2
		95th percentile	5	7
		99th percentile	17.4	24.6

[a] Object/surface categories mouthed outdoors included: animal, clothes/towels, fabric, hands, metal, non-dietary water, paper/wrapper, plastic, skin, toys, vegetation/grass, and wood.
N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-25. Indoor Mouthing Duration (minutes/hour), Video-Transcription of Nine Children with >15 minutes in View Indoors

Age Group	*N*	Statistic	Hand	Total Non-Dietary[a]
13 to 84 months	9	Mean	1.8	2.3
		Median	0.7	0.9
		Range	0−10.7	0−11.1
≤24 months	1	Observation	10.7	11.1
>24 months	8	Mean	0.7	1.2
		Median	0.7	0.9
		Range	0−1.9	0−3.7

[a] Object/surface categories mouthed indoors included: clothes/towels, hands, metal, paper/wrapper, plastic, skin, toys, and wood.
N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-26. Outdoor Mouthing Duration (minutes/hour), Video-Transcription of 38 Children, by Age

Age Group	*N*	Statistic	Hand	Total Non-Dietary[a]
13 to 84 months	38	Mean	0.9	1.2
		5th percentile	0	0
		25th percentile	0.1	0.2
		50th percentile	0.2	0.6
		75th percentile	0.6	1.2
		95th percentile	2.6	2.9
		99th percentile	11.2	11.5
		Range	0−15.5	0−15.8
≤24 months	8	Mean	2.7	3.1
		5th percentile	0	0.2
		25th percentile	0.2	0.2
		50th percentile	0.4	0.8
		75th percentile	1.5	3.1
		95th percentile	11.5	11.7
		99th percentile	14.7	15
		Range	0−15.5	0.2−15.8
>24 months	30	Mean	0.4	0.7
		5th percentile	0	0
		25th percentile	0.1	0.2
		Median	0.2	0.6
		75th percentile	0.4	1
		95th percentile	1.2	2.1
		99th percentile	2.2	2.5
		Range	0−2.4	0−2.6

[a] Object/surface categories mouthed outdoors included: animal, clothes/towels, fabric, hands, metal, non-dietary water, paper/wrapper, plastic, skin, toys, vegetation/grass, and wood.

N = Number of subjects.

Source: AuYeung et al., 2004.

Table 4-27. Reported Daily Prevalence of Massachusetts Children's Non-Food Mouthing/Ingestion Behaviors

Object or Substance Mouthed or Ingested	Percent of Children Reported to Mouth/Ingest Daily				
	1 Year *N* = 171	2 Years *N* = 70	3 to <6 Years[a] *N* = 265	6 Years *N* = 22	All Years *N* = 528
Grass, leaf, flower	16	0	1	0	6
Twig, stick, woodchip	12	0	0	0	4
Teething toy	44	6	2	9	17
Other toy	63	27	12	5	30
Blanket, cloth	29	11	10	5	16
Shoes, Footwear	20	1	0	0	7
Clothing	25	7	9	14	14
Crib, chair, furniture	13	3	1	0	5
Paper, cardboard, tissue	28	9	5	5	13
Crayon, pencil, eraser	19	17	5	18	12
Toothpaste	52	87	89	82	77
Soap, detergent, shampoo	15	14	2	0	8
Plastic, plastic wrap	7	4	1	0	3
Cigarette butt, tobacco	4	0	1	0	2
Suck finger/thumb	44	21	24	14	30
Suck feet or toe	8	1	0	0	3
Bite nail	2	7	10	14	7
Use pacifier	20	6	2	0	9

[a] Weighted mean of 3-, 4-, and 5-year-olds' data calculated by U.S. EPA to conform to standardized age categories used in this handbook.

Source: Stanek et al., 1998.

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5. SOIL AND DUST INGESTION

5.1. INTRODUCTION

The ingestion of soil and dust is a potential route of exposure for both adults and children to environmental chemicals. Children, in particular, may ingest significant quantities of soil due to their tendency to play on the floor indoors and on the ground outdoors and their tendency to mouth objects or their hands. Children may ingest soil and dust through deliberate hand-to-mouth movements, or unintentionally by eating food that has dropped on the floor. Adults may also ingest soil or dust particles that adhere to food, cigarettes, or their hands. Thus, understanding soil and dust ingestion patterns is an important part of estimating overall exposures to environmental chemicals.

At this point in time, knowledge of soil and dust ingestion patterns within the United States is somewhat limited. Only a few researchers have attempted to quantify soil and dust ingestion patterns in U.S. adults or children.

This chapter explains the concepts of soil ingestion, soil pica, and geophagy, defines these terms for the purpose of this handbook's exposure factors, and presents available data from the literature on the amount of soil and dust ingested.

The Centers for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry (ATSDR) held a workshop in June 2000 in which a panel of soil ingestion experts developed definitions for soil ingestion, soil-pica, and geophagy, to distinguish aspects of soil ingestion patterns that are important from a research perspective (ATSDR, 2001). This chapter uses the definitions that are based on those developed by participants in that workshop:

Soil ingestion is the consumption of soil. This may result from various behaviors including, but not limited to, mouthing, contacting dirty hands, eating dropped food, or consuming soil directly.

Soil-pica is the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000−5,000 mg/day or more).

Geophagy is the intentional ingestion of earths and is usually associated with cultural practices.

Some studies are of a behavior known as "pica," and the subset of "pica" that consists of ingesting soil. A general definition of the concept of pica is that of ingesting non-food substances, or ingesting large quantities of certain particular foods. Definitions of pica often include references to recurring or repeated ingestion of these substances. Soil-pica is specific to ingesting materials that are defined as soil, such as clays, yard soil, and flower-pot soil. Although soil-pica is a fairly common behavior among children, information about the prevalence of pica behavior is limited. Gavrelis et al. (2010) reported that the prevalence of non-food substance consumption varies by age, race, and income level. The behavior was most prevalent among children 1 to <3 years (Gavrelis et al., 2010). Geophagy, on the other hand, is an extremely rare behavior, especially among children, as is soil-pica among adults. One distinction between geophagy and soil-pica that may have public health implications is the fact that surface soils generally are not the main source of geophagy materials. Instead, geophagy is typically the consumption of clay from known, uncontaminated sources, whereas soil-pica involves the consumption of surface soils, usually the top 2−3 inches (ATSDR, 2001).

Researchers in many different disciplines have hypothesized motivations for human soil-pica or geophagy behavior, including alleviating nutritional deficiencies, a desire to remove toxins or self-medicate, and other physiological or cultural influences (Danford, 1982). Bruhn and Pangborn (1971) and Harris and Harper (1997) suggest a religious context for certain geophagy or soil ingestion practices. Geophagy is characterized as an intentional behavior, whereas soil-pica should not be limited to intentional soil ingestion, primarily because children can consume large amounts of soil from their typical behaviors and because differentiating intentional and unintentional behavior in young children is difficult (ATSDR, 2001). Some researchers have investigated populations that may be more likely than others to exhibit soil-pica or geophagy behavior on a recurring basis. These populations might include pregnant women who exhibit soil-pica behavior (Simpson et al., 2000), adults and children who practice geophagy (Vermeer and Frate, 1979), institutionalized children (Wong, 1988), and children with developmental delays (Danford, 1983), autism (Kinnell, 1985), or celiac disease (Korman, 1990). However, identifying specific soil-pica and geophagy populations remains difficult due to limited research on this topic. It has been estimated that 33% of children ingest more than 10 grams of soil 1 or 2 days a year (ATSDR, 2001). No information was located regarding the prevalence of geophagy behavior.

Because some soil and dust ingestion may be a result of hand-to-mouth behavior, soil properties may be important. For example, soil particle size, organic matter content, moisture content, and other soil properties may affect the adherence of soil to the skin. Soil particle sizes range from 50−2,000 µm for sand, 2−50 µm for silt, and are <2 µm for clay (USDA, 1999), while typical atmospheric dust particle sizes are in the range of 0.001−30 µm (U.S. OSHA, 1987). Studies on particle size have indicated that finer soil particles (generally <63 µm in diameter) tend to be adhered more efficiently to human hands, whereas adhered soil fractions are independent of organic matter content or soil origin (Choate et al., 2006; Yamamoto et al., 2006). More large particle soil fractions have been shown to adhere to the skin for soils with higher moisture content (Choate et al., 2006).

In this handbook, soil, indoor settled dust and outdoor settled dust are defined generally as the following:

Soil. Particles of unconsolidated mineral and/or organic matter from the earth's surface that are located outdoors, or are used indoors to support plant growth. It includes particles that have settled onto outdoor objects and surfaces (outdoor settled dust).

Indoor Settled Dust. Particles in building interiors that have settled onto objects, surfaces, floors, and carpeting. These particles may include soil particles that have been tracked or blown into the indoor environment from outdoors as well as organic matter.

Outdoor Settled Dust. Particles that have settled onto outdoor objects and surfaces due to either wet or dry deposition. Note that it may not be possible to distinguish between soil and outdoor settled dust, since outdoor settled dust generally would be present on the uppermost surface layer of soil.

For the purposes of this handbook, soil ingestion includes both soil and outdoor settled dust, and dust ingestion includes indoor settled dust only.

There are several methodologies represented in the literature related to soil and dust ingestion. Two methodologies combine biomarker measurements with measurements of the biomarker substance's presence in environmental media. An additional methodology offers modeled estimates of soil/dust ingestion from activity pattern data from observational studies (e.g., videography) or from the responses to survey questionnaires about children's activities, behaviors, and locations.

The first of the biomarker methodologies measures quantities of specific elements present in feces, urine, food and medications, yard soil, house dust, and sometimes also community soil and dust, and combines this information using certain assumptions about the elements' behavior in the gastrointestinal tract to produce estimates of soil and dust quantities ingested (Davis et al., 1990). In this chapter, this methodology is referred to as the "tracer element" methodology. The second biomarker methodology compares results from a biokinetic model of lead exposure and uptake that predict blood lead levels, with biomarker measurements of lead in blood (Von Lindern et al., 2003). The model predictions are made using assumptions about ingested soil and dust quantities that are based, in part, on results from early versions of the first methodology. Therefore, the comparison with actual measured blood lead levels serves to confirm, to some extent, the assumptions about ingested soil and dust quantities used in the biokinetic model. In this chapter, this methodology is referred to as the "biokinetic model comparison" methodology. Lead isotope ratios have also been used as a biomarker to study sources of lead exposures in children. This technique involves measurements of different lead isotopes in blood and/or urine, food, water, and house dust and compares the ratio of different lead isotopes to infer sources of lead exposure that may include dust or other environmental exposures (Manton et al., 2000). However, application of lead isotope ratios to derive estimates of dust ingestion by children has not been attempted. Therefore, it is not discussed any further in this chapter.

The third, "activity pattern" methodology, combines information from hand-to-mouth and object-to-mouth behaviors with microenvironment data (i.e., time spent at different locations) to derive estimates of soil and dust ingestion. Behavioral information often comes from data obtained using videography techniques or from responses to survey questions obtained from adults, caregivers, and/or children. Surveys often include questions about hand-to-mouth and object-to-mouth behaviors, soil and dust ingestion behaviors, frequency, and sometimes quantity (Barltrop, 1966).

Although not directly evaluated in this chapter, a fourth methodology uses assumptions regarding ingested quantities of soil and dust that are based on a general knowledge of human behavior, and potentially supplemented or informed by data from other methodologies (Hawley, 1985; Kissel et al., 1998; Wong et al., 2000).

The recommendations for soil, dust, and soil + dust ingestion rates are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by the U.S. Environmental Protection Agency (U.S. EPA) for this factor. Following the recommendations, a description of the three methodologies used to estimate soil and dust ingestion is provided, followed by a summary of key and relevant studies. Because strengths and limitations of each one of the key and relevant studies relate to the strengths and limitations inherent of the methodologies themselves, they are discussed at the end of the key and relevant studies.

5.2. RECOMMENDATIONS

The key studies described in Section 5.3 were used to recommend values for soil and dust ingestion for adults and children. Table 5-1 shows the central tendency recommendations for daily ingestion of soil, dust, or soil + dust, in mg/day. It also shows the high end recommendations for daily ingestion of soil, in mg/day. The high end recommendations are subdivided into a general population soil ingestion rate, an ingestion rate for "soil-pica," and an estimate for individuals who exhibit "geophagy." The soil pica and geophagy recommendations are likely to represent an acute high soil ingestion episode or behaviors at an unknown point on the high end of the distribution of soil ingestion. Published estimates from the key studies have been rounded to one significant figure.

The soil ingestion recommendations in Table 5-1 are intended to represent ingestion of a combination of soil and outdoor settled dust, without distinguishing between these two sources. The source of the soil in these recommendations could be outdoor soil, indoor containerized soil used to support growth of indoor plants, or a combination of both outdoor soil and containerized indoor soil. The inhalation and subsequent swallowing of soil particles is accounted for in these recommended values, therefore, this pathway does not need to be considered separately. These recommendations are called "soil." The dust ingestion recommendations in Table 5-1 include soil tracked into the indoor setting, indoor settled dust, and air-suspended particulate matter that is inhaled and swallowed. Central tendency "dust" recommendations are provided, in the event that assessors need recommendations for an indoor or inside a transportation vehicle scenario in which dust, but not outdoor soil, is the exposure medium of concern. The soil + dust recommendations would include soil, either from outdoor or containerized indoor sources, dust that is a combination of outdoor settled dust, indoor settled dust, and air-suspended particulate matter that is inhaled, subsequently trapped in mucous and moved from the respiratory system to the gastrointestinal tract, and a soil-origin material located on indoor floor surfaces that was tracked indoors by building occupants. Soil and dust recommendations exclude the soil or dust's moisture content. In other words, recommended values represent mass of ingested soil or dust that is represented on a dry-weight basis.

Studies estimating adult soil ingestion are extremely limited, and only two of these are considered to be key studies (i.e., Vermeer and Frate, 1979; Davis and Mirick, 2006). In the Davis and Mirick (2006) study, soil ingestion for adults and children in the same family was calculated using a mass-balance approach. The adult data were seen to be more variable than for the children in the study, possibly indicating an important occupational contribution of soil ingestion in some of the adults. For the aluminum and silicon tracers, soil ingestion rates ranged from 23−92 mg/day (mean), 0−23 mg/day (median), and 138−814 mg/day (maximum), with an overall mean value of 52 mg/day for the adults in the study. Based on this value, the recommended mean value from the Davis and Mirick (2006) study is estimated to be 50 mg/day for adult soil and dust ingestion (see Table 5-1). There are no available studies estimating the ingestion of dust by adults, therefore, the assumption used by U.S. EPA's Integrated Exposure and Uptake Biokinetic (IEUBK) model for lead in children (i.e., 45% soil, 55% dust contribution) was used to derive estimates for soil and dust using the soil + dust value derived from Davis and Mirick (2006). Rounded to one significant figure, these estimates are 20 mg/day and 30 mg/day for soil and dust respectively.

The key studies pre-dated the age groups recommended for children by U.S. EPA (2005) and were performed on groups of children of varying ages. As a result, central tendency recommendations can be used for the life stage categories of 6 to <12 months, 1 to <2 years, 2 to <3 years, 3 to <6 years, and part of the 6 to <11 years categories. Upper percentile recommendations can be used for the life stage categories of 1 to <2 years, 2 to <3 years, 3 to <6 years, 6 to <11 years, and part or all of the 11 to <16 years category.

The recommended central tendency soil + dust ingestion estimate for infants from 6 weeks up to their first birthday is 60 mg/day (Van Wijnen et al., 1990; Hogan et al., 1998). If an estimate is needed for soil only, from soil derived from outdoor or indoor sources, or both outdoor and indoor sources, the recommendation is 30 mg/day (Van Wïjnen et al., 1990). If an estimate for indoor dust only is needed, that would include a certain quantity of tracked-in soil from outside, the recommendation is 30 mg/day (Hogan et al., 1998). This dust ingestion value is based on the 30 mg/day value for soil ingestion for this age group (Van Wïjnen et al., 1990), and the assumption that the soil and dust inhalation values will be comparable, as were the Hogan et al. (1998) values for the 1 to <6 year age group. The confidence rating for this recommendation is low due to the small numbers of study subjects in the IEUBK model study on which the recommendation is in part based and the inferences needed to develop a quantitative estimate. Examples of these inferences include: an assumption that the relative proportions of soil and dust ingested by 6 week to <12 month old children are the same as those ingested by older children (45% soil, 55% dust, based on U.S. EPA, 1994a), and the assumption that pre-natal or non-soil, non-dust sources of lead exposure do not dominate these children's blood lead levels.

When assessing risks for individuals who are not expected to exhibit soil-pica or geophagy behavior, the recommended central tendency soil + dust ingestion estimate is 100 mg/day for children ages 1 to <21 years (Hogan et al., 1998). If an estimate for soil only is needed, for exposure to soil such as manufactured topsoil or potted-plant soil that could occur in either an indoor or outdoor setting, or when the risk assessment is not considering children's ingestion of indoor dust (in an indoor setting) as well, the recommendation is 50 mg/day (Hogan et al., 1998). If an estimate for indoor dust only is needed, the recommendation is 60 mg/day (Hogan et al., 1998). Although these quantities add up to 110 mg/day, the sum is rounded to one significant figure. Although there were no tracer element studies or biokinetic model comparison studies performed for children 6 to <21 years, as a group, their mean or central tendency soil ingestion would not be zero. In the absence of data that can be used to develop specific central tendency soil and dust ingestion recommendations for children aged 6 to <11 years, 11 to <16 years and 16 to <21 years, U.S. EPA recommends using the same central tendency soil and dust ingestion rates that are recommended for children in the 1 to <6 year old age range.

No key studies are available estimating soil-pica behavior in children less than 12 months of age or in adults, therefore, no recommended values are provided for these age groups. The upper percentile recommendation for soil and dust ingestion among the general population of children 3 to <6 years old is 200 mg/day and it is based on the 95th percentile value obtained from modeling efforts from Özkaynak et al. (2010) and from 95th percentile estimates derived by Stanek and Calabrese (1995a). When assessing risks for children who may exhibit soil-pica behavior, or a group of children that includes individual children who may exhibit soil-pica behavior, the soil-pica ingestion estimate in the literature for children up to age 14 ranges from 400 to 41,000 mg/day (Barnes, 1990; Calabrese et al., 1997a, b, 1991, 1989; Vermeer and Frate, 1979; Wong, 1988; Stanek et al., 1998; Calabrese and Stanek, 1993). Due to the definition of soil-pica used in this chapter, that sets a lower bound on the quantity referred to as "soil-pica" at 1,000 mg/day (ATSDR, 2001), and due to the significant number of observations in the U.S. tracer element studies that are at or exceed that quantity, the recommended soil-pica ingestion rate is 1,000 mg/day. It should be noted, however, that this value may be more appropriate for acute exposures. Currently, no data are available for soil-pica behavior for children ages 6 to <21 years. Because pica behavior may occur among some children ages ~1 to 21 years old (Hyman et al., 1990), it is prudent to assume that, for some children, soil-pica behavior may occur at any age up to 21 years.

The recommended geophagy soil estimate is 50,000 mg/day (50 grams) for both adults and children (Vermeer and Frate, 1979). It is important to note that this value may be more representative of acute exposures. Risk assessors should use this value for soil ingestion in areas where residents are known to exhibit geophagy behaviors.

Table 5-2 shows the confidence ratings for these recommendations. Section 5.4 gives a more detailed explanation of the basis for the confidence ratings.

An important factor to consider when using these recommendations is that they are limited to estimates of soil and dust quantities ingested. The scope of this chapter is limited to quantities of soil and dust taken into the gastrointestinal tract, and does not extend to issues regarding bioavailability of environmental contaminants present in that soil and dust. Information from other sources is needed to address bioavailability. In addition, as more information becomes available regarding gastrointestinal absorption of environmental contaminants, adjustments to the soil and dust ingestion exposure equations may need to be made, to better represent the direction of movement of those contaminants within the gastrointestinal tract.

To place these recommendations into context, it is useful to compare these soil ingestion rates to common measurements. The central tendency recommendation of 50 mg/day or 0.050 g/day, dry-weight basis, would be equivalent to approximately 1/6 of an aspirin tablet per day because the average aspirin tablet is approximately 325 mg. The 50 g/day ingestion rate recommended to represent geophagy behavior would be roughly equivalent to 150 aspirin tablets per day.

Table 5-1. Recommended Values for Daily Soil, Dust, and Soil + Dust Ingestion (mg/day)

	Soil[a]				Dust[b]		Soil + Dust	
		High End						
Age Group	General Population Central Tendency [c]	General Population Upper Percentile [d]	Soil-Pica[e]	Geophagy [f]	General Population Central Tendency [g]	General Population Upper Percentile [h]	General Population Central Tendency [c]	General Population Upper Percentile [h]
6 weeks to <1 year	30				30		60	
1 to <6 years	50		1,000	50,000	60		100[i]	
3 to <6 years		200				100		200
6 to <21 years	50		1,000	50,000	60		100[i]	
Adult	20[j]			50,000	30[j]		50	

a Includes soil and outdoor settled dust.
b Includes indoor settled dust only.
c Davis and Mirick, 2006; Hogan et al., 1998; Davis et al., 1990; Van Wïjnen et al., 1990; Calabrese and Stanek, 1995.
d Özkaynak et al., 2010; Stanek and Calabrese, 1995a; rounded to one significant figure.
e ATSDR, 2001; Stanek et al., 1998; Calabrese et al., 1997a,b, 1991, 1989; Calabrese and Stanek, 1993; Barnes, 1990; Wong, 1988; Vermeer and Frate, 1979.
f Vermeer and Frate, 1979.
g Hogan et al, 1998.
h Özkaynak et al., 2010; rounded to one significant figure.
i Total soil and dust ingestion rate is 110 mg/day; rounded to one significant figure it is 100 mg/day.
j Estimates of soil and dust were derived from the soil + dust and assuming 45% soil and 55% dust.

Table 5-2. Confidence in Recommendations for Ingestion of Soil and Dust		
General Assessment Factors	Rationale	Rating
Soundness		Low
Adequacy of Approach	The methodologies have significant limitations. The studies did not capture all of the information needed (quantities ingested, frequency of high soil ingestion episodes, prevalence of high soil ingestion). Six of the 12 key studies were of census or randomized design. Sample selection may have introduced some bias in the results (i.e., children near smelter or Superfund sites, volunteers in nursery schools). The total number of adults and children in key studies were 122 and 1,203 (859 U.S. children, 292 Dutch, and 52 Jamaican children), respectively, while the target population currently numbers more than 74 million (U.S. DOC, 2008). Modeled estimates were based on 1,000 simulated individuals. The response rates for in-person interviews and telephone surveys were often not stated in published articles. Primary data were collected for 381 U.S. children and 292 Dutch children; secondary data for 478 U.S. children and 52 Jamaican children. Two key studies provided data for adults.	
Minimal (or defined) Bias	Numerous sources of measurement error exist in the tracer element studies. Biokinetic model comparison studies may contain less measurement error than tracer element studies. Survey response study may contain measurement error. Some input variables for the modeled estimates are uncertain.	
Applicability and Utility		Low
Exposure Factor of Interest	Eleven of the 12 key studies focused on the soil exposure factor, with no or less focus on the dust exposure factor. The biokinetic model comparison study did not focus exclusively on soil and dust exposure factors.	
Representativeness	The study samples may not be representative of the United States in terms of race, ethnicity, socioeconomics, and geographical location; studies focused on specific areas.	
Currency	Studies results are likely to represent current conditions.	
Data Collection Period	Tracer element studies' data collection periods may not represent long-term behaviors. Biokinetic model comparison and survey response studies do represent longer term behaviors. Data used in modeled simulation estimates may not represent long-term behaviors.	
Clarity and Completeness		Low
Accessibility	Observations for individual children are available for only three of the 12 key studies.	
Reproducibility	For the methodologies used by more than one research group, reproducible results were obtained in some instances. Some methodologies have been used by only one research group and have not been reproduced by others.	
Quality Assurance	For some studies, information on quality assurance/quality control was limited or absent.	
Variability and Uncertainty		Low
Variability in Population	Tracer element and activity pattern methodology studies characterized variability among study sample members; biokinetic model comparison and survey response studies did not. Day-to-day and seasonal variability was not very well characterized. Numerous factors that may influence variability have not been explored in detail.	
Minimal Uncertainty	Estimates are highly uncertain. Tracer element studies' design appears to introduce biases in the results. Modeled estimates may be sensitive to input variables.	
Evaluation and Review		Medium
Peer Review	All key studies appeared in peer-review journals.	
Number and Agreement of Studies	12 key studies. Some key studies are reanalysis of previously published data. Researchers using similar methodologies obtained generally similar results; somewhat general agreement between researchers using different methodologies.	
Overall Rating		**Low**

5.3. KEY AND RELEVANT STUDIES

The key tracer element, biokinetic model comparison, and survey response studies are summarized in the following sections. Certain studies were considered "key" and were used as a basis for developing the recommendations, using judgment about the study's design features, applicability, and utility of the data to U.S. soil and dust ingestion rates, clarity and completeness, and characterization of uncertainty and variability in ingestion estimates. Because the studies often were performed for reasons unrelated to developing soil and dust ingestion recommendations, their attributes that were characterized as "limitations" in this chapter might not be limitations when viewed in the context of the study's original purpose. However, when studies are used for developing a soil or dust ingestion recommendation, U.S. EPA has categorized some studies' design or implementation as preferable to others. In general, U.S. EPA chose studies designed either with a census or randomized sample approach over studies that used a convenience sample, or other non-randomized approach, as well as studies that more clearly explained various factors in the study's implementation that affect interpretation of the results. However, in some cases, studies that used a non-randomized design contain information that is useful for developing exposure factor recommendations (for example, if they are the only studies of children in a particular age category), and thus may have been designated as "key" studies. Other studies were considered "relevant" but not "key" because they provide useful information for evaluating the reasonableness of the data in the key studies, but in U.S. EPA's judgment they did not meet the same level of soundness, applicability and utility, clarity and completeness, and characterization of uncertainty and variability that the key studies did. In addition, studies that did not contain information that can be used to develop a specific recommendation for mg/day soil and dust ingestion were classified as relevant rather than key.

Some studies are re-analyses of previously published data. For this reason, the sections that follow are organized into key and relevant studies of primary analysis (that is, studies in which researchers have developed primary data pertaining to soil and dust ingestion) and key and relevant studies of secondary analysis (that is, studies in which researchers have interpreted previously published results, or data that were originally collected for a different purpose).

5.3.1. Methodologies Used in Key Studies

5.3.1.1. *Tracer Element Methodology*

The tracer element methodology attempts to quantify the amounts of soil ingested by analyzing samples of soil and dust from residences and/or children's play areas, and feces or urine. The soil, dust, fecal, and urine samples are analyzed for the presence and quantity of tracer elements—typically, aluminum, silicon, titanium, and other elements. A key underlying assumption is that these elements are not metabolized into other substances in the body or absorbed from the gastrointestinal tract in significant quantities, and thus their presence in feces and urine can be used to estimate the quantity of soil ingested by mouth. Although they are sometimes called mass balance studies, none of the studies attempt to quantify amounts excreted in perspiration, tears, glandular secretions, or shed skin, hair or finger- and toenails, nor do they account for tracer element exposure via the dermal or inhalation into the lung routes, and thus they are not a complete "mass balance" methodology. Early studies using this methodology did not always account for the contribution of tracer elements from non-soil substances (food, medications, and non-food sources such as toothpaste) that might be swallowed. U.S. studies using this methodology in or after the mid to late 1980s account for, or attempt to account for, tracer element contributions from these non-soil sources. Some study authors adjust their soil ingestion estimate results to account for the potential contribution of tracer elements found in household dust as well as soil.

The general algorithm that is used to calculate the quantity of soil or dust estimated to have been ingested is as follows: the quantity of a given tracer element, in milligrams, present in the feces and urine, minus the quantity of that tracer element, in milligrams, present in the food and medicine, the result of which is divided by the tracer element's soil or dust concentration, in milligrams of tracer per gram of soil or dust, to yield an estimate of ingested soil, in grams.

The U.S. tracer element researchers have all assumed a certain offset, or lag time between ingestion of food, medication, and soil, and the resulting fecal and urinary output. The lag times used are typically 24 or 28 hours; thus, these researchers subtract the previous day's food and medication tracer element quantity ingested from the current day's fecal and urinary tracer element quantity that was excreted. When compositing food, medication, fecal and urine samples across the entire study period, daily estimates can be obtained by dividing the total estimated soil ingestion by the number of days in which fecal and/or urine samples were collected. A variation of the algorithm that provides slightly higher estimates of soil ingestion is to divide the total estimated soil ingestion by the number of days on which feces were produced, which by definition would be equal to or less than the total number of days of the study period's fecal sample collection.

Substituting tracer element dust concentrations for tracer element soil concentrations yields a dust ingestion estimate. Because the actual non-food, non-medication quantity ingested is a combination of soil and dust, the unknown true soil and dust ingestion is likely to be somewhere between the estimates that are based on soil concentrations and estimates that are based on dust concentrations. Tracer element researchers have described ingestion estimates for soil that actually represent a combination of soil and dust, but were calculated based on tracer element concentrations in soil. Similarly, they have described ingestion estimates for dust that are actually for a combination of soil and dust, but were calculated based on tracer element concentrations in dust. Other variations on these general soil and dust ingestion algorithms have been published, in attempts to account for time spent indoors, time spent away from the house, etc. that could be expected to influence the relative proportion of soil versus dust.

Each individual's soil and dust ingestion can be represented as an unknown constant in a set of simultaneous equations of soil or dust ingestion represented by different tracer elements. To date, only two of the U.S. research teams (Lásztity et al., 1989; Barnes, 1990) have published estimates calculated for pairs of tracer elements using simultaneous equations.

The U.S. tracer element studies have been performed for only short-duration study periods, and only for 33 adults (Davis and Mirick, 2006) and 241 children (101 in Davis et al. [1990], 12 of whom were studied again in Davis and Mirick [2006]; 64 in Calabrese et al. [1989] and Barnes [1990]; 64 in Calabrese et al. [1997a]; and 12 in Calabrese et al. [1997b]). They provide information on quantities of soil and dust ingested for the studied groups for short time periods, but provide limited information on overall prevalence of soil ingestion by U.S. adults and children, and limited information on the frequency of higher soil ingestion episodes.

The tracer element studies appear to contain numerous sources of error that influence the estimates upward and downward. Sometimes the error sources cause individual soil or dust ingestion estimates to be negative, which is not physically possible. In some studies, for some of the tracers, so many individual "mass balance" soil ingestion estimates were negative that median or mean estimates based on that tracer were negative. For soil and dust ingestion estimates based on each particular tracer, or averaged across tracers, the net impact of these competing upward and downward sources of error is unclear.

5.3.1.2. *Biokinetic Model Comparison Methodology*

The Biokinetic Model Comparison methodology compares direct measurements of a biomarker, such as blood or urine levels of a toxicant, with predictions from a biokinetic model of oral, dermal and inhalation exposure routes with air, food, water, soil, and dust toxicant sources. An example is to compare measured children's blood lead levels with predictions from the IEUBK model. Where environmental contamination of lead in soil, dust, and drinking water has been measured and those measurements can be used as model inputs for the children in a specific community, the model's assumed soil and dust ingestion values can be confirmed or refuted by comparing the model's predictions of blood lead levels with those children's measured blood lead levels. It should be noted, however, that such confirmation of the predicted blood lead levels would be confirmation of the net impact of all model inputs, and not just soil and dust ingestions. Under the assumption that the actual measured blood lead levels of various groups of children studied have minimal error, and those measured blood lead levels roughly match biokinetic model predictions for those groups of children, then the model's default assumptions may be roughly accurate for the central tendency, or typical, children in an assessed group of children. The model's default assumptions likely are not as useful for predicting outcomes for highly exposed children.

5.3.1.3. *Activity Pattern Methodology*

The activity pattern methodology includes observational studies as well as surveys of adults, children's caretakers, or children themselves, via in-person or mailed questionnaires that ask about mouthing behavior and ingestion of various non-food items and time spent in various microenvironments. There are three general approaches to gather data on children's mouthing behavior: real-time hand recording, in which trained observers manually record information (Davis et al., 1995); video-transcription, in which trained videographers tape a child's activities and subsequently extract the pertinent data manually or with computer software (Black et al., 2005); and questionnaire, or survey response, techniques (Stanek et al., 1998).

The activity-pattern methodology combines information on hand-to-mouth and object-to-mouth activities (microactivities) and time spent at various locations (microenvironments) with assumptions about transfer parameters (e.g., soil-to-skin adherence, saliva removal efficiency) and other exposure factors (e.g., frequency of hand washing) to derive estimates of soil and dust ingestion. This methodology has been used in U.S. EPA's Stochastic Human Exposure and Dose Simulation (SHEDS) model. The SHEDS model is a probabilistic model that can simulate cumulative (multiple chemicals) or aggregate (single chemical) residential exposures for a population of interest over time via multiple routes of exposure for different types of chemicals and scenarios, including those involving soil ingestion (U.S. EPA, 2010).

One of the limitations of this approach includes the availability and quality of the input variables. Özkaynak et al. (2010) found that the model is most sensitive to dust loadings on carpets and hard floor surfaces, soil-to-skin adherence factors, hand mouthing frequency, and hand washing frequency (Özkaynak et al., 2010).

5.3.2. Key Studies of Primary Analysis

5.3.2.1. *Vermeer and Frate (1979)—Geophagia in Rural Mississippi: Environmental and Cultural Contexts and Nutritional Implications*

Vermeer and Frate (1979) performed a survey response study in Holmes County, Mississippi in the 1970s (date unspecified). Questions about geophagy (defined as regular consumption of clay over a period of weeks) were asked of household members ($N = 229$ in 50 households; 56 were women, 33 were men, and 140 were children or adolescents) of a subset of a random sample of nutrition survey respondents. Caregiver responses to questions about 115 children under 13 indicate that geophagy was likely to be practiced by a minimum of 18 (16%) of these children; however, 16 of these 18 children were 1 to 4 years old, and only 2 of the 18 were older than 4 years. Of the 56 women, 32 (57%) reported eating clay. There was no reported geophagy among 33 men or 25 adolescent study subjects questioned.

In a separately administered survey, geophagy and pica data were obtained from 142 pregnant women over a period of 10 months. Geophagy was reported by 40 of these women (28%), and an additional 27 respondents (19%) reported other pica behavior, including the consumption of laundry starch, dry powdered milk, and baking soda.

The average daily amount of clay consumed was reported to be about 50 grams, for the adult and child respondents who acknowledged practicing geophagy. Quantities were usually described as either portions or multiples of the amount that could be held in a single, cupped hand. Clays for consumption were generally obtained from the B soil horizon, or subsoil rather than an uppermost layer, at a depth of 50 to 130 centimeters.

5.3.2.2. *Calabrese et al. (1989)—How Much Soil Do Young Children Ingest: An Epidemiologic Study/Barnes (1990)—Childhood Soil Ingestion: How Much Dirt Do Kids Eat?/Calabrese et al. (1991)—Evidence of Soil-Pica Behaviour and Quantification of Soil Ingested*

Calabrese et al. (1989) and Barnes (1990) studied soil ingestion among children using eight tracer elements—aluminum, barium, manganese, silicon, titanium, vanadium, yttrium, and zirconium. A non-random sample of 30 male and 34 female 1, 2, and 3-year-olds from the greater Amherst, Massachusetts area were studied, presumably in 1987. The children were predominantly from two-parent households where the parents were highly educated. The study was conducted over a period of 8 days spread over 2 weeks. During each week, duplicate samples of food, beverages, medicines, and vitamins were collected on Monday through Wednesday, while excreta, excluding wipes and toilet paper, were collected for four 24-hour cycles running from Monday/Tuesday through Thursday/Friday. Soil and dust samples were also collected from the child's home and play area. Study participants were supplied with toothpaste, baby cornstarch, diaper rash cream, and soap with low levels of most of the tracer elements.

Table 5-3 shows the published mean soil ingestion estimates ranging from −294 mg/day based on manganese to 459 mg/day based on vanadium, median soil ingestion estimates ranging from −261 mg/day based on manganese to 96 mg/day based on vanadium, and 95th percentile estimates ranged from 106 mg/day based on yttrium to 1,903 mg/day based on vanadium. Maximum daily soil ingestion estimates ranged from 1,391 mg/day based on zirconium to 7,281 mg/day based on manganese. Dust ingestions calculated using tracer concentrations in dust were often, but not always, higher than soil ingestions calculated using tracer concentrations in soil.

Data for the uppermost 23 subject-weeks (the highest soil ingestion estimates, averaged over the 4 days of excreta collection during each of the 2 weeks) were published in Calabrese et al. (1991). One child's soil-pica behavior was estimated in Barnes (1990) using both the subtraction/division algorithm and the simultaneous equations method. On two particular days during the second week of the study period, the child's aluminum-based soil ingestion estimates were 19 g/day (18,700 mg/day) and 36 g/day (35,600 mg/day), silicon-based soil ingestion estimates were 20 g/day (20,000 mg/day) and 24 g/day (24,000), and simultaneous-equation soil ingestion estimates were 20 g/day (20,100 mg/day) and 23 g/day (23,100 mg/day) (Barnes, 1990). By tracer, averaged across the entire week, this child's estimates ranged from approximately 10 to 14 g/day during the second week of observation (Calabrese et al., 1991, shown in Table 5-4), and averaged 6 g/day across the entire study period. Additional information about this child's apparent ingestion of soil versus dust during the study period was published in Calabrese and Stanek (1992a).

5.3.2.3. *Van Wijnen et al. (1990)—Estimated Soil Ingestion by Children*

In a tracer element study by Van Wijnen et al. (1990), soil ingestion among Dutch children ranging in age from 1 to 5 years was evaluated using a tracer element methodology. Van Wijnen et al. (1990) measured three tracers (titanium, aluminum, and acid insoluble residue [AIR]) in soil and feces. The authors estimated soil ingestion based on an assumption called the Limiting Tracer Method (LTM), which assumed that soil ingestion could not be higher than the lowest value of the three tracers. LTM values represented soil ingestion estimates that were not corrected for dietary intake.

An average daily feces dry weight of 15 grams was assumed. A total of 292 children attending daycare centers were studied during the first of two sampling periods and 187 children were studied in the second sampling period; 162 of these children were studied during both periods (i.e., at the beginning and near the end of the summer of 1986). A total of 78 children were studied at campgrounds. The authors reported geometric mean LTM values because soil ingestion rates were found to be skewed and the log-transformed data were approximately normally distributed. Geometric mean LTM values were estimated to be 111 mg/day for children in daycare centers and 174 mg/day for children vacationing at campgrounds (see Table 5-5). For the 162 daycare center children studied during both sampling periods the arithmetic mean LTM was 162 mg/day, and the median was 114 mg/day.

Fifteen hospitalized children were studied and used as a control group. These children's LTM soil ingestion estimates were 74 (geometric mean), 93 (mean), and 110 (median) mg/day. The authors assumed the hospitalized children's soil ingestion estimates represented dietary intake of tracer elements, and used rounded 95% confidence limits on the arithmetic mean, 70 to 120 mg/day, to correct the daycare and campground children's LTM estimates for dietary intake of tracers. Corrected soil ingestion rates were 69 mg/day (162 mg/day minus 93 mg/day) for daycare children and 120 mg/day (213 mg/day minus 93 mg/day) for campers. Corrected geometric mean soil ingestion was estimated to range from 0 to 90 mg/day, with a 90th percentile value of up to 190 mg/day for the various age categories within the daycare group and 30 to 200 mg/day, with a 90th percentile value of up to 300 mg/day for the various age categories within the camping group.

AIR was the limiting tracer in about 80%of the samples. Among children attending daycare centers, soil ingestion was also found to be higher when the weather was good (i.e., <2 days/week precipitation) than when the weather was bad (i.e., >4 days/week precipitation (see Table 5-6).

5.3.2.4. *Davis et al. (1990)—Quantitative Estimates of Soil Ingestion in Normal Children between the Ages of 2 and 7 Years: Population-based Estimates Using Aluminum, Silicon, and Titanium as Soil Tracer Elements*

Davis et al. (1990) used a tracer element technique to estimate soil ingestion among children. In this study, 104 children between the ages of 2 and 7 years were randomly selected from a three-city area in southeastern Washington State. Soil and dust ingestion was evaluated by analyzing soil and house dust, feces, urine, and duplicate food, dietary supplement, medication and mouthwash samples for aluminum, silicon, and titanium. Data were collected for 101 of the 104 children during July, August, or September, 1987. In each family, data were collected over a 7-day period, with 4 days of excreta sample collection. Participants were supplied with toothpaste with known tracer element content. In addition, information on dietary habits and demographics was collected in an attempt to identify behavioral and demographic characteristics that influence soil ingestion rates among children. The amount of soil ingested on a daily basis was estimated using Equation 5-1:

$$S_{i,e} = \frac{(((DW_f + DW_p) \times E_f) + 2E_u) - (DW_{fd} \times E_{fd})}{E_{soil}} \quad \text{(Eqn. 5-1)}$$

where:

$S_{i,e}$	=soil ingested for child *i* based on tracer *e* (grams);
DW_f	=feces dry weight (grams);
DW_p	=feces dry weight on toilet paper (grams);
E_f	=tracer concentration in feces (µg/g);
E_u	=tracer amount in urine (µg);
DW_{fd}	=food dry weight (grams);
E_{fd}	=tracer concentration in food (µg/g); and
E_{soil}	=tracer concentration in soil (µg/g).

The soil ingestion rates were corrected by adding the amount of tracer in vitamins and medications to the amount of tracer in food, and adjusting the food, fecal and urine sample weights to account for missing samples. Food, fecal and urine samples were composited over a 4-day period, and estimates for daily soil ingestion were obtained by dividing the 4-day composited tracer quantities by 4.

Soil ingestion rates were highly variable, especially those based on titanium. Mean daily soil ingestion estimates were 38.9 mg/day for aluminum, 82.4 mg/day for silicon and 245.5 mg/day for titanium (see Table 5-7). Median values were 25 mg/day for aluminum, 59 mg/day for silicon, and 81 mg/day for titanium. The investigators also evaluated the extent to which differences in tracer concentrations in house dust and yard soil impacted estimated soil ingestion rates. The value used in the denominator of the soil ingestion estimate equation was recalculated to represent a weighted average of the tracer concentration in yard soil and house dust based on the proportion of time the child spent indoors and outdoors, using an assumption that the likelihood of ingesting soil outdoors was the same as that of ingesting dust indoors. The adjusted mean soil/dust ingestion rates were 64.5 mg/day for aluminum, 160.0 mg/day for silicon, and 268.4 mg/day for titanium. Adjusted median soil/dust ingestion rates were: 51.8 mg/day for aluminum, 112.4 mg/day for silicon, and 116.6 mg/day for titanium. The authors investigated whether nine behavioral and demographic factors could be used to predict soil ingestion, and found family income less than $15,000/year and swallowing toothpaste to be significant predictors with silicon-based estimates; residing in one of the three cities to be a significant predictor with aluminum-based estimates, and washing the face before eating significant for titanium-based estimates.

5.3.2.5. *Calabrese et al. (1997a)—Soil Ingestion Estimates for Children Residing on a Superfund Site*

Calabrese et al. (1997a) estimated soil ingestion rates for children residing on a Superfund site using a methodology in which eight tracer elements were analyzed. The methodology used in this study is similar to that employed in Calabrese et al. (1989), except that rather than using barium, manganese, and vanadium as three of the eight tracers, the researchers replaced them with cerium, lanthanum, and neodymium. A total of 64 children ages 1−3 years (36 male, 28 female) were selected for this study of the Anaconda, Montana area. The study was conducted for seven consecutive days during September or September and October, apparently in 1992, shortly after soil was removed and replaced in some residential yards in the area. Duplicate samples of meals, beverages, and over-the-counter medicines and vitamins were collected over the 7 day period, along with fecal samples. In addition, soil and dust samples were collected from the children's home and play areas. Toothpaste containing non-detectable levels of the tracer elements, with the exception of silica, was provided to all of the children. Infants were provided with baby cornstarch, diaper rash cream, and soap, which were found to contain low levels of tracer elements.

Because of the high degree of intertracer variability, Calabrese et al. (1997a) also derived estimates based on the "Best Tracer Methodology" (BTM). This BTM uses food/soil tracer concentration ratios in order to correct for errors caused by misalignment of tracer input and outputs, ingestion of non-food sources, and non-soil sources (Stanek and Calabrese, 1995a). A low food/soil ratio is desired because it minimizes transit time errors. The BTM did not use the results from Ce, La, and Nd despite these tracers having low food/soil ratios because the soil concentrations for these elements were found to be affected by particle size and more susceptible to source errors. Calabrese et al. (1997a) noted that estimates based on Al, Si, and Y in this study may result in lower soil ingestion estimates than the true value because the apparent residual negative errors found for these three tracers for a large majority of subjects. It was noted that soil ingestion estimates for this population may be lower than estimates found by previous studies in the literature because of families' awareness of contamination from the Superfund site, which may have resulted in altered behavior.

Soil ingestion estimates were also examined based on various demographic characteristics. There were no statistically significant differences in soil ingestion based on age, sex, birth order, or house yard characteristics (Calabrese et al., 1997a). Although not statistically significant, soil ingestion rates were generally higher for females, children with lower birth number, children with parents employed as laborers, or in service profession, homemakers, or unemployed and for children with pets (Calabrese et al., 1997a).

Table 5-8 shows the estimated soil and dust ingestion by each tracer element and by the BTM. Based on the BTM, the mean soil and dust ingestion rates were 65.5 mg/day and 127.2 mg/day, respectively.

5.3.2.6. *Stanek et al. (1998)—Prevalence of Soil Mouthing/Ingestion among Healthy Children Aged One to Six/Calabrese et al. (1997b)—Soil Ingestion Rates in Children Identified by Parental Observation as Likely High Soil Ingesters*

Stanek et al. (1998) conducted a survey response study using in-person interviews of parents of children attending well visits at three western Massachusetts medical clinics in August, September, and October of 1992. Of 528 children ages 1 to 7 with completed interviews, parents reported daily mouthing or ingestion of sand and stones in 6%, daily mouthing or ingestion of soil and dirt in 4%, and daily mouthing or ingestion of dust, lint and dustballs in 1%. Parents reported more than weekly mouthing or ingestion of sand and stones in 16%, more than weekly mouthing or ingestion of soil and dirt in 10%, and more than weekly mouthing or ingestion of dust, lint and dustballs in 3%. Parents reported more than monthly mouthing or ingestion of sand and stones in 27%, more than monthly mouthing or ingestion of soil and dirt in 18%, and more than monthly mouthing or ingestion of dust, lint, and dustballs in 6%.

Calabrese and colleagues performed a follow-up tracer element study (Calabrese et al., 1997b) for a subset ($N = 12$) of the Stanek et al. (1998) children whose caregivers had reported daily sand/soil ingestion ($N = 17$). The time frame of the follow-up tracer study relative to the original survey response study was not stated; the study duration was 7 days. Of the 12 children in Calabrese et al. (1997b), one exhibited behavior that the authors believed was clearly soil pica; Table 5-9 shows estimated soil ingestion rates for this child during the study period. Estimates ranged from –10 mg/day to 7,253 mg/day depending on the tracer. Table 5-10 presents the estimated average daily soil ingestion estimates for the 12 children studied. Estimates calculated based on soil tracer element concentrations only ranged from –15 to +1,783 mg/day based on aluminum, −46 to +931 mg/day based on silicon, and –47 to +3,581 mg/day based on titanium. Estimated average daily dust ingestion estimates ranged from −39 to +2,652 mg/day based on aluminum, –351 to +3,145 mg/day based on silicon, and –98 to +3,632 mg/day based on titanium. Calabrese et al. (1997b) question the validity of retrospective caregiver reports of soil pica on the basis of the tracer element results.

5.3.2.7. *Davis and Mirick (2006)—Soil ingestion in children and adults in the same family*

Davis and Mirick (2006) calculated soil ingestion for children and adults in the same family using a tracer element approach. Data were collected in 1988, one year after the Davis et al. (1990) study was conducted. Samples were collected and prepared for laboratory analysis and then stored for a 2-year period prior to tracer element quantification with laboratory analysis. Analytical recovery values for spiked samples were within the quality control limits of ±25%. The 20 families in this study were a non-random subset of the 104 families who participated in the soil ingestion study by Davis et al. (1990). Data collection issues resulted in sufficiently complete data for only 19 of the 20 families consisting of a child participant from the Davis et al. (1990) study ages 3 to 7, inclusive, and a female and male parent or guardian living in the same house. Duplicate samples of all food and medication items consumed, and all feces excreted, were collected for 11 consecutive days. Urine samples were collected twice daily for 9 of the 11 days; for the remaining 2 days, attempts were made to collect full 24-hour urine specimens. Soil and house dust samples were also collected. Only 12 children had sufficiently complete data for use in the soil and dust ingestion estimates.

Tracer elements for this study included aluminum, silicon, and titanium. Toothpaste was supplied for use by study participants. In addition, parents completed a daily diary of activities for themselves and the participant child for 4 consecutive days during the study period.

Table 5-11 shows soil ingestion rates for all three family member participants. The mean and median estimates for children for all three tracers ranged from 36.7 to 206.9 mg/day and 26.4 to 46.7 mg/day, respectively, and fall within the range of those reported by Davis et al. (1990). Adult soil ingestion estimates ranged from 23.2 to 624.9 mg/day for mean values and from 0 to 259.5 mg/day for median values. Adult soil ingestion estimates were more variable than those of children in the study regardless of the tracer. The authors believed that this higher variability may have indicated an important occupational contribution of soil ingestion in some, but not all, of the adults. Similar to previous studies, the soil ingestion estimates were the highest for titanium. Although toothpaste is a known source of titanium, the titanium content of the toothpaste used by study participants was not determined.

Only three of a number of behaviors examined for their relationship to soil ingestion were found to be associated with increased soil ingestion in this study:

- reported eating of dirt (for children);
- occupational contact with soil (for adults); and
- hand washing before meals (for both children and adults).

Several typical childhood behaviors, however, including thumb-sucking, furniture licking, and carrying around a blanket or toy were not associated with increased soil ingestion for the participating children. Among both parents and children, neither nail-biting nor eating unwashed fruits or vegetables was correlated with increased soil ingestion. However, because the study design required an equal amount of any food consumed to be included in the sample for analysis, eating unwashed fruits or vegetables would not have contributed to an increase in soil ingestion. Although eating unwashed fruits or vegetables was not associated with soil ingestion in either children or adults in this study, the authors noted that it is a behavior that could lead to soil ingestion. When investigating correlations within the same family, a child's soil ingestion was not found to be associated with either parent's soil ingestion, nor did the mother and father's soil ingestion appear to be correlated.

5.3.3. Key Studies of Secondary Analysis

5.3.3.1. *Wong (1988)—The Role of Environmental and Host Behavioral Factors in Determining Exposure to Infection with Ascaris lumbricoides and Trichuris Trichiura/Calabrese and Stanek (1993)—Soil Pica: Not a Rare Event*

Calabrese and Stanek (1993) reviewed a tracer element study that was conducted by Wong (1988) to estimate the amount of soil ingested by two groups of children. Wong (1988) studied a total of 52 children in two government institutions in Jamaica. The younger group included 24 children with an average age of 3.1 years (range of 0.3 to 7.5 years). The older group included 28 children with an average age of 7.2 years (range of 1.8 to 14 years). One fecal sample was collected each month from each subject over the 4-month study period. The amount of silicon in dry feces was measured to estimate soil ingestion.

An unspecified number of daily fecal samples were collected from a hospital control group of 30 children with an average age of 4.8 years (range of 0.3 to 12 years). Dry feces were observed to contain 1.45% silicon, or 14.5 mg Si per gram of dry feces. This quantity was used to correct measured fecal silicon from dietary sources. Fecal silicon quantities greater than 1.45% in the 52 studied children were interpreted as originating from soil ingestion.

For the 28 children in the older group, soil ingestion was estimated to be 58 mg/day, based on the mean minus one outlier, and 1,520 mg/day, based on the mean of all the children. The outlier was a child with an estimated average soil ingestion rate of 41 g/day over the 4 months.

Estimates of soil ingestion were higher in the younger group of 24 children. The mean soil ingestion of all the children was 470 ± 370 mg/day. Due to some sample losses, of the 24 children studied, only 15 had samples for each of the 4 months of the study. Over the entire 4-month study period, 9 of 84 samples (or 10.5%) yielded soil ingestion estimates in excess of 1 g/day.

Of the 52 children studied, 6 had one-day estimates of more than 1,000 mg/day. Table 5-12 shows the estimated soil ingestion for these six children. The article describes 5 of 24 (or 20.8%) in the younger group of children as having a >1,000 mg/day estimate on at least one of the four study days; in the older group one child is described in this manner. A high degree of daily variability in soil ingestion was observed among these six children; three showed soil-pica behavior on 2, 3, and 4 days, respectively, with the most consistent (4 out of

4 days) soil-pica child having the highest estimated soil ingestion, 3.8 to 60.7 g/day.

5.3.3.2. *Calabrese and Stanek (1995)—Resolving Intertracer Inconsistencies in Soil Ingestion Estimation*

Calabrese and Stanek (1995) explored sources and magnitude of positive and negative errors in soil ingestion estimates for children on a subject-week and trace element basis. Calabrese and Stanek (1995) identified possible sources of positive errors as follows:

- Ingestion of high levels of tracers before the start of the study and low ingestion during the study period; and
- Ingestion of element tracers from a non-food or non-soil source during the study period.

Possible sources of negative bias were identified as follows:

- Ingestion of tracers in food that are not captured in the fecal sample either due to slow lag time or not having a fecal sample available on the final study day; and
- Sample measurement errors that result in diminished detection of fecal tracers, but not in soil tracer levels.

The authors developed an approach that attempted to reduce the magnitude of error in the individual trace element ingestion estimates. Results from a previous study conducted by Calabrese et al. (1989) were used to quantify these errors based on the following criteria: (1) a lag period of 28 hours was assumed for the passage of tracers ingested in food to the feces (this value was applied to all subject-day estimates); (2) a daily soil ingestion rate was estimated for each tracer for each 24-hour day a fecal sample was obtained; (3) the median tracer-based soil ingestion rate for each subject-day was determined; and (4) negative errors due to missing fecal samples at the end of the study period were also determined. Also, upper- and lower-bound estimates were determined based on criteria formed using an assumption of the magnitude of the relative standard deviation presented in another study conducted by Stanek and Calabrese (1995b). Daily soil ingestion rates for tracers that fell beyond the upper and lower ranges were excluded from subsequent calculations, and the median soil ingestion rates of the remaining tracer elements were considered the best estimate for that particular day. The magnitude of positive or negative error for a specific tracer per day was derived by determining the difference between the value for the tracer and the median value.

Table 5-13 presents the estimated magnitude of positive and negative error for six tracer elements in the children's study (conducted by Calabrese et al., 1989). The original non-negative mean soil ingestion rates (see Table 5-3) ranged from a low of 21 mg/day based on zirconium to a high of 459 mg/day based on vanadium. The adjusted mean soil ingestion rate after correcting for negative and positive errors ranged from 97 mg/day based on yttrium to 208 mg/day based on titanium. Calabrese and Stanek (1995) concluded that correcting for errors at the individual level for each tracer element provides more reliable estimates of soil ingestion.

5.3.3.3. *Stanek and Calabrese (1995a)—Soil Ingestion Estimates for Use in Site Evaluations Based on the Best Tracer Method*

Stanek and Calabrese (1995a) recalculated soil ingestion rates for adults and children from two previous studies, using data for eight tracers from Calabrese et al. (1989) and three tracers from Davis et al. (1990). Recalculations were performed using the BTM. This method selected the "best" tracer(s), by dividing the total amount of tracer in a particular child's duplicate food sample by tracer concentration in that child's soil sample to yield a food/soil (F/S) ratio. The F/S ratio was small when the tracer concentration in food was low compared to the tracer concentration in soil. Small F/S ratios were desirable because they lessened the impact of transit time error (the error that occurs when fecal output does not reflect food ingestion, due to fluctuation in gastrointestinal transit time) in the soil ingestion calculation.

For adults, Stanek and Calabrese (1995a) used data for eight tracers from the Calabrese et al. (1989) study to estimate soil ingestion by the BTM. The lowest F/S ratios were Zr and Al and the element with the highest F/S ratio was Mn. For soil ingestion estimates based on the median of the lowest four F/S ratios, the tracers contributing most often to the soil ingestion estimates were Al, Si, Ti, Y, V, and Zr. Using the median of the soil ingestion rates based on the best four tracer elements, the average adult soil ingestion rate was estimated to be 64 mg/day with a median of 87 mg/day. The 95th percentile soil ingestion estimate was 142 mg/day. These estimates are based on 18 subject weeks for the six adult volunteers described in Calabrese et al. (1989).

The BTM used a ranking scheme of F/S ratios to determine the best tracers for use in the ingestion rate calculation. To reduce the impact of biases that may occur as a result of sources of fecal tracers other than food or soil, the median of soil ingestion estimates based on the four lowest F/S ratios was used to represent soil ingestion.

Using the lowest four F/S ratios for each individual, calculated on a per-week ("subject-week") basis, the median of the soil ingestion estimates from the Calabrese et al. (1989) study most often included aluminum, silicon, titanium, yttrium, and zirconium. Based on the median of soil ingestion estimates from the best four tracers, the mean soil ingestion rate for children was 132 mg/day and the median was 33 mg/day. The 95th percentile value was 154 mg/day. For the 101 children in the Davis et al. (1990) study, the mean soil ingestion rate was 69 mg/day and the median soil ingestion rate was 44 mg/day. The 95th percentile estimate was 246 mg/day. These data are based on the three tracers (i.e., aluminum, silicon, and titanium) from the Davis et al. (1990) study. When the results for the 128 subject-weeks in Calabrese et al. (1989) and 101 children in Davis et al. (1990) were combined, soil ingestion for children was estimated to be 104 mg/day (mean); 37 mg/day (median); and 217 mg/day (95th percentile), using the BTM.

5.3.3.4. *Hogan et al. (1998)—Integrated Exposure Uptake Biokinetic Model for Lead in Children: Empirical Comparisons with Epidemiologic Data*

Hogan et al. (1998) used the biokinetic model comparison methodology to review the measured blood lead levels of 478 children. These children were a subset of the entire population of children living in three historic lead smelting communities (Palmerton, Pennsylvania; Madison County, Illinois; and southeastern Kansas/southwestern Missouri), whose environmental lead exposures (soil and dust lead levels) had been studied as part of public health evaluations in these communities. The study populations were, in general, random samples of children 6 months to 7 years of age. Children who had lived in their residence for less than 3 months or those reported by their parents to be away from home more than 10 hours per week (>20 hours/week for the Pennsylvania data set) were excluded due to lack of information regarding lead exposure at the secondary location. The nature of the soil and dust exposures for the residential study population were typical, with the sample size considered sufficiently large to ensure that a wide enough range of children's behavior would be spanned by the data. Comparisons were made for a number of exposure factors, including age, location, time spent away from home, time spent outside, and whether or not children took food outside to eat.

The IEUBK model is a biokinetic model for predicting children's blood lead levels that uses measurements of lead content in house dust, soil, drinking water, food, and air, and child-specific estimates of intake for each exposure medium (dust, soil, drinking water, food and air). Model users can also use default assumptions for the lead contents and intake rates for each exposure medium when they do not have specific information for each child.

Hogan et al. (1998) compared children's measured blood lead levels with biokinetic model predictions (IEUBK version 0.99d) of blood lead levels, using the children's measured drinking water, soil, and dust lead contamination levels together with default IEUBK model inputs for soil and dust ingestion, relative proportions of soil and dust ingestion, lead bioavailability from soil and dust, and other model parameters. Thus, the default soil and dust ingestion rates in the model, and other default assumptions in the model, were tested by comparing measured blood lead levels with the model's predictions for those children's blood lead levels. Most IEUBK model kinetic and intake parameters were drawn independently from published literature (White et al., 1998; U.S. EPA, 1994b). Elimination parameters in particular had relatively less literature to draw upon (few data in children) and were fixed through a calibration exercise using a data set with children's blood lead levels paired with measured environmental lead exposures in and around their homes, while holding the other model parameters constant.

For Palmerton, Pennsylvania ($N = 34$), the community-wide geometric mean measured blood lead levels (6.8 µg/dL) were slightly over-predicted by the model (7.5 µg/dL); for southeastern Kansas/southwestern Missouri ($N = 111$), the blood lead levels (5.2 µg/dL) were slightly under-predicted (4.6 µg/dL), and for Madison County, Illinois ($N = 333$), the geometric mean measured blood lead levels matched the model predictions (5.9 µg/dL measured and predicted), with very slight differences in the 95% confidence interval. Although there may be uncertainty in these estimates, these results suggest that the default soil and dust ingestion rates used in this version of the IEUBK model (approximately 50 mg/day soil and 60 mg/day dust for a total soil + dust ingestion of 110 mg/day, averaged over children ages 1 through 6) may be roughly accurate in representing the central tendency soil and dust ingestion rates of residence-dwelling children in the three locations studied.

5.3.3.5. *Özkaynak et al. (2010)—Modeled Estimates of Soil and Dust Ingestion Rates for Children*

Özkaynak et al. (2010) developed soil and dust ingestion rates for children 3 to <6 years of age using U.S. EPA's SHEDS model for multimedia pollutants (SHEDS-Multimedia). The authors had two main objectives for this research: (1) to demonstrate an application of the SHEDS model while identifying and quantifying the key factors contributing to the predicted variability and uncertainty in the soil and dust ingestion exposure estimates, and (2) to compare the modeled results to existing tracer-element field measurements. The SHEDS model is a physically based probabilistic exposure model, which combines diary information on sequential time spent in different locations and activities drawn from U.S. EPA's Consolidated Human Activity Database (CHAD), with micro-activity data (e.g., hand-to-mouth frequency, hand-to-surface frequency), surface/object soil or dust loadings, and other exposure factors (e.g., soil-to-skin adherence, saliva removal efficiency). The SHEDS model generates simulated individuals, who are then followed through time, generally up to one year. The model computes changes to their exposure at the diary event level.

For this study, an indirect modeling approach was used, in which soil and dust were assumed to first adhere to the hands, and remain until washed off or ingested by mouthing. The object-to-mouth pathway for soil/dust ingestion was also addressed. For this application of the SHEDS model, however, other avenues of soil/dust ingestion were not considered. Outdoor matter was designated as "soil" and indoor matter as "dust." Estimates for the distributions of exposure factors such as activity, time outdoors, environmental concentrations, soil-skin and dust-skin transfer, hand washing frequency and efficiency, hand-mouthing frequency, area of object or hand mouthed, mouthing removal rates, and other variables were obtained from the literature. These input variables were used in this SHEDS model application to generate estimates of soil and dust ingestion rates for a simulated population of 1,000. Both sensitivity and uncertainty analyses were conducted. Based on the sensitivity analysis, the model results are the most sensitive to dust loadings on carpet and hard floor surfaces; soil-skin adherence factor; hand mouthing frequency, and; mean number of hand washes per day. Based on 200 uncertainty simulations that were conducted, the modeling uncertainties were seen to be asymmetrically distributed around the 50^{th} (median) or the central variability distribution.

Table 5-14 shows the predicted soil- and dust-ingestion rates. Mean total soil and dust ingestion was predicted to be 68 mg/day, with approximately 60% originating from soil ingestion, 30% from dust on hands, and 10% from dust on objects. Hand-to-mouth soil and dust ingestion was found to be the most important pathway, followed by hand-to-mouth dust ingestion, then object-to-mouth dust ingestion. The authors noted that these modeled estimates were found to be consistent with other soil/dust ingestion values in the literature, but slightly lower than the central tendency value of 100 mg/day recommended in U.S. EPA's *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2008).

The advantages of this study include the fact that the SHEDS methodology can be applied to specific study populations of interest, a wide range of input parameters can be applied, and a full range of distributions can be generated. The primary limitation of this study is the lack of data for some of the input variables. Data needs include additional information on the activities and environments of children in younger age groups, including children with high hand-to-mouth, object-to-mouth, and pica behaviors, and information on skin adherence and dust loadings on indoor objects and floors. In addition, other age groups of interest were not included because of lack of data for some of the input variables.

5.3.4. Relevant Studies of Primary Analysis

The following studies are classified as relevant rather than key. The tracer element studies described in this section are not designated as key because the methodology to account for non-soil tracer exposures was not as well-developed as the methodology in the U.S. tracer element studies described in Sections 5.3.2 and 5.3.3, or because they do not provide a quantitative estimate of soil ingestion. However, the method of Clausing et al. (1987) was used in developing biokinetic model default soil and dust ingestion rates (U.S. EPA, 1994a) used in the Hogan et al. (1998) study, which was designated as key. In the survey response studies, in most cases the studies were of a non-randomized design, insufficient information was provided to determine important details regarding study design, or no data were provided to allow quantitative estimates of soil and/or dust ingestion rates.

5.3.4.1. *Dickins and Ford (1942)—Geophagy (Dirt Eating) Among Mississippi Negro School Children*

Dickens and Ford conducted a survey response study of rural Black school children (4th grade and above) in Oktibbeha County, Mississippi in September 1941. A total of 52 of 207 children (18 of 69 boys and 34 of 138 girls) studied gave positive responses to questions administered in a test-taking format regarding having eaten dirt in the previous 10 to 16 days. The authors stated that the study sample likely was more representative of the higher socioeconomic levels in the community, because older children from lower socioeconomic levels sometimes left school in order to work, and because children in the lower grades, who were more socioeconomically representative of the overall community, were excluded from the study. Clay was identified as the predominant type of soil eaten.

5.3.4.2. *Ferguson and Keaton (1950)—Studies of the Diets of Pregnant Women in Mississippi: II Diet Patterns*

Ferguson and Keaton (1950) conducted a survey response study of a group of 361 pregnant women receiving health care at the Mississippi State Board of Health, who were interviewed regarding their diet, including the consumption of clay or starch. All of the women were from the lowest economic and educational level in the area, and 92% were Black. Of the Black women, 27% reported clay-eating and 41% starch-eating. In the group of White women, 7 and 10% reporting clay- and starch-eating, respectively. The amount of starch eaten ranged from 2−3 small lumps to 3 boxes (24 ounces) per day. The amount of clay eaten ranged from one tablespoon to one cup per day.

5.3.4.3. *Cooper (1957)—Pica: A Survey of the Historical Literature as well as Reports from the Fields of Veterinary Medicine and Anthropology, the Present Study of Pica in Young Children, and a Discussion of Its Pediatric and Psychological Implications*

Cooper (1957) conducted a non-randomized survey response study in the 1950s of children age 7 months or older referred to a Baltimore, Maryland mental hygiene clinic. For 86 out of 784 children studied, parents or caretakers gave positive responses to the question, “Does your child have a habit, or did he ever have a habit, of eating dirt, plaster, ashes, etc.?” and identified dirt, or dirt combined with other substances, as the substance ingested. Cooper (1957) described a pattern of pica behavior, including ingesting substances other than soil, being most common between ages 2 and 4 or 5 years, with one of the 86 children ingesting clay at age 10 years and 9 months.

5.3.4.4. *Barltrop (1966)—The Prevalence of Pica*

Barltrop (1966) conducted a randomized survey response study of children born in Boston, Massachusetts between 1958 and 1962, inclusive, whose parents resided in Boston and who were neither illegitimate nor adopted. A stratified random subsample of 500 of these children was contacted for in-person caregiver interviews, in which a total of 186 families (37%) participated. A separate stratified subsample of 1,000 children was selected for a mailed survey, in which 277 (28%) of the families participated. Interview-obtained data regarding care-giver reports of pica (in this study is defined as placing non-food items in the mouth and swallowing them) behavior in all children ages 1 to 6 years in the 186 families (N = 439) indicated 19 had ingested dirt (defined as yard dirt, house dust, plant-pot soil, pebbles, ashes, cigarette ash, glass fragments, lint, and hair combings) in the preceding 14 days. It does not appear that these data were corrected for unequal selection probability in the stratified random sample, nor were they corrected for non-response bias. Interviews were conducted in the March/April time frame, presumably in 1964. Mail-survey obtained data regarding caregiver reports of pica in the preceding 14 days indicated that 39 of 277 children had ingested dirt, presumably using the same definition as above. Barltrop (1966) mentions several possible limitations of the study, including non-participation bias and respondents’ memory, or recall, effects.

5.3.4.5. *Bruhn and Pangborn (1971)—Reported Incidence of Pica among Migrant Families*

Bruhn and Pangborn (1971) conducted a survey among 91 low income families of migrant agricultural workers in California in May through August 1969. Families were of Mexican descent in two labor camps (Madison camp, 10 miles west of Woodland, and Davis camp, 10 miles east of Davis) and were “Anglo” families at the Harney Lane camp 17 miles north of Stockton. Participation was 34 of 50 families at the Madison camp, 31 of 50 families at the Davis camp, and 26 of 26 families at the Harney Lane camp. Respondents for the studied families (primarily wives) gave positive responses to open-ended questions such as "Do you know of anyone who eats dirt or laundry starch?" Bruhn and Pangborn (1971) apparently asked a modified version of this question pertaining to the respondents' own or relatives' families. They reported 18% (12 of 65) of Mexican families' respondents as giving positive responses for consumption of "dirt" among children within the Mexican respondents' own or relatives' families. They reported 42% (11 of 26) of "Anglo" families' respondents as giving positive responses for consumption of "dirt" among children within the Anglo respondents' own or relatives' families.

5.3.4.6. *Robischon (1971)—Pica Practice and Other Hand-Mouth Behavior and Children's Developmental Level*

A survey response sample of 19- to 24-month old children examined at an urban well-child clinic in the late 1960s or 1970 in an unspecified location indicated that 48 of the 130 children whose caregivers were interviewed, exhibited pica behavior (defined as "ate non-edibles more than once a week"). The specific substances eaten were reported for 30 of the 48 children. All except 2 of the 30 children habitually ate more than one non-edible substance. The soil and dust-like substances reported as eaten by these 30 children were: ashes (17), "earth" (5), dust (3), fuzz from rugs (2), clay (1), and pebbles/stones (1). Caregivers for some of the study subjects (between 0 and 52 of the 130 subjects, exact number not specified) reported that the children "ate non-edibles less than once a week."

5.3.4.7. *Bronstein and Dollar (1974)—Pica in Pregnancy*

The frequency and effects of pica behavior was investigated by Bronstein and Dollar (1974) in 410 pregnant, low-income women from both urban ($N = 201$) and rural ($N = 209$) areas in Georgia. The women selected were part of the Nutrition Demonstration Project, a study investigating the effect of nutrition on the outcome of the pregnancy, conducted at the Eugene Talmadge Memorial Hospital and University Hospital in Augusta, Georgia. During their initial prenatal visit, each patient was interviewed by a nutrition counselor who questioned her food frequency, social and dietary history, and the presence of pica. Patients were categorized by age, parity, and place of residence (rural or urban).

Of the 410 women interviewed, 65 (16%) stated that they practiced pica. A variety of substances were ingested, with laundry starch being the most common. There was no significant difference in the practice of pica between rural and urban women, although older rural women (20−35 years) showed a greater tendency to practice pica than younger rural or urban women (<20 years). The number of previous pregnancies did not influence the practice of pica. The authors noted that the frequency of pica among rural patients had declined from a previous study conducted 8 years earlier, and attributed the reduction to a program of intensified nutrition education and counseling provided in the area. No specific information on the amount of pica substances ingested was provided by this study, and the data are more than 30 years old.

5.3.4.8. *Hook (1978)—Dietary Cravings and Aversions During Pregnancy*

Hook (1978) conducted interviews of 250 women who had each delivered a live infant at two New York hospitals; the interviews took place in 1975. The mothers were first asked about any differences in consumption of seven beverages during their pregnancy, and the reasons for any changes. They were then asked, without mentioning specific items, about any cravings or aversions for other foods or non-food items that may have developed at any time during their pregnancy.

Non-food items reportedly ingested during pregnancy were ice, reported by three women, and chalk from a river clay bank, reported by one woman. In addition, one woman reported an aversion to non-food items (specific non-food item not reported). No quantity data were provided by this study.

5.3.4.9. *Binder et al. (1986)—Estimating Soil Ingestion: The Use of Tracer Elements in Estimating the Amount of Soil Ingested by Young Children*

Binder et al. (1986) used a tracer technique modified from a method previously used to measure soil ingestion among grazing animals to study the ingestion of soil among children 1 to 3 years of age who wore diapers. The children were studied during the summer of 1984 as part of a larger study of residents living near a lead smelter in East Helena, Montana. Soiled diapers were collected over a 3-day period from 65 children (42 males and 23 females), and composited samples of soil were obtained from the children's yards. Both excreta and soil samples were analyzed for aluminum, silicon, and titanium. These elements were found in soil but were thought to be poorly absorbed in the gut and to have been present in the diet only in limited quantities. Excreta measurements were obtained for 59 of the children. Soil ingestion by each child was estimated on the basis of each of the three tracer elements using a standard assumed fecal dry weight of 15 g/day, and the following equation (5-2):

$$T_{i,e} = \frac{f_{i,e} \times F_i}{S_{i,e}} \qquad \text{(Eqn. 5-2)}$$

where:

$T_{i,e}$	=	estimated soil ingestion for child i based on element e (g/day),
$f_{i,e}$	=	concentration of element e in fecal sample of child i (mg/g),
F_i	=	fecal dry weight (g/day), and
$S_{i,e}$	=	concentration of element e in child i's yard soil (mg/g).

The analysis assumed that (1) the tracer elements were neither lost nor introduced during sample processing; (2) the soil ingested by children originates primarily from their own yards; and (3) that absorption of the tracer elements by children occurred in only small amounts. The study did not distinguish between ingestion of soil and house dust, nor did it account for the presence of the tracer elements in ingested foods or medicines.

The arithmetic mean quantity of soil ingested by the children in the Binder et al. (1986) study was estimated to be 181 mg/day (range 25 to 1,324) based on the aluminum tracer; 184 mg/day (range 31 to 799) based on the silicon tracer; and 1,834 mg/day (range 4 to 17,076) based on the titanium tracer (see Table 5-15). The overall mean soil ingestion estimate, based on the minimum of the three individual tracer estimates for each child, was 108 mg/day (range 4 to 708). The median values were 121 mg/day, 136 mg/day, and 618 mg/day for aluminum, silicon, and titanium, respectively. The 95th percentile values for aluminum, silicon, and titanium were 584 mg/day, 578 mg/day, and 9,590 mg/day, respectively. The 95th percentile value based on the minimum of the three individual tracer estimates for each child was 386 mg/day.

The authors were not able to explain the difference between the results for titanium and for the other two elements, but they speculated that unrecognized sources of titanium in the diet or in the laboratory processing of stool samples may have accounted for the increased levels. The frequency distribution graph of soil ingestion estimates based on titanium shows that a group of 21 children had particularly high titanium values (i.e., >1,000 mg/day). The remainder of the children showed titanium ingestion estimates at lower levels, with a distribution more comparable to that of the other elements.

5.3.4.10. *Clausing et al. (1987)—A Method for Estimating Soil Ingestion by Children*

Clausing et al. (1987) conducted a soil ingestion study with Dutch children using a tracer element methodology. Clausing et al. (1987) measured aluminum, titanium, and acid-insoluble residue contents of fecal samples from children aged 2 to 4 years attending a nursery school, and for samples of playground dirt at that school. Over a 5-day period, 27 daily fecal samples were obtained for 18 children. Using the average soil concentrations present at the school, and assuming a standard fecal dry weight of 10 g/day, soil ingestion was estimated for each tracer. Six hospitalized, bedridden children served as a control group, representing children who had very limited access to soil; eight daily fecal samples were collected from the hospitalized children.

Without correcting for the tracer element contribution from background sources, represented by the hospitalized children's soil ingestion estimates, the aluminum-based soil ingestion estimates for the school children in this study ranged from 23 to 979 mg/day, the AIR-based estimates ranged from 48 to 362 mg/day, and the titanium-based estimates ranged from 64 to 11,620 mg/day. As in the Binder et al. (1986) study, a fraction of the children (6/18) showed titanium values above 1,000 mg/day, with most of the remaining children showing substantially lower values. Calculating an arithmetic mean quantity of soil ingested based on each fecal sample yielded 230 mg/day for aluminum; 129 mg/day for AIR, and 1,430 mg/day for titanium (see Table 5-16). Based on the LTM and averaging across each fecal sample, the arithmetic mean soil ingestion was estimated to be 105 mg/day with a population standard deviation of 67 mg/day (range 23 to 362 mg/day); geometric mean soil ingestion was estimated to be 90 mg/day. Use of the LTM assumed that "the maximum amount of soil ingested corresponded with the lowest estimate from the three tracers" (Clausing et al., 1987).

The hospitalized children's arithmetic mean aluminum-based soil ingestion estimate was 56 mg/day; titanium-based estimates included estimates for three of the six children that exceeded 1,000 mg/day, with the remaining three children in the range of 28 to 58 mg/day (see Table 5-17). AIR measurements were not reported for the hospitalized children. Using the LTM method, the mean soil ingestion rate was estimated to be 49 mg/day with a population standard deviation of 22 mg/day (range 26 to 84 mg/day). The geometric mean soil ingestion rate was 45 mg/day. The hospitalized children's data suggested a major non-soil source of titanium for some children and a background non-soil source of aluminum. However, conditions specific to hospitalization (e.g., medications) were not considered.

Clausing et al. (1987) estimated that the average soil ingestion of the nursery school children was 56 mg/day, after subtracting the mean LTM soil ingestion for the hospitalized children (49 mg/day) from the nursery school children's mean LTM soil ingestion (105 mg/day), to account for background tracer intake from dietary and other non-soil sources.

5.3.4.11. *Calabrese et al. (1990)—Preliminary Adult Soil Ingestion Estimates: Results of a Pilot Study*

Calabrese et al. (1990) studied six adults to evaluate the extent to which they ingest soil. This adult study was originally part of the children soil ingestion study (Calabrese et al., 1989) and was used to validate part of the analytical methodology used in the children's study. The participants were six healthy adults, three males and three females, 25−41 years old. Each volunteer ingested one empty gelatin capsule at breakfast and one at dinner Monday, Tuesday, and Wednesday during the first week of the study. During the second week, they ingested 50 milligrams of sterilized soil within a gelatin capsule at breakfast and at dinner (a total of 100 milligrams of sterilized soil per day) for 3 days. For the third week, the participants ingested 250 milligrams of sterilized soil in a gelatin capsule at breakfast and at dinner (a total of 500 milligrams of soil per day) during the 3 days. Duplicate meal samples (food and beverage) were collected from the six adults. The sample included all foods ingested from breakfast Monday, through the evening meal Wednesday during each of the 3 weeks. In addition, all medications and vitamins ingested by the adults were collected. Total excretory output was collected from Monday noon through Friday midnight over 3 consecutive weeks.

Data obtained from the first week, when empty gelatin capsules were ingested, were used to estimate soil intake by adults. On the basis of recovery values, Al, Si, Y, and Zr were considered the most valid tracers. The mean values for these four tracers were: Al, 110 milligrams; Si, 30 milligrams; Y, 63 milligrams; and Zr, 134 mg. A limitation of this study is the small sample size.

5.3.4.12. *Cooksey (1995)—Pica and Olfactory Craving of Pregnancy: How Deep Are the Secrets?*

Postpartum interviews were conducted between 1992 and 1994 of 300 women at a mid-western hospital, to document their experiences of pica behavior. The majority of women were Black and low-income, and ranged in age from 13 to 42 years. In addition to questions regarding nutrition, each woman was asked if during her pregnancy she experienced a craving to eat ice or other things that are not food.

Of the 300 women, 194 (65%) described ingesting one or more pica substances during their pregnancy, and the majority (78%) ate ice/freezer frost alone or in addition to other pica substances. Reported quantities of items ingested on a daily basis were three to four 8-pound bags of ice, two to three boxes of cornstarch, two cans of baking powder, one cereal bowl of dirt, five quarts of freezer frost, and one large can of powdered cleanser.

5.3.4.13. *Smulian et al. (1995)—Pica in a Rural Obstetric Population*

In 1992, Smulian et al. (1995) conducted a survey response study of pica in a convenience sample of 125 pregnant women in Muscogee County, Georgia, who ranged in age from 12 to 37 years. Of these, 73 were Black, 47 were White, 4 were Hispanic, and 1 was Asian. Interviews were conducted at the time of the first prenatal visit, using non-directive questionnaires to obtain information regarding substances ingested as well as patterns of pica behavior and influences on pica behavior. Only women ingesting non-food items were considered to have pica. Ingestion of ice was included as a pica behavior only if the ice was reported to be ingested multiple times per day, if the ice was purchased solely for ingestion, or if the ice was obtained from an unusual source such as freezer frost.

The overall prevalence of pica behavior in this study was 14.4% (18 of 125 women), and was highest among Black women (17.8%). There was no significant difference between groups with respect to age, race, weight, or gestational age at the time of enrollment in the study. The most common form of pica was ice eating (pagophagia), reported by 44.4% of the patients. Nine of the women reported information on the frequency and amount of the substances they were ingesting. Of these women, 66.7% reported daily consumption and 33.3% reported pica behavior three times per week. Soap, paint chips, or burnt matches were reportedly ingested 3 days per week. One patient ate ice

60 times per week. Women who ate dirt or clay reported ingesting 0.5−1 pound per week. The largest amount of ice consumed was five pounds per day.

5.3.4.14. *Grigsby et al. (1999)—Chalk Eating in Middle Georgia: A Culture-Bound Syndrome of Pica?*

Grigsby et al. (1999) investigated the ingestion of kaolin, also known as white dirt, chalk, or white clay, in the central Georgia Piedmont area as a culture-bound syndrome. A total of 21 individuals who consumed kaolin at the time or had a history of consuming kaolin were interviewed, using a seven-item, one-page interview protocol. All of those interviewed were Black, ranging in age from 28 to 88 years (mean age of 46.5 years), and all were female except for one.

Reasons for eating kaolin included liking the taste, being pregnant, craving it, and to gain weight. Eight respondents indicated that they obtained the kaolin from others, five reported getting it directly from the earth, four purchased it from a store, and two obtained it from a kaolin pit mine. The majority of the respondents reported that they liked the taste and feel of the kaolin as they ate it. Only three individuals reported knowing either males or White persons who consumed kaolin. Most individuals were not forthcoming in discussing their ingestion of kaolin and recognized that their behavior was unusual.

The study suggests that kaolin-eating is primarily practiced by Black women who were introduced to the behavior by family members or friends, during childhood or pregnancy. The authors concluded that kaolin ingestion is a culturally-transmitted form of pica, not associated with any other psychopathology. Although information on kaolin eating habits and attitudes were provided by this study, no quantitative information on consumption was included, and the sample population was small and non-random.

5.3.4.15. *Ward and Kutner (1999)—Reported Pica Behavior in a Sample of Incident Dialysis Patients*

Structured interviews were conducted with a sample of 226 dialysis patients in the metropolitan Atlanta, Georgia area from September 1996 to September 1997. Interviewers were trained in nutrition data collection methods, and patients also received a 3-day diet diary that they were asked to complete and return by mail. If a subject reported a strong past or current food or non-food craving, a separate form was used to collect information to determine if this was a pica behavior.

Pica behavior was reported by 37 of the dialysis patients studied (16%), and most of these patients (31 of 37) reported that they were currently practicing some form of pica behavior. The patients' race and sex were significantly associated with pica behavior, with Black patients and women making up 86% and 84% of those reporting pica, respectively. Those reporting pica behavior were also younger than the remainder of the sample, and approximately 2 described a persistent craving for ice. Other pica items reportedly consumed included starch, dirt, flour, or aspirin.

5.3.4.16. *Simpson et al. (2000)—Pica During Pregnancy in Low-Income Women Born in Mexico*

Simpson et al. (2000) interviewed 225 Mexican-born women, aged 18−42 years (mean age of 25 years), using a questionnaire administered in Spanish. Subjects were recruited by approaching women in medical facilities that served low-income populations in the cities of Ensenada, Mexico ($N = 75$), and Santa Ana, Bakersfield, and East Los Angeles, California ($N = 150$). Criteria for participation were that the women had to be Mexican-born, speak Spanish as their primary language, and be pregnant or have been pregnant within the past year. Only data for U.S. women are included in this handbook.

Pica behavior was reported in 31% of the women interviewed in the United States. Table 5-18 shows the items ingested and the number of women reporting the pica behavior. Of the items ingested, only ice was said to be routinely eaten outside of pregnancy, and was only reported by U.S. women, probably because none of the low-income women interviewed in Mexico owned a refrigerator. Removing the 12 women who reported eating only ice from the survey lowers the percentage of U.S. women who reported pica behavior to 23%. Women said they engaged in pica behavior because of the taste, smell, or texture of the items, for medicinal purposes, or because of advice from someone, and one woman reported eating clay for religious reasons. Magnesium carbonate, a pica item not found to be previously reported in the literature, was reportedly consumed by 17% of women. The amount of magnesium carbonate ingested ranged from a quarter of a block to five blocks per day; the blocks were approximately the size of a 35-mm film box. No specific quantity information on the amounts of pica substances ingested was provided in the study.

5.3.4.17. *Obialo et al. (2001)—Clay Pica Has No Hematologic or Metabolic Correlate to Chronic Hemodialysis Patients*

A total of 138 dialysis patients at the Morehouse School of Medicine, Atlanta, Georgia, were interviewed about their unusual cravings or food habits. The patients were Black and ranged in age from 37 to 78 years.

Thirty of the patients (22%) reported some form of pica behavior, while 13 patients (9.4%) reported clay pica. The patients with clay pica reported daily consumption of 225−450 grams of clay.

5.3.4.18. *Klitzman et al. (2002)—Lead Poisoning Among Pregnant Women in New York City: Risk Factors and Screening Practices*

Klitzman et al. (2002) interviewed 33 pregnant women whose blood lead levels were >20 µg/dL as reported to the New York City Department of Health between 1996 and 1999. The median age of the women was 24 years (range of 15 to 43 years), and the majority were foreign born. The women were interviewed regarding their work, reproductive and lead exposure history. A home visit was also conducted and included a visual inspection and a colorimetric swab test; consumable items suspected to contain lead were sent to a laboratory for analysis.

There were 13 women (39%) who reported pica behavior during their current pregnancies. Of these, 10 reported eating soil, dirt or clay, 2 reported pulverizing and eating pottery, and 1 reported eating soap. One of the women reported eating approximately one quart of dirt daily from her backyard for the past three months. No other quantity data were reported.

5.3.5. Relevant Studies of Secondary Analysis

The secondary analysis literature on soil and dust ingestion rates gives important insights into methodological strengths and limitations. The tracer element studies described in this section are grouped to some extent according to methodological issues associated with the tracer element methodology. These methodological issues include attempting to determine the origins of apparent positive and negative bias in the methodologies, including: food input/fecal output misalignment; missed fecal samples; assumptions about children's fecal weights; particle sizes of, and relative contributions of soils and dusts to total soil and dust ingestion; and attempts to identify a "best" tracer element or combination of tracer elements. Potential error from using short-term studies' estimates for long term soil and dust ingestion behavior estimates is also discussed.

5.3.5.1. *Stanek and Calabrese (1995b)—Daily Estimates of Soil Ingestion in Children*

Stanek and Calabrese (1995b) presented a methodology that links the physical passage of food and fecal samples to construct daily soil ingestion estimates from daily food and fecal trace-element concentrations. Soil ingestion data for children obtained from the Amherst study (Calabrese et al., 1989) were reanalyzed by Stanek and Calabrese (1995b). A lag period of 28 hours between food intake and fecal output was assumed for all respondents. Day 1 for the food sample corresponded to the 24-hour period from midnight on Sunday to midnight on Monday of a study week; day 1 of the fecal sample corresponded to the 24-hour period from noon on Monday to noon on Tuesday. Based on these definitions, the food soil equivalent was subtracted from the fecal soil equivalent to obtain an estimate of soil ingestion for a trace element. A daily overall ingestion estimate was constructed for each child as the median of trace element values remaining after tracers falling outside of a defined range around the overall median were excluded.

Table 5-19 presents adjusted estimates, modified according to the input/output misalignment correction, of mean daily soil ingestion per child (mg/day) for the 64 study participants. The approach adopted in this paper led to changes in ingestion estimates from those presented in Calabrese et al. (1989).

Estimates of children's soil ingestion projected over a period of 365 days were derived by fitting lognormal distributions to the overall daily soil ingestion estimates using estimates modified according to the input/output misalignment correction (see Table 5-20). The estimated median value of the 64 respondents' daily soil ingestion averaged over a year was 75 mg/day, while the 95th percentile was 1,751 mg/day. In developing the 365-day soil ingestion estimates, data that were obtained over a short period of time (as is the case with all available soil ingestion studies) were extrapolated over a year. The 2-week study period may not reflect variability in tracer element ingestion over a year. While Stanek and Calabrese (1995b) attempted to address this through modeling of the long term ingestion, new uncertainties were introduced through the parametric modeling of the limited subject day data.

5.3.5.2. *Calabrese and Stanek (1992b)—What Proportion of Household Dust is Derived from Outdoor Soil?*

Calabrese and Stanek (1992b) estimated the amount of outdoor soil in indoor dust using statistical modeling. The model used soil and dust data from the 60 households that participated in the Calabrese et al. (1989) study, by preparing scatter plots of each tracer's concentration in soil versus dust. Correlation analysis of the scatter plots was performed. The scatter plots showed little evidence of a consistent relationship between outdoor soil and indoor dust concentrations. The model estimated the proportion of outdoor soil in indoor dust using the simplifying assumption that the following variables were constants in all houses: the amount of dust produced every day from both indoor and outdoor sources; the proportion of indoor dust due to outdoor soil; and the concentration of the tracer element in dust produced from indoor sources. Using these assumptions, the model predicted that 31.3% by weight of indoor dust came from outdoor soil. This model was then used to adjust the soil ingestion estimates from Calabrese et al. (1989).

5.3.5.3. *Calabrese et al. (1996)—Methodology to Estimate the Amount and Particle Size of Soil Ingested by Children: Implications for Exposure Assessment at Waste Sites*

Calabrese et al. (1996) examined the hypothesis that one cause of the variation between tracers seen in soil ingestion studies could be related to differences in soil tracer concentrations by particle size. This study, published prior to the Calabrese et al. (1997a) primary analysis study results, used laboratory analytical results for the Anaconda, Montana soil's tracer concentration after it had been sieved to a particle size of <250 µm in diameter (it was sieved to <2 mm soil particle size in Calabrese et al. [1997a]). The smaller particle size was examined based on the assumption that children principally ingest soil of small particle size adhering to fingertips and under fingernails. For five of the tracers used in the original study (aluminum, silicon, titanium, yttrium, and zirconium), soil concentration was not changed by particle size. However, the soil concentrations of three tracers (lanthanum, cerium, and neodymium) were increased 2- to 4-fold at the smaller soil particle size. Soil ingestion estimates for these three tracers were decreased by approximately 60% at the 95th percentile compared to the Calabrese et al. (1997a) results.

5.3.5.4. *Stanek et al. (1999)—Soil Ingestion Estimates for Children in Anaconda Using Trace Element Concentrations in Different Particle Size Fractions*

Stanek et al. (1999) extended the findings from Calabrese et al. (1996) by quantifying trace element concentrations in soil based on sieving to particle sizes of 100−250 µm and to particle sizes of 53 to <100 µm. The earlier study (Calabrese et al., 1996) used particle sizes of 0−2 µm and 1−250 µm. This study used the data from soil concentrations from the Anaconda, Montana site reported by Calabrese et al. (1997a). Results of the study indicated that soil concentrations of aluminum, silicon, and titanium did not increase at the two finer particle size ranges measured. However, soil concentrations of cerium, lanthanum, and neodymium increased by a factor of 2.5 to 4.0 in the 100−250 µm particle size range when compared with the 0−2 µm particle size range. There was not a significant increase in concentration in the 53−100 µm particle size range.

5.3.5.5. *Stanek and Calabrese (2000)—Daily Soil Ingestion Estimates for Children at a Superfund Site*

Stanek and Calabrese (2000) reanalyzed the soil ingestion data from the Anaconda study. The authors assumed a lognormal distribution for the soil ingestion estimates in the Anaconda study to predict average soil ingestion for children over a longer time period. Using "best linear unbiased predictors," the authors predicted 95th percentile soil ingestion values over time periods of 7 days, 30 days, 90 days, and 365 days. The 95th percentile soil ingestion values were predicted to be 133 mg/day over 7 days, 112 mg/day over 30 days, 108 mg/day over 90 days, and 106 mg/day over 365 days. Based on this analysis, estimates of the distribution of longer term average soil ingestion are expected to be narrower, with the 95th percentile estimates being as much as 25% lower (Stanek and Calabrese, 2000).

5.3.5.6. *Stanek et al. (2001a)—Biasing Factors for Simple Soil Ingestion Estimates in Mass Balance Studies of Soil Ingestion*

In order to identify and evaluate biasing factors for soil ingestion estimates, the authors developed a simulation model based on data from previous soil ingestion studies. The soil ingestion data used in this model were taken from Calabrese et al. (1989) (the Amherst study); Davis et al. (1990) (southeastern Washington State); Calabrese et al. (1997a) (the Anaconda study); and Calabrese et al. (1997b) (soil-pica in Massachusetts), and relied only on the aluminum and silicon trace element estimates provided in these studies.

Of the biasing factors explored, the impact of study duration was the most striking, with a positive bias of more than 100% for 95th percentile estimates in a 4-day tracer element study. A smaller bias was observed for the impact of absorption of trace elements from food. Although the trace elements selected for use in these studies are believed to have low absorption, whatever amount is not accounted for will result in an underestimation of the soil ingestion distribution. In these simulations, the absorption of trace elements from food of up to 30% was shown to negatively bias the estimated soil ingestion distribution by less than 20 mg/day. No biasing effect was found for misidentifying play areas for soil sampling (i.e., ingested soil from a yard other than the subject's yard).

5.3.5.7. *Stanek et al. (2001b)—Soil Ingestion Distributions for Monte Carlo Risk Assessment in Children*

Stanek et al. (2001b) developed "best linear unbiased predictors" to reduce the biasing effect of short-term soil ingestion estimates. This study estimated the long-term average soil ingestion distribution using daily soil ingestion estimates from children who participated in the Anaconda, Montana study. In this long-term (annual) distribution, the soil ingestion estimates were: mean 31, median 24, 75th percentile 42, 90th percentile 75, and 95th percentile 91 mg/day.

5.3.5.8. *Von Lindern et al. (2003)—Assessing Remedial Effectiveness Through the Blood Lead: Soil/Dust Lead Relationship at the Bunker Hill Superfund Site in the Silver Valley of Idaho*

Similar to Hogan et al. (1998), Von Lindern et al. (2003) used the IEUBK model to predict blood lead levels in a non-random sample of several hundred children ages 0−9 years in an area of northern Idaho from 1989−1998 during community-wide soil remediation. Von Lindern et al. (2003) used the IEUBK default soil and dust ingestion rates together with observed house dust/soil lead levels (and imputed values based on community soil and dust lead levels, when observations were missing). The authors compared the predicted blood lead levels with observed blood lead levels and found that the default IEUBK soil and dust ingestion rates and lead bioavailability value over-predicted blood lead levels, with the over-prediction decreasing as the community soil remediation progressed. The authors stated that the over-prediction may have been caused either by a default soil and dust ingestion that was too high, a default bioavailability value for lead that was too high, or some combination of the two. They also noted under-predictions for some children, for whom follow up interviews revealed exposures to lead sources not accounted for by the model, and noted that the study sample included many children with a short residence time within the community.

Von Lindern et al. (2003) developed a statistical model that apportioned the contributions of community soils, yard soils of the residence, and house dust to lead intake; the models' results suggested that community soils contributed more (50%) than neighborhood soils (28%) or yard soils (22%) to soil found in house dust of the studied children.

5.3.5.9. *Gavrelis et al. (2011)—An Analysis of the Proportion of the U.S. Population that Ingests Soil or Other Non-Food Substances.*

Gavrelis et al. (2011) evaluated the prevalence of the U.S. population that ingests non-food substances such as soil, clay, starch, paint, or plaster. Data were compiled from the National Health and Nutrition Examination Survey (NHANES) collected from 1971−1975 (NHANES I) and 1976−1980 (NHANES II), which represent a complex, stratified, multistage, probability-cluster design and include nationwide probability samples of approximately 21,000 and 25,000 study participants, respectively. NHANES I surveyed people aged 1 to 74 years and NHANES II surveyed those 6 months to 74 years. The study population included women of childbearing age, people with low income status, the elderly, and preschool children, who represented an oversampling of specific groups in the population that were believed to have high risks for malnutrition. The survey questions were demographic, socioeconomic, dietary, and health-related queries, and included specific questions regarding soil and non-food substance ingestion. Survey questions for children under 12 years asked whether they consumed non-food substances including dirt or clay, starch, paint or plaster, and other materials (NHANES I) or about consumption of clay, starch, paint or plaster, dirt, and other materials (NHANES II). For participants over 12 years of age, the survey questions asked only about consumption of dirt or clay, starch, and other materials (NHANES I) or about non-food substances including clay, starch, and other materials (NHANES II). Age groupings used in this analysis vary slightly from the age group categories established by U.S. EPA and described in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Other demographic parameters included sex (including pregnant and non-pregnant females); race (White, Black, and other); geography (urban and rural, with "urban" defined as populations ≥2,500); income level (ranging from $0−$9,999 up to >$20,000, or not stated); and highest grade head of household (population under 18 years) or respondent (population >18 years) attended. For statistical analysis, frequency estimates were generated for the proportion of the total U.S. population that reported consumption of dirt, clay, starch, paint or plaster, or other materials "considered unusual" using the appropriate NCHS sampling weights and responses to the relevant questions in NHANES I and II. NHANES I and II were evaluated separately, because the data sets did not provide components of the weight variable separately (i.e., probability of selection, non-response adjustment weight, and post-stratification weight).

Although the overall prevalence estimates were higher in NHANES I compared with NHANES II, similar patterns were generally observed across substance types and demographic groups studied. For NHANES I, the estimated prevalence of all non-food substance consumption in the United States for all ages combined was 2.5% (95% Confidence Interval [CI]: 2.2−2.9%), whereas for NHANES II, the estimated prevalence of all non-food substance consumption in the United States for all ages combined was 1.1% (95% CI: 1.0−1.2%). Table 5-21 provides the prevalence estimates by type of substance consumed for all ages combined. By type of substance, the estimated prevalence was greatest for dirt and clay consumption and lowest for starch. Figures 5-1, 5-2 and 5-3, respectively, show the prevalence of non-food substance consumption by age, race, and income. The most notable differences were seen across age, race (Black versus White), and income groups. For both NHANES I and II, prevalence for the ingestion of all non-food substances decreased with increasing age, was higher among Blacks (5.7%; 95% CI: 4.4−7.0%) as compared to Whites (2.1%; 95% CI: 1.8−2.5%), and was inversely related to income level, with prevalence of non-food consumption decreasing as household income increased. The estimated prevalence of all non-food substances for the 1 to <3 year age category was at least twice that of the next oldest category (3 to <6 years). Prevalence estimates were 22.7% (95% CI: 20.1–25.3%) for the 1 to <3 year age group based on NHANES I and 12% based on NHANES II. In contrast, prevalence estimates for the >21 year age group was 0.7% (95% CI: 0.5–1.0%) and 0.4% (95% CI: 0.3–0.5%) for NHANES I and NHANES II, respectively. Other differences related to geography (i.e., urban and rural), highest grade level of the household head, and sex were less remarkable. For NHANES I, for example, the estimated prevalence of non-food substance consumption was only slightly higher among females (2.9%; CI: 2.3−3.5%) compared to males (2.1%; CI: 1.8−2.5%) of all ages. For pregnant females, prevalence estimates (2.5%; 95% CI: 0.0−5.6%) for those 12 years and over were more than twice those for non-pregnant females (1.0%; 95% CI: 0.7−1.4%).

5.4. LIMITATIONS OF STUDY METHODOLOGIES

The three types of information needed to provide recommendations to exposure assessors on soil and dust ingestion rates among U.S. children include quantities of soil and dust ingested, frequency of high soil and dust ingestion episodes, and prevalence of high soil and dust ingesters. The methodologies provide different types of information: the tracer element, biokinetic model comparison, and activity pattern methodologies provide information on quantities of soil and dust ingested; the tracer element methodology provides limited evidence of the frequency of high soil ingestion episodes; the survey response methodology can shed light on prevalence of high soil ingesters and frequency of high soil ingestion episodes. The methodologies used to estimate soil and dust ingestion rates and prevalence of soil and dust ingestion behaviors have certain limitations, when used for the purpose of developing recommended soil and dust ingestion rates. These limitations may not have excluded specific studies from use in the development of recommended ingestion rates, but have been noted throughout this handbook. This section describes some of the known limitations, presents an evaluation of the current state of the science for U.S. children's soil and dust ingestion rates, and describes how the limitations affect the confidence ratings given to the recommendations.

5.4.1. Tracer Element Methodology

This section describes some previously identified limitations of the tracer element methodology as it has been implemented by U.S. researchers, as well as additional potential limitations that have not been explored. Some of these same limitations would also apply to the Dutch and Jamaican studies that used a control group of hospitalized children to account for dietary and pharmaceutical tracer intakes.

Binder et al. (1986) described some of the major and obvious limitations of the early U.S. tracer element methodology as follows:

> [T]he algorithm assumes that children ingest predominantly soil from their own yards and that concentrations of elements in composite soil samples from front and back yards are representative of overall concentrations in the yards....children probably eat a combination of soil and dust; the algorithm used does not distinguish between soil and dust ingestion....fecal sample weights...were much lower than expected...the assumption that aluminum, silicon and titanium are not absorbed is not entirely true....dietary intake of aluminum, silicon and titanium is not negligible when compared with the potential intake of these elements from soil....Before accepting these estimates as true values of soil ingestion in toddlers, we need a better understanding of the metabolisms of aluminum, silicon and titanium in children, and the validity of the assumptions we made in our calculations should be explored further.

The subsequent U.S. tracer element studies (Calabrese et al., 1997a, 1989; Barnes, 1990; Davis et al., 1990; Davis and Mirick, 2006) made some progress in addressing some of the Binder et al. (1986) study's stated limitations.

Regarding the issue of non-yard (community-wide) soil as a source of ingested soil, one study (Calabrese et al., 1989; Barnes, 1990) addressed this issue to some extent, by including samples of children's daycare center soil in the analysis. Calabrese et al. (1997a) attempted to address the issue by excluding children in daycare from the study sample frame. Homogeneity of community soils' tracer element content would play a role in whether this issue is an important biasing factor for the tracer element studies' estimates. Davis et al. (1990) evaluated community soils' aluminum, silicon, and titanium content and found little variation among 101 yards throughout the three-city area. Stanek et al. (2001a) concluded that there was "minimal impact" on estimates of soil ingestion due to mis-specifying a child's play area.

Regarding the issue of soil and dust both contributing to measured tracer element quantities in excreta samples, the key U.S. tracer element studies all attempted to address the issue by including samples of household dust in the analysis, and in some cases estimates are presented in the published articles that adjust soil ingestion estimates on the basis of the measured tracer elements found in the household dust. The relationship between soil ingestion rates and indoor settled dust ingestion rates has been evaluated in some of the secondary studies (Calabrese and Stanek, 1992b). An issue similar to the community-wide soil exposures in the previous paragraph could also exist with community-wide indoor dust exposures (such as dust found in schools and community buildings occupied by study subjects during or prior to the study period). A portion of the community-wide indoor dust exposures (due to occupying daycare facilities) was addressed in the Calabrese et al. (1989) and Barnes (1990) studies, but not in the other three key tracer element studies. In addition, if the key studies' vacuum cleaner collection method for household and daycare indoor settled dust samples influenced tracer element composition of indoor settled dust samples, the dust sample collection method would be another area of uncertainty with the key studies' indoor dust related estimates. The survey response studies suggest that some young children may prefer ingesting dust to ingesting soil. The existing literature on soil versus dust sources of children's lead exposure may provide useful information that has not yet been compiled for use in soil and dust ingestion recommendations.

Regarding the issue of fecal sample weights and the related issue of missing fecal and urine samples, the key tracer element studies have varying strengths and limitations. The Calabrese et al. (1989) article stated that wipes and toilet paper were not collected by the researchers, and thus underestimates of fecal quantities may have occurred. Calabrese et al. (1989) stated that cotton cloth diapers were supplied for use during the study; commodes apparently were used to collect both feces and urine for those children who were not using diapers. Barnes (1990) described cellulose and polyester disposable diapers with significant variability in silicon and titanium content and suggested that children's urine was not included in the analysis. Thus, it is unclear to what extent complete fecal and urine output was obtained, for each study subject. The Calabrese et al. (1997a) study did not describe missing fecal samples and did not state whether urinary tracer element quantities were used in the soil and dust ingestion estimates, but stated that wipes and toilet paper were not collected. Missing fecal samples may have resulted in negative bias in the estimates from both of these studies. Davis et al. (1990) and Davis and Mirick (2006) were limited to children who no longer wore diapers.

Missed fecal sample adjustments might affect those studies' estimates in either a positive or negative direction, due to the assumptions the authors made regarding the quantities of feces and urine in missed samples. Adjustments for missing fecal and urine samples could introduce errors sufficient to cause negative estimates if missed samples were heavier than the collected samples used in the soil and dust ingestion estimate calculations.

Regarding the issue of dietary intake, the key U.S. tracer element studies have all addressed dietary (and non-dietary, non-soil) intake by subtracting calculated estimates of these sources of tracer elements from excreta tracer element quantities, or by providing study subjects with personal hygiene products that were low in tracer element content. Applying the food and non-dietary, non-soil corrections required subtracting the tracer element contributions from these non-soil sources from the measured fecal/urine tracer element quantities. To perform this correction required assumptions to be made regarding the gastrointestinal transit time, or the time lag between inputs (food, non-dietary non-soil, and soil) and outputs (fecal and urine). The gastrointestinal transit time assumption introduced a new potential source of bias that some authors (Stanek and Calabrese, 1995b) called input/output misalignment or transit time error. Stanek and Calabrese (1995a) attempted to correct for this transit time error by using the BTM and focusing estimates on those tracers that had a low food/soil tracer concentration ratios. The lag time may also be a function of age. Davis et al. (1990) and Davis and Mirick (2006) assumed a 24-hour lag time in contrast to the 28-hour lag times used in Calabrese et al. (1989); Barnes (1990); and Calabrese et al. (1997a). ICRP (2002) suggested a lag time of 37 hours for one year old children and 5 to 15 year old children. Stanek and Calabrese (1995b) describe a method designed to reduce bias from this error source.

Regarding gastrointestinal absorption, the authors of three of the studies appeared to agree that the presence of silicon in urine represented evidence that silicon was being absorbed from the gastrointestinal tract (Davis et al., 1990; Calabrese et al., 1989; Barnes, 1990; Davis and Mirick, 2006). There was some evidence of aluminum absorption in Calabrese et al. (1989); Barnes (1990); Davis and Mirick (2006) stated that aluminum and titanium did not appear to have been absorbed, based on low urinary levels. Davis et al. (1990) stated that silicon appears to have been absorbed to a greater degree than aluminum and titanium, based on urine concentrations.

Aside from the gastrointestinal absorption, lag time, and missed fecal sample issues, Davis and Mirick (2006) offered another possible explanation for the negative soil and dust ingestion rates estimated for some study participants. Negative values result when the tracer amount in food and medicine is greater than that in urine/fecal matter. Given that some analytical error may occur, any overestimation of tracer amounts in the food samples would be greater than an overestimation in urine/feces, since the food samples were many times heavier than the urine and fecal samples.

Another limitation on accuracy of tracer element-based estimates of soil and dust ingestion relates to inaccuracies inherent in environmental sampling and laboratory analytical techniques. The "percent recovery" of different tracer elements varies (according to validation of the study methodology performed with adults who swallowed gelatin capsules with known quantities of sterilized soil, as part of the Calabrese et al. [1989, 1997a] studies). Estimates based on a particular tracer element with a lower or higher recovery than the expected 100% in any of the study samples would be influenced in either a positive or negative direction, depending on the recoveries in the various samples and their degree of deviation from 100% (Calabrese et al., 1989). Soil/dust size fractions, and digestion/extraction methods of sample analysis may be additional limitations.

Davis et al. (1990) offered an assessment of the impact of swallowed toothpaste on the tracer-based estimates by adjusting estimates for those children whose caregivers reported that they had swallowed toothpaste. Davis et al. (1990) had supplied study children with toothpaste that had been pre-analyzed for its tracer element content, but it is not known to what extent the children actually used the supplied toothpaste. Similarly, Calabrese et al. (1989, 1997a) supplied children in the Amherst, Massachusetts and Anaconda, Montana studies with toothpaste containing low levels of most tracers, but it is unclear to what extent those children used the supplied toothpaste.

Other research suggests additional possible limitations that have not yet been explored. First, lymph tissue structures in the gastrointestinal tract might serve as reservoirs for titanium dioxide food additives and soil particles, which could bias estimates either upward or downward depending on tracers' entrapment within, or release from, these reservoirs during the study period (ICRP, 2002; Shepherd et al., 1987; Powell et al., 1996). Second, gastrointestinal uptake of silicon may have occurred, which could bias those estimates downward. Evidence of silicon's role in bone formation (Carlisle, 1980) supported by newer research on dietary silicon uptake (Jugdaohsingh et al., 2002); Van Dyck et al. (2000) suggests a possible negative bias in the silicon-based soil ingestion estimates, depending on the quantities of silicon absorbed by growing children. Third, regarding the potential for swallowed toothpaste to bias soil ingestion estimates upward, commercially available toothpaste may contain quantities of titanium and perhaps silicon and aluminum in the range that could be expected to affect the soil and dust ingestion estimates. Fourth, for those children who drank bottled or tap water during the study period, and did not include those drinking water samples in their duplicate food samples, slight upward bias may exist in some of the estimates for those children, since drinking water may contain small, but relevant, quantities of silicon and potentially other tracer elements. Fifth, the tracer element studies conducted to date have not explored the impact of soil properties' influence on toxicant uptake or excretion within the gastrointestinal tract. Nutrition researchers investigating influence of clay geophagy behavior on human nutrition have begun using in vitro models of the human digestion (Dominy et al., 2003; Hooda et al., 2004). A recent review (Wilson, 2003) covers a wide range of geophagy research in humans and various hypotheses proposed to explain soil ingestion behaviors, with emphasis on the soil properties of geophagy materials.

5.4.2. Biokinetic Model Comparison Methodology

It is possible that the IEUBK biokinetic model comparison methodology contained sources of both positive and negative bias, like the tracer element studies, and that the net impact of the competing biases was in either the positive or negative direction. U.S. EPA's judgment about the major sources of bias in biokinetic model comparison studies is that there may be several significant sources of bias. The first source of potential bias was the possibility that the biokinetic model failed to account for sources of lead exposure that are important for certain children. For these children, the model might either under-predict, or accurately predict, blood lead levels compared to actual measured lead levels. However, this result may actually mean that the default assumed lead intake rates via either soil and dust ingestion, or another lead source that is accounted for by the model, are too high. A second source of potential bias was use of the biokinetic model for predicting blood lead levels in children who have not spent a significant amount of time in the areas characterized as the main sources of environmental lead exposure. Modeling this population could result in either upward or downward biases in predicted blood lead levels. Comparing upward-biased predictions with actual measured blood lead levels and finding a relatively good match could lead to inferences that the model's default soil and dust ingestion rates are accurate, when in fact the children's soil and dust ingestion rates, or some other lead source, were actually higher than the default assumption. A third source of potential bias was the assumption within the model itself regarding the biokinetics of absorbed lead, which could result in either positively or negatively biased predictions and the same kinds of incorrect inferences as the second source of potential bias.

In addition, there was no extensive sensitivity analysis. The calibration step used to fix model parameters limits the degree that most parameters can reasonably be varied. Second, the IEUBK model was not designed to predict blood lead levels greater than 25−30 μg/dL; there are few data to develop such predictions and less to validate them. If there are site-specific data that indicate soil ingestion rates (or other ingestion/intake rates) are higher than the defaults on average (not for specific children), the site-specific data should be considered. U.S. EPA considers the default IEUBK value of 30% reasonable for most data sets/sites. Bioavailability has been assayed for soils similar to those in the calibration step and the empirical comparison data sets; 30% was used in the calibration step, and is therefore recommended for similar sites. The default provides a reasonable substitute when there are no specific data. Speciation of lead compounds for a particular exposure scenario could support adjusting bioavailability if they are known to differ strongly from 30%. In general, U.S. EPA supports using bioavailability rates determined for the particular soils of interest if available.

5.4.3. Activity Pattern Methodology

The limitations associated with the activity pattern methodology relate to the availability and quality of the underlying data used to model soil ingestion rates. Real-time hand recording, where observations are made by trained professionals (rather than parents), may offer the advantage of consistency in interpreting visible behaviors and may be less subjective than observations made by someone who maintains a care giving relationship to the child. On the other hand, young children's behavior may be influenced by the presence of unfamiliar people (Davis et al., 1995). Groot et al. (1998) indicated that parent observers perceived that deviating from their usual care giving behavior by observing and recording mouthing behavior appeared to have influenced the children's behavior. With video-transcription methodology, an assumption is made that the presence of the videographer or camera does not influence the child's behavior. This assumption may result in minimal biases introduced when filming newborns, or when the camera and videographer are not visible to the child. However, if the children being studied are older than newborns and can see the camera or videographer, biases may be introduced. Ferguson et al. (2006) described apprehension caused by videotaping and described situations where a child's awareness of the videotaping crew caused "play-acting" to occur, or parents indicated that the child was behaving differently during the taping session. Another possible source of measurement error may be introduced when children's movements or positions cause their mouthing not to be captured by the camera. Data transcription errors can bias results in either the negative or positive direction. Finally, measurement error can occur if situations arise in which care givers are absent during videotaping and researchers must stop videotaping and intervene to prevent risky behaviors (Zartarian et al., 1995). Survey response studies rely on responses to questions about a child's mouthing behavior posed to parents or care givers. Measurement errors from these studies could occur for a number of different reasons, including language/dialect differences between interviewers and respondents, question wording problems and lack of definitions for terms used in questions, differences in respondents' interpretation of questions, and recall/memory effects.

Other data collection methodologies (in-person interview, mailed questionnaire, or questions administered in "test" format in a school setting) may have had specific limitations. In-person interviews could result in either positive or negative response bias due to distractions posed by young children, especially when interview respondents simultaneously care for young children and answer questions. Other limitations include positive or negative response bias due to respondents' perceptions of a "correct" answer, question wording difficulties, lack of understanding of definitions of terms used, language and dialect differences between investigators and respondents, respondents' desires to avoid negative emotions associated with giving a particular type of answer, and respondent memory problems ("recall" effects) concerning past events. Mailed questionnaires have many of the same limitations as in-person interviews, but may allow respondents to respond when they are not distracted by childcare duties. An in-school test format is more problematic than either interviews or mailed surveys, because respondent bias related to teacher expectations could influence responses.

One approach to evaluating the degree of bias in survey response studies may be to make use of a surrogate biomarker indicator providing suggestive evidence of ingestion of significant quantities of soil (although quantitative estimates would not be possible). The biomarker technique measures the presence of serum antibodies to *Toxocara* species, a parasitic roundworm from cat and dog feces. Two U.S. studies have found associations between reported soil ingestion and positive serum antibody tests for *Toxocara* infection (Marmor et al., 1987; Glickman et al., 1981); a third (Nelson et al., 1996) has not, but the authors state that reliability of survey responses regarding soil ingestion may have been an issue. Further refinement of survey response methodologies, together with recent NHANES data on U.S. prevalence of positive serum antibody status regarding infection with *Toxocara* species, may be useful.

5.4.4. Key Studies: Representativeness of U.S. Population

The two key studies of Dutch and Jamaican children may represent different conditions and different study populations than those in the United States; thus, it is unclear to what extent those children's soil ingestion behaviors may differ from U.S. children's soil ingestion behaviors. The subjects in the Davis and Mirick (2006) study may not have been representative of the general population since they were selected for their high compliance with the protocol from a previous study.

Limitations regarding the key studies performed in the United States for estimating soil and dust ingestion rates in the entire population of U.S. children ages 0 to <21 years fall into the broad categories of geographic range and demographics (age, sex, race/ethnicity, socioeconomic status).

Regarding geographic range, the two most obvious issues relate to soil types and climate. Soil properties might influence the soil ingestion estimates that are based on excreted tracer elements. The Davis et al. (1990); Calabrese et al. (1989); Barnes (1990); Davis and Mirick (2006); and Calabrese et al. (1997a) tracer element studies were in locations with soils that had sand content ranging from 21−80%, silt content ranging from 16−71%, and clay content ranging from 3−20% by weight, based on data from USDA (2008). The location of children in the Calabrese et al. (1997b) study was not specified, but due to the original survey response study's occurrence in western Massachusetts, the soil types in the vicinity of the Calabrese et al. (1997b) study are likely to be similar to those in the Calabrese et al. (1989) and Barnes (1990) study.

The Hogan et al. (1998) study included locations in the central part of the United States (an area along the Kansas/Missouri border, and an area in western Illinois) and one in the eastern United States (Palmerton, Pennsylvania). The only key study conducted in the southern part of the United States was Vermeer and Frate (1979).

Children might be outside and have access to soil in a very wide range of weather conditions (Wong et al., 2000). In the parts of the United States that experience moderate temperatures year-round, soil ingestion rates may be fairly evenly distributed throughout the year. During conditions of deep snow cover, extreme cold, or extreme heat, children could be expected to have minimal contact with outside soil. All children, regardless of location, could ingest soils located indoors in plant containers, soil derived particulates transported into dwellings as ambient airborne particulates, or outdoor soil tracked inside buildings by human or animal building occupants. Davis et al. (1990) did not find a clear or consistent association between the number of hours spent indoors per day and soil ingestion, but reported a consistent association between spending a greater number of hours outdoors and high (defined as the uppermost tertile) soil ingestion levels across all three tracers used.

The key tracer element studies all took place in northern latitudes. The temperature and precipitation patterns that occurred during these four studies' data collection periods were difficult to discern due to no mention of specific data collection dates in the published articles. The Calabrese et al. (1989) and Barnes (1990) study apparently took place in mid to late September 1987 in and near Amherst, Massachusetts; Calabrese et al. (1997a) apparently took place in late September and early October 1992, in Anaconda, Montana; Davis et al. (1990) took place in July, August, and September 1987, in Richland, Kennewick, and Pasco, Washington; and Davis and Mirick (2006) took place in the same Washington state location in late July, August, and very early September 1988 (raw data). Inferring exact data collection dates, a wide range of temperatures may have occurred during the four studies' data collection periods (daily lows from 22−60°F and 25−48°F, and daily highs from 53−81°F and 55−88°F in Calabrese et al. [1989] and Calabrese et al. [1997a], respectively, and daily lows from 51−72°F and 51−67°F, and daily highs from 69−103°F and 80−102°F in Davis et al. [1990] and Davis and Mirick [2006], respectively) (NCDC, 2008). Significant amounts of precipitation occurred during Calabrese et al. (1989) (more than 0.1 inches per 24-hour period) on several days; somewhat less precipitation was observed during Calabrese et al. (1997a); precipitation in Kennewick and Richland during the data collection periods of Davis et al. (1990) was almost non-existent; there was no recorded precipitation in Kennewick or Richland during the data collection period for Davis and Mirick (2006) (NCDC, 2008).

The key biokinetic model comparison study (Hogan et al., 1998) targeted three locations in more southerly latitudes (Pennsylvania, southern Illinois, and southern Kansas/Missouri) than the tracer element studies. The biokinetic model comparison methodology had an advantage over the tracer element studies in that the study represented long-term environmental exposures over periods up to several years that would include a range of seasons and climate conditions.

A brief review of the representativeness of the key studies' samples with respect to sex and age suggested that males and females were represented roughly equally in those studies for which study subjects' sex was stated. Children up to age 8 years were studied in seven of the nine studies, with an emphasis on younger children. Wong (1988); Calabrese and Stanek. (1993); and Vermeer and Frate (1979) are the only studies with children 8 years or older.

A brief review of the representativeness of the key studies' samples with respect to socioeconomic status and racial/ethnic identity suggested that there were some discrepancies between the study subjects and the current U.S. population of children age 0 to <21 years. The single survey response study (Vermeer and Frate, 1979) was specifically targeted toward a predominantly rural Black population in a particular county in Mississippi. The tracer element studies are of predominantly White populations, apparently with limited representation from other racial and ethnic groups. The Amherst, Massachusetts study (Calabrese et al., 1989; Barnes, 1990) did not publish the study participants' socioeconomic status or racial and ethnic identities. The socioeconomic level of the Davis et al. (1990) studied children was reported to be primarily of middle to high income. Self-reported race and ethnicity of relatives of the children studied (in most cases, they were the parents of the children studied) in Davis et al. (1990) were White (86.5%), Asian (6.7%), Hispanic (4.8%), Native American (1.0%), and Other (1.0%), and the 91 married or living-as-married respondents identified their spouses as White (86.8%), Hispanic

(7.7%), Asian (4.4%), and Other (1.1%). Davis and Mirick (2006) did not state the race and ethnicity of the follow-up study participants, who were a subset of the original study participants from Davis et al. (1990). For the Calabrese et al. (1997a) study in Anaconda, Montana, population demographics were not presented in the published article. The study sample appeared to have been drawn from a door-to-door census of Anaconda residents that identified 642 toilet trained children who were less than 72 months of age. Of the 414 children participating in a companion study (out of the 642 eligible children identified), 271 had complete study data for that companion study, and of these 271, 97.4% were identified as White and the remaining 2.6% were identified as Native American, Black, Asian, and Hispanic (Hwang et al., 1997). The 64 children in the Calabrese et al. (1997a) study apparently were a stratified random sample (based on such factors as behavior during a previous study, the existence of a disability, or attendance in daycare) drawn from the 642 children identified in the door-to-door census. Presumably these children identified as similar races and ethnicities to the Hwang et al. (1997) study children. The Calabrese et al. (1997b) study indicated that 11 of the 12 children studied were White.

In summary, the geographic range of the key study populations was somewhat limited. Of those performed in the United States, locations included Massachusetts, Kansas, Montana, Missouri, Illinois, Washington, and Pennsylvania. The two most obvious issues regarding geographic range relate to soil types and climate. Soil types were not always described, so the representativeness of the key studies related to soil types and properties is unclear. The key tracer element studies all took place in northern latitudes. The only key study conducted in the southern part of the United States was Vermeer and Frate (1979).

In terms of sex and age, males and females were represented roughly equally in those studies for which study subjects' sex was stated, while the majority of children studied were under the age of eight. The tracer element studies are of predominantly White populations, with a single survey response study (Vermeer and Frate, 1979) targeted toward a rural Black population. Other racial and ethnic identities were not well reported among the key studies, nor was socioeconomic status. The socioeconomic level of the Davis et al. (1990) studied children was reported to be primarily of middle to high income.

5.5. SUMMARY OF SOIL AND DUST INGESTION ESTIMATES FROM KEY STUDIES

Table 5-22 summarizes the soil and dust ingestion estimates from the 12 key studies in chronological order. For the U.S. tracer element studies, in order to compare estimates that were calculated in a similar manner, the summary is limited to estimates that use the same basic algorithm of ([fecal and urine tracer content] - [food and medication tracer content])/[soil or dust tracer concentration]. Note that several of the published reanalyses suggest different variations on these algorithms, or suggest adjustments that should be made for various reasons (Calabrese and Stanek, 1995; Stanek and Calabrese, 1995a). Other reanalyses suggest that omitting some of the data according to statistical criteria would be a worthwhile exercise. Due to the current state of the science regarding soil and dust ingestion estimates, U.S. EPA does not advise omitting an individual's soil or dust ingestion estimate, based on statistical criteria, at this point in time.

There is a wide range of estimated soil and dust ingestion across key studies. Note that some of the soil-pica ingestion estimates from the tracer element studies were consistent with the estimated mean soil ingestion from the survey response study of geophagy behavior. The biokinetic model comparison methodology's confirmation of central tendency soil and dust ingestion default assumptions corresponded roughly with some of the central tendency tracer element study estimates. Also note that estimates based on the activity pattern methodology are comparable with estimates derived from the tracer element methodology.

5.6. DERIVATION OF RECOMMENDED SOIL AND DUST INGESTION VALUES

As stated earlier in this chapter, the key studies were used as the basis for developing the soil and dust ingestion recommendations shown in Table 5-1. The following sections describe in more detail how the recommended soil and dust ingestion values were derived.

5.6.1. Central Tendency Soil and Dust Ingestion Recommendations

For the central tendency recommendations shown in Table 5-1, Van Wïjnen et al. (1990) published soil ingestion "LTM" estimates based on infants older than 6 weeks but less than 1 year old (exact ages unspecified). During "bad" weather (>4 days per week of precipitation), the geometric mean estimated LTM values were 67 and 94 milligrams soil (dry weight)/day; during "good" weather (<2 days/week of precipitation) the geometric mean estimated LTM values were 102 milligrams soil (dry weight)/day (Van Wïjnen et al., 1990). These values were not corrected to exclude dietary intake of the tracers on which they were based. The developers of the IEUBK model used these data as the basis for the default soil and dust intakes for the 6 to <12 month old infants in the IEUBK model (U.S. EPA, 1994b) of 38.25 milligrams soil/day and 46.75 mg house dust/day, for a total soil + dust intake default assumption of 85 mg/day for this age group (U.S. EPA, 1994a).

Further evidence of dust intake by infants has been conducted in the context of evaluating blood lead levels and the potential contributions of lead from three sources: bone turnover, food sources, and environmental exposures such as house dust. Manton et al. (2000) conducted a study with older infants and young children, and concluded that appreciable quantities of dust were ingested by infants. Gulson et al. (2001) studied younger infants than Manton et al. (2000) and did not explicitly include dust sources, but the authors acknowledged that, based on ratios of different isotopes of lead found in infants' blood and urine, there appeared to be a non-food, non-bone source of lead of environmental origin that contributed "minimally," relative to food intakes and bone turnover in 0- to 6-month-old infants.

The Hogan et al. (1998) data for 38 infants (one group $N = 7$ and one group $N = 31$) indicated that the IEUBK default soil and dust estimate for 6 to <12 month olds (85 mg/day) over-predicted blood lead levels in this group, suggesting that applying an 85 mg soil + dust (38 mg soil + 47 mg house dust) per day estimate for 6 months' exposure may be too high for this life stage.

For the larger of two groups of infants aged 6 to <12 months in the Hogan et al. (1998) study ($N = 31$), the default IEUBK value of 85 mg/day predicted geometric mean blood lead levels of 5.2 µg/dL versus 3.8 µg/dL actual measured blood lead level (a ratio of 1.37). It is possible that the other major sources of lead accounted for in the IEUBK model (dietary and drinking water lead) are responsible for part of the over-prediction seen with the Hogan et al. (1998) study. Rounded to the ones place, the default assumed daily lead intakes were (dietary) 6 µg/day and (drinking water) 1 µg/day, compared to the soil lead intake of 8 µg/day and house dust lead intake of 9 µg/day (U.S. EPA, 1994b). The dietary lead intake default assumption thus might be expected to be responsible for the over-predictions as well as the soil and dust intake, since these three sources (diet, soil, and dust) comprise the majority of the total lead intake in the model. Data from Manton et al. (2000) suggest that the default assumption for dietary lead intake might be somewhat high (reported geometric mean daily lead intake from food in Manton et al., 2000 was 3.2 µg/day, arithmetic mean 3.3 µg/day).

Making use of the epidemiologic data from the larger group of 31 infants in the Hogan et al. (1998) study, it is possible to develop an extremely rough estimate of soil + dust intake by infants 6 weeks to <12 months of age. The ratio of the geometric mean IEUBK-predicted to actual measured blood lead levels in 31 infants was 1.37. This value may be used to adjust the soil and dust intake rate for the 6 to <12 month age range. Using the inverse of 1.37 (0.73) and multiplying the 85 mg/day soil + house dust intake rate by this value, gives an adjusted value of 62 mg/day soil + dust, rounded to one significant figure at 60 mg/day. The 38 mg soil/day intake rate, multiplied by the 0.73 adjustment factor, yields 28 mg soil per day (rounding to 30 mg soil per day); the 47 mg house dust/day intake rate multiplied by 0.73 yields 34 mg house dust per day (rounding to 30 mg house dust per day). These values, adjusted from the IEUBK default values, are the basis for the soil (30 mg/day) and dust (30 mg/day) recommendations for children aged 6 weeks to 12 months.

For children age 1 to <6 years, the IEUBK default values used in the Hogan et al. (1998) study were: 135 mg/day for 1, 2, and 3 year olds; 100 mg/day for 4 year olds; 90 mg/day for 5 year olds; and 85 mg/day for 6 year olds. These values were based on an assumption of 45% soil, 55% dust (U.S. EPA, 1994a). The time-averaged daily soil + dust ingestion rate for these 6 years of life is 113 mg/day, dry-weight basis. The Hogan et al. (1998) study found the following over- and under-predictions of blood lead levels, compared to actual measured blood lead levels, using the default values shown in Table 5-23. Apportioning the 113 mg/day, on average, into 45% soil and 55% dust (U.S. EPA, 1994a), yields an average for this age group of 51 mg/day soil, 62 mg/day dust. Rounded to one significant figure, these values are 50 and 60 mg/day, respectively. The 60 mg/day dust would be comprised of a combination of outdoor soil tracked indoors onto floors, indoor dust on floors, indoor settled dust on non-floor surfaces, and probably a certain amount of inhaled suspended dust that is swallowed and enters the gastrointestinal tract. Soil ingestion rates were assumed to be comparable for children age 1 to <6 years and 6 to <21 years, and therefore the same recommended values were used for both age groups. Estimates derived by Özkaynak et al. (2010) suggest soil and dust ingestion rates comparable to other estimates in the literature based on tracer element methodology (i.e., a mean value of 68 mg/day).

The recommended soil and dust ingestion rate of 50 mg/day for adults was taken from the overall mean value of 52 mg/day for the adults in the Davis and Mirick (2006) study. Based on this value, the recommended adult soil and dust ingestion value is estimated to be 50 mg/day. There are no available studies estimating the ingestion of dust by adults, therefore, the recommended values for soil and dust were derived from the soil + dust ingestion, assuming 45% soil and 55% dust contribution.

5.6.2. Upper Percentile, Soil Pica, and Geophagy Recommendations

Upper percentile estimates for children 3 to <6 years old were derived from Özkaynak et al. (2010) and Stanek and Calabrese (1995a). These two studies had similar estimates of 95th percentile value (i.e., 224 mg/day and 207 mg/day, respectively). Rounding to one significant figure, the recommended upper percentile estimate of soil and dust ingestion is 200 mg/day. Soil and dust ingestion recommendations were obtained from Özkaynak et al. (2010). For the upper percentile soil pica and geophagy recommendations shown in Table 5-1, two primary lines of evidence suggest that at least some U.S. children exhibit soil-pica behavior at least once during childhood. First, the survey response studies of reported soil ingestion behavior that were conducted in numerous U.S. locations and of different populations consistently yield a certain proportion of respondents who acknowledge soil ingestion by children. The surveys typically did not ask explicit and detailed questions about the soil ingestion incidents reported by the care givers who acknowledged soil ingestion in children. Responses conceivably could fall into three categories: (1) responses in which care givers interpret visible dirt on children's hands, and subsequent hand-to-mouth behavior, as soil ingestion; (2) responses in which care givers interpret intentional ingestion of clay, "dirt" or soil as soil ingestion; and (3) responses in which care givers regard observations of hand-to-mouth behavior of visible quantities of soil as soil ingestion. Knowledge of soils' bulk density allows inferences to be made that these latter observed hand-to-mouth soil ingestion incidents are likely to represent a quantity of soil that meets the quantity part of the definition of soil-pica used in this chapter, or 1,000 mg. Occasionally, what is not known from survey response studies is whether the latter type of survey responses include responses regarding repeated soil ingestion that meets the definition of soil-pica used in this chapter. The second category probably does represent ingestion that would satisfy the definition of soil-pica as well as geophagy. The first category may represent relatively small amounts that appear to be ingested by many children based on the Hogan et al. (1998) study and the tracer element studies. Second, the U.S. tracer studies report a wide range of soil ingestion values. Due to averaging procedures used, for 4, 7, or 8 day periods, the rounded range of these estimates of soil ingestion behavior that apparently met the definition of soil-pica used in this chapter is from 400 to 41,000 mg/day. The recommendation of 1,000 mg/day for soil-pica is based on this range.

Although there were no tracer element studies or biokinetic model comparison studies performed for children 15 to <21 years, in which soil-pica behavior of children in this age range has been investigated, U.S. EPA is aware of one study documenting pica behavior in a group that includes children in this age range (Hyman et al., 1990). The study was not specific regarding whether soil-pica (versus other pica substances) was observed, nor did it identify the specific ages of the children observed to practice pica. In the absence of data that can be used to develop specific soil-pica soil ingestion recommendations for children aged 15 years and 16 to <21 years, U.S. EPA recommends that risk assessors who need to assess risks via soil and dust ingestion to children ages 15 to <21 years use the same soil ingestion rate as that recommended for younger children, in the 1 to <6, 6 to <11, and 11 to <16 year old age categories.

Researchers who have studied human geophagy behavior around the world typically have studied populations in specific locations, and often include investigations of soil properties as part of the research (Wilson, 2003; Aufreiter et al., 1997). Most studies of geophagy behavior in the United States were survey response studies of residents in specific locations who acknowledged eating clays. Typically, study subjects were from a relatively small area such as a county, or a group of counties within the same state. Although geophagy behavior may have been studied in only a single county in a given state, documentation of geophagy behavior by some residents in one or more counties of a given state may suggest that the same behavior also occurs elsewhere within that state.

A qualitative description of amounts of soil ingested by geophagy practitioners was provided by Vermeer and Frate (1979) with an estimated mean amount, 50 g/day, that apparently was averaged over 32 adults and 18 children. The 18 children whose caregivers acknowledged geophagy (or more specifically, eating of clay) were ($N = 16$) ages 1 to 4 and ($N = 2$) ages 5 to 12 years. The definition of geophagy used included consumption of clay "on a regular basis over a period of weeks." U.S. EPA is recommending this 50 g/day value for geophagy. This mean quantity is roughly consistent with a median quantity reported by Geissler et al. (1998) in a survey response study of geophagy in primary school children in Nyanza Province, Kenya (28 g/day, range 8 to 108 g/day; interquartile range 13 to 42 g/day).

Recent studies of pica among pregnant women in various U.S. locations (Rainville, 1998; Corbett et al., 2003; Smulian et al., 1995) suggest that clay geophagy among pregnant women may include children less than 21 years old (Smulian et al., 1995; Corbett et al., 2003). Smulian provides a quantitative estimate of clay consumption of approximately 200−500 g/week, for the very small number of geophagy practitioners ($N = 4$) in that study's sample ($N = 125$). If consumed on a daily basis, this quantity (approximately 30 to 70 g/day) is roughly consistent with the Vermeer and Frate (1979) estimated mean of 50 g/day.

Johns and Duquette (1991) describe use of clays in baking bread made from acorn flour, in a ratio of 1 part clay to 10 or 20 parts acorn flour, by volume, in a Native American population in California, and in Sardinia (~12 grams clay suspended in water added to 100 grams acorn). Either preparation method would add several grams of clay to the final prepared food; daily ingestion of the food would amount to several grams of clay ingested daily.

5.7. REFERENCES FOR CHAPTER 5

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Table 5-3. Soil, Dust, and Soil + Dust Ingestion Estimates for Amherst, Massachusetts Study Children

Tracer Element	*N*	Ingestion (mg/day)				
		Mean	Median	SD	95th Percentile	Maximum
Aluminum						
soil	64	153	29	852	223	6,837
dust	64	317	31	1,272	506	8,462
soil/dust combined	64	154	30	629	478	4,929
Barium						
soil	64	32	–37	1,002	283	6,773
dust	64	31	–18	860	337	5,480
soil/dust combined	64	29	–19	868	331	5,626
Manganese						
soil	64	–294	–261	1,266	788	7,281
dust	64	–1,289	–340	9,087	2,916	20,575
soil/dust combined	64	–496	–340	1,974	3,174	4,189
Silicon						
soil	64	154	40	693	276	5,549
dust	64	964	49	6,848	692	54,870
soil/dust combined	64	483	49	3,105	653	24,900
Vanadium						
soil	62	459	96	1,037	1,903	5,676
dust	64	453	127	1,005	1,918	6,782
soil//dust combined	62	456	123	1,013	1,783	6,736
Yttrium						
soil	62	85	9	890	106	6,736
dust	64	62	15	687	169	5,096
soil/dust combined	62	65	11	717	159	5,269
Zirconium						
soil	62	21	16	209	110	1,391
dust	64	27	12	133	160	789
soil/dust combined	62	23	11	138	159	838
Titanium						
soil	64	218	55	1,150	1,432	6,707
dust	64	163	28	659	1,266	3,354
soil/dust combined	64	170	30	691	1,059	3,597

SD = Standard deviation.
N = Number of subjects.

Source: Calabrese et al., 1989.

Table 5-4. Amherst, Massachusetts Soil-Pica Child's Daily Ingestion Estimates by Tracer and by Week (mg/day)

Tracer element	Estimated Soil Ingestion (mg/day)	
	Week 1	Week 2
Al	74	13,600
Ba	458	12,088
Mn	2,221	12,341
Si	142	10,955
Ti	1,543	11,870
V	1,269	10,071
Y	147	13,325
Zr	86	2,695

Source: Calabrese et al., 1991.

Table 5-5. Van Wijnen et al. (1990) Limiting Tracer Method (LTM) Soil Ingestion Estimates for Sample of Dutch Children

Age (years)	Sex	Daycare Center			Campground		
		N	GM LTM (mg/day)	GSD LTM (mg/day)	*N*	GM LTM (mg/day)	GSD LTM (mg/day)
Birth to <1	Girls	3	81	1.09	NA	NA	NA
	Boys	1	75		NA	NA	NA
1 to <2	Girls	20	124	1.87	3	207	1.99
	Boys	17	114	1.47	5	312	2.58
2 to <3	Girls	34	118	1.74	4	367	2.44
	Boys	17	96	1.53	8	232	2.15
3 to <4	Girls	26	111	1.57	6	164	1.27
	Boys	29	110	1.32	8	148	1.42
4 to <5	Girls	1	180		19	164	1.48
	Boys	4	99	1.62	18	136	1.30
All girls		86	117	1.70	36	179	1.67
All boys		72	104	1.46	42	169	1.79
Total		162[a]	111	1.60	78[b]	174	1.73

[a] Age and/or sex not registered for 8 children; one untransformed value = 0.
[b] Age not registered for 7 children; geometric mean LTM value = 140.
N = Number of subjects.
GM = Geometric mean.
LTM = Limiting tracer method.
GSD = Geometric standard deviation.
NA = Not available.

Source: Adapted from Van Wijnen et al., 1990.

Table 5-6. Estimated Geometric Mean Limiting Tracer Method (LTM) Soil Ingestion Values of Children Attending Daycare Centers According to Age, Weather Category, and Sampling Period

Weather Category	Age (years)	First Sampling Period		Second Sampling Period	
		N	Estimated Geometric Mean LTM Value (mg/day)	*N*	Estimated Geometric Mean LTM Value (mg/day)
Bad (>4 days/week precipitation)	<1	3	94	3	67
	1 to <2	18	103	33	80
	2 to <3	33	109	48	91
	4 to <5	5	124	6	109
Reasonable (2−3 days/week precipitation)	<1			1	61
	1 to <2			10	96
	2 to <3			13	99
	3 to <4			19	94
	4 to <5			1	61
Good (<2 days/week precipitation)	<1	4	102		
	1 to <2	42	229		
	2 to <3	65	166		
	3 to <4	67	138		
	4 to <5	10	132		

N = Number of subjects.
LTM = Limiting tracer method.

Source: Van Wïjnen et al., 1990.

Table 5-7. Estimated Soil Ingestion for Sample of Washington State Children[a]

Element	Mean (mg/day)	Median (mg/day)	Standard Error of the Mean (mg/day)	Range (mg/day)[b]
Aluminum	38.9	25.3	14.4	–279.0 to 904.5
Silicon	82.4	59.4	12.2	–404.0 to 534.6
Titanium	245.5	81.3	119.7	–5,820.8 to 6,182.2
Minimum	38.9	25.3	12.2	–5,820.8
Maximum	245.5	81.3	119.7	6,182.2

[a] Excludes three children who did not provide any samples (*N* = 101).
[b] Negative values occurred as a result of correction for non-soil sources of the tracer elements. For aluminum, lower end of range published as 279.0 mg/day in article appears to be a typographical error that omitted the negative sign.

Source: Adapted from Davis et al., 1990.

Table 5-8. Soil Ingestion Estimates for 64 Anaconda Children

Tracer	Estimated Soil Ingestion (mg/day)							
	p1	p50	p75	p90	p95	Max	Mean	SD
Al	–202.8	–3.3	17.7	66.6	94.3	461.1	2.7	95.8
Ce	–219.8	44.9	164.6	424.7	455.8	862.2	116.9	186.1
La	–10,673	84.5	247.9	460.8	639.0	1,089.7	8.6	1,377.2
Nd	–387.2	220.1	410.5	812.6	875.2	993.5	269.6	304.8
Si	–128.8	–18.2	1.4	36.9	68.9	262.3	–16.5	57.3
Ti	–15,736	11.9	398.2	1,237.9	1,377.8	4,066.6	–544.4	2,509.0
Y	–441.3	32.1	85.0	200.6	242.6	299.3	42.3	113.7
Zr	–298.3	–30.8	17.7	94.6	122.8	376.1	–19.6	92.5
BTM soil	NA	20.1	68.9	223.6	282.4	609.9	65.5	120.3
BTM dust	NA	26.8	198.1	558.6	613.6	1,499.4	127.2	299.1

p = Percentile.
SD = Standard deviation.
BTM = Best Tracer Methodology.
NA Not available.
Note: Negative values are a result of limitations in the methodology.

Source: Calabrese et al., 1997a.

Table 5-9. Soil Ingestion Estimates for Massachusetts Children Displaying Soil Pica Behavior (mg/day)

Study day	Al-based estimate	Si-based estimate	Ti-based estimate
1	53	9	153
2	7,253	2,704	5,437
3	2,755	1,841	2,007
4	725	534	801
5	5	–10	21
6	1,452	1,373	794
7	238	76	84

Note: Negative values are a result of limitations in the methodology.

Source: Calabrese et al., 1997b.

Table 5-10. Average Daily Soil and Dust Ingestion Estimate (mg/day)

Type of Estimate	Soil Ingestion			Dust Ingestion		
	Al	Si	Ti	Al	Si	Ti
Mean	168	89	448	260	297	415
Median	7	0	32	13	2	66
SD	510	270	1,056	759	907	1,032
Range	–15 to +1,783	–46 to +931	–47 to +3,581	–39 to +2,652	–351 to +3,145	–98 to +3,632

SD = Standard deviation.
Note: Negative values are a result of limitations in the methodology.

Source: Calabrese et al., 1997b.

Table 5-11. Mean and Median Soil Ingestion (mg/day) by Family Member

Participant	Tracer Element	Estimated Soil Ingestion[a] (mg/day)			Maximum
		Mean	Median	SD	
Child[b]	Aluminum	36.7	33.3	35.4	107.9
	Silicon	38.1	26.4	31.4	95.0
	Titanium	206.9	46.7	277.5	808.3
Mother[c]	Aluminum	92.1	0	218.3	813.6
	Silicon	23.2	5.2	37.0	138.1
	Titanium	359.0	259.5	421.5	1,394.3
Father[d]	Aluminum	68.4	23.2	129.9	537.4
	Silicon	26.1	0.2	49.0	196.8
	Titanium	624.9	198.7	835.0	2,899.1

[a] For some study participants, estimated soil ingestion resulted in a negative value. These estimates have been set to 0 mg/day for tabulation and analysis.
[b] Results based on 12 children with complete food, excreta, and soil data.
[c] Results based on 16 mothers with complete food, excreta, and soil data.
[d] Results based on 17 fathers with complete food, excreta, and soil data.
SD = Standard deviation.

Source: Davis and Mirick, 2006.

Table 5-12. Estimated Soil Ingestion for Six High Soil Ingesting Jamaican Children

Child	Month	Estimated soil ingestion (mg/day)
11	1	55
	2	1,447
	3	22
	4	40
12	1	0
	2	0
	3	7,924
	4	192
14	1	1,016
	2	464
	3	2,690
	4	898
18	1	30
	2	10,343
	3	4,222
	4	1,404
22	1	0
	2	-
	3	5,341
	4	0
27	1	48,314
	2	60,692
	3	51,422
	4	3,782

- = No data.

Source: Calabrese and Stanek, 1993.

Table 5-13. Positive/Negative Error (Bias) in Soil Ingestion Estimates in Calabrese et al. (1989) Study: Effect on Mean Soil Ingestion Estimate (mg/day)[a]

Tracer	Negative Error						
	Lack of Fecal Sample on Final Study Day	Other Cause[b]	Total Negative Error	Total Positive Error	Net Error	Original Mean	Adjusted Mean
Aluminum	14	11	25	43	+18	153	136
Silicon	15	6	21	41	+20	154	133
Titanium	82	187	269	282	+13	218	208
Vanadium	66	55	121	432	+311	459	148
Yttrium	8	26	34	22	–12	85	97
Zirconium	6	91	97	5	–92	21	113

[a] How to read table: for example, aluminum as a soil tracer displayed both negative and positive error. The cumulative total negative error is estimated to bias the mean estimate by 25 mg/day downward. However, aluminum has positive error biasing the original mean upward by 43 mg/day. The net bias in the original mean was 18 mg/day positive bias. Thus, the original 156 mg/day mean for aluminum should be corrected downward to 136 mg/day.

[b] Values indicate impact on mean of 128-subject-weeks in milligrams of soil ingested per day.

Source: Calabrese and Stanek, 1995.

Table 5-14. Predicted Soil and Dust Ingestion Rates for Children Age 3 to <6 Years (mg/day)

		Mean	Percentile					
			5	25	50	75	95	100
Dust ingestion/hand-to-mouth	1,000	19.8	0.6	3.4	8.4	21.3	73.7	649.3
Dust ingestion/ object-to-mouth	1,000	6.9	0.1	0.7	2.4	7.4	27.2	252.7
Total dust ingestion[a]	1,000	27			13		109	360
Soil ingestion/hand-to-mouth	1,000	41.0	0.2	5.3	15.3	44.9	175.6	1,367.4
Total ingestion	1,000	67.6	4.9	16.8	37.8	83.2	224.0	1,369.7

[a] Email from Haluk Özkaynak (NERL, U.S. EPA) to Jacqueline Moya (NCEA, EPA) dated 3/8/11.

Source: Özkaynak et al., 2010.

Table 5-15. Estimated Daily Soil Ingestion for East Helena, Montana Children

Estimation Method	Mean (mg/day)	Median (mg/day)	Standard Deviation (mg/day)	Range (mg/day)	95th Percentile (mg/day)	Geometric Mean (mg/day)
Aluminum	181	121	203	25−1,324	584	128
Silicon	184	136	175	31−799	578	130
Titanium	1,834	618	3,091	4−17,076	9,590	401
Minimum	108	88	121	4−708	386	65

Source: Binder et al., 1986.

Table 5-16. Estimated Soil Ingestion for Sample of Dutch Nursery School Children

Child	Sample Number	Soil Ingestion as Calculated from Ti (mg/day)	Soil Ingestion as Calculated from Al (mg/day)	Soil Ingestion as Calculated from AIR (mg/day)	Limiting Tracer (mg/day)
1	L3	103	300	107	103
	L14	154	211	172	154
	L25	130	23	-	23
2	L5	131	-	71	71
	L13	184	103	82	82
	L27	142	81	84	81
3	L2	124	42	84	42
	L17	670	566	174	174
4	L4	246	62	145	62
	L11	2,990	65	139	65
5	L8	293	-	108	108
	L21	313	-	152	152
6	L12	1,110	693	362	362
	L16	176	-	145	145
7	L18	11,620	-	120	120
	L22	11,320	77	-	77
8	L1	3,060	82	96	82
9	L6	624	979	111	111
10	L7	600	200	124	124
11	L9	133	-	95	95
12	L10	354	195	106	106
13	L15	2,400	-	48	48
14	L19	124	71	93	71
15	L20	269	212	274	212
16	L23	1,130	51	84	51
17	L24	64	566	-	64
18	L26	184	56	-	56
Arithmetic Mean		1,431	232	129	105

- = No data.
AIR = Acid insoluble residue.

Source: Adapted from Clausing et al., 1987.

Table 5-17. Estimated Soil Ingestion for Sample of Dutch Hospitalized, Bedridden Children

Child	Sample	Soil Ingestion as Calculated from Ti (mg/day)	Soil Ingestion as Calculated from Al (mg/day)	Limiting Tracer (mg/day)
1	G5	3,290	57	57
	G6	4,790	71	71
2	G1	28	26	26
3	G2	6,570	94	84
	G8	2,480	57	57
4	G3	28	77	28
5	G4	1,100	30	30
6	G7	58	38	38
Arithmetic Mean		2,293	56	49

Source: Adapted from Clausing et al., 1987.

Table 5-18. Items Ingested by Low-Income Mexican-Born Women Who Practiced Pica During Pregnancy in the United States (*N* = 46)

Item Ingested	Number (%) Ingesting Items
Dirt	11 (24)
Bean stones[a]	17 (37)
Magnesium carbonate	8 (17)
Ashes	5 (11)
Clay	4 (9)
Ice	18 (39)
Other[b]	17 (37)

[a] Little clods of dirt found among unwashed beans.
[b] Including eggshells, starch, paper, lipstick, pieces of clay pot, and adobe.
N = Number of individuals reporting pica behavior.

Source: Simpson et al., 2000.

Table 5-19. Distribution of Average (Mean) Daily Soil Ingestion Estimates per Child for 64 Children[a] (mg/day)

Type of Estimate	Overall	Al	Ba	Mn	Si	Ti	V	Y	Zr
Number of Samples	64	64	33	19	63	56	52	61	62
Mean	179	122	655	1,053	139	271	112	165	23
25th Percentile	10	10	28	35	5	8	8	0	0
50th Percentile	45	19	65	121	32	31	47	15	15
75th Percentile	88	73	260	319	94	93	177	47	41
90th Percentile	186	131	470	478	206	154	340	105	87
95th Percentile	208	254	518	17,374	224	279	398	144	117
Maximum	7,703	4,692	17,991	17,374	4,975	12,055	845	8,976	208

[a] For each child, estimates of soil ingestion were formed on days 4–8 and the mean of these estimates was then evaluated for each child. The values in the column “overall” correspond to percentiles of the distribution of these means over the 64 children. When specific trace elements were not excluded via the relative standard deviation criteria, estimates of soil ingestion based on the specific trace element were formed for 108 days for each subject. The mean soil ingestion estimate was again evaluated. The distribution of these means for specific trace elements is shown.

Source: Stanek and Calabrese, 1995b.

Table 5-20. Estimated Distribution of Individual Mean Daily Soil Ingestion Based on Data for 64 Subjects Projected over 365 Days[a]

Range	1−2,268 mg/day[b]
50th Percentile (median)	75 mg/day
90th Percentile	1,190 mg/day
95th Percentile	1,751 mg/day

[a] Based on fitting a lognormal distribution to model daily soil ingestion values.
[b] Subject with pica excluded.

Source: Stanek and Calabrese, 1995b.

Table 5-21. Prevalence of Non-Food Consumption by Substance for NHANES I and NHANES II

	NHANES I (age 1−74 years) N (sample size) = 20,724 (unweighted); 193,716,939 (weighted)			NHANES II (age 6 months−74 years) N (sample size) = 25,271 (unweighted); 203,432,944 (weighted)		
Substance	N Unweighted (Weighted)	Prevalence[a]	95% Confidence Interval	N Unweighted (Weighted)	Prevalence[a]	95% Confidence Interval
Any Non-Food Substance	732 (4,900,370)	2.5%	2.2−2.9%	480 (2,237,993)	1.1%	1.0−1.2%
Clay				46 (223,361)	0.1%	0.1−0.2%
Starch	131 (582,101)	0.3%	0.2−0.4%	61 (450,915)	0.2%	0.1−0.3%
Paint and Plaster	39 (195,764)	0.5%[b]	0.3−0.7%	55 (213,588)	0.6%[c]	0.4−0.8%
Dirt				216 (772,714)	2.1%[d]	1.7−2.5%
Dirt and Clay	385 (2,466,210)	1.3%	1.1−1.5%			
Other	190 (1,488,327)	0.8%	0.6−0.9%	218 (1,008,476)	0.5%	0.4−0.6%

Unweighted = Raw counts.
Weighted = Adjusted to account for the unequal selection probabilities caused by the cluster design, item non-response, and planned oversampling of certain subgroups, and representative of the civilian non-institutionalized Census population in the coterminous United States.
[a] Prevalence = Frequency (*n*) (weighted)/Sample Size (*N*) (weighted).
[b] NHANES I sample size (<12 years): 4,968 (unweighted); 40,463,951 (weighted).
[c] NHANES II sample size (<12 years): 6,834 (unweighted); 37,697,059 (weighted).
[d] For those aged <12 years only; question not prompted for those ≥12 years.

Source: Gavrelis et al., 2011.

Table 5-22. Summary of Estimates of Soil and Dust Ingestion by Adults and Children (0.5 to 14 years old) from Key Studies (mg/day)

Sample Size	Age (year)	Ingestion medium	Mean	p25	p50	p75	p90	p95	Reference
140	1 to13+	Soil	50,000[a]	NR	NR	NR	NR	NR	Vermeer and Frate, 1979
89	Adult	Soil	50,000[a]	NR	NR	NR	NR	NR	Vermeer and Frate, 1979
52	0.3 to14	Soil	NR	NR	NR	NR	~1,267	~4,000	Wong, 1988; Calabrese and Stanek, 1993
64	1 to <4	Soil	−294 to +459	NR	−261 to +96	NR	67 to 1,366	106 to 1,903	Calabrese et al., 1989
		Dust	−1,289 to +964	NR	−340 to +127	NR	91 to 1,700	160 to 2,916	
		Soil and Dust	−496 to +483	NR	−340 to +456	NR	89 to 1,701	159 to 3,174	
292	0.1 to <1	Soil	0 to 30[b]	NR	NR	NR	NR	NR	Van Wijnen et al., 1990
	1 to <5	Soil	0 to 200[b]	NR	NR	NR	≤300	NR	
101	2 to <8	Soil	39 to 246	NR	25 to 81	NR	NR	NR	Davis et al., 1990
		Soil and Dust	65 to 268	NR	52 to 117	NR	NR	NR	
64	1 to <4	Soil	97 to 208	NR	NR	NR	NR	NR	Calabrese and Stanek, 1995
165	1 to <8	Soil	104	NR	37	NR	NR	217	Stanek and Calabrese, 1995a
64	1 to <4	Soil	−544 to +270	−582to +65	−31 to +220	1 to 411	37 to 1,238	69 to 1,378	Calabrese et al., 1997a
478	<1 to <7	Soil and Dust	113	NR	NR	NR	NR	NR	Hogan et al., 1998
33	Adult	Soil	23 to 625	NR	0 to 260	NR	NR	138 to 2,899	Davis and Mirick, 2006
12	3 to <8	Soil	37 to 207	NR	26 to 47	NR	NR	95 to 808	Davis and Mirick, 2006
1,000[c]	3 to <6	Soil	41	5.3	15.3	44.9	NR	175.6	Özkaynak et al., 2010
		Dust	27	NR	13	NR	NR	109	
		Soil and Dust	68	16.8	37.8	83.2	NR	224	

[a] Average includes adults and children.
[b] Geometric mean.
[c] Simulated.
NR = Not reported.
p = Percentile.

Table 5-23. Comparison of Hogan et al. (1998) Study Subjects' Predicted Blood Lead Levels with Actual Measured Blood Lead Levels, and Default Soil + Dust Intakes Used in IEUBK Modeling

Age (year)	*N*	*N* prediction >actual	*N* prediction <actual	time-averaged default soil + dust intake (mg/day)
1 and 2	164	14	150	135
3 and 4	142	104	38	117.5
5 and 6	134	0	134	87.5
Average				113

N = Number.

Source: Adapted from Hogan et al., 1998.

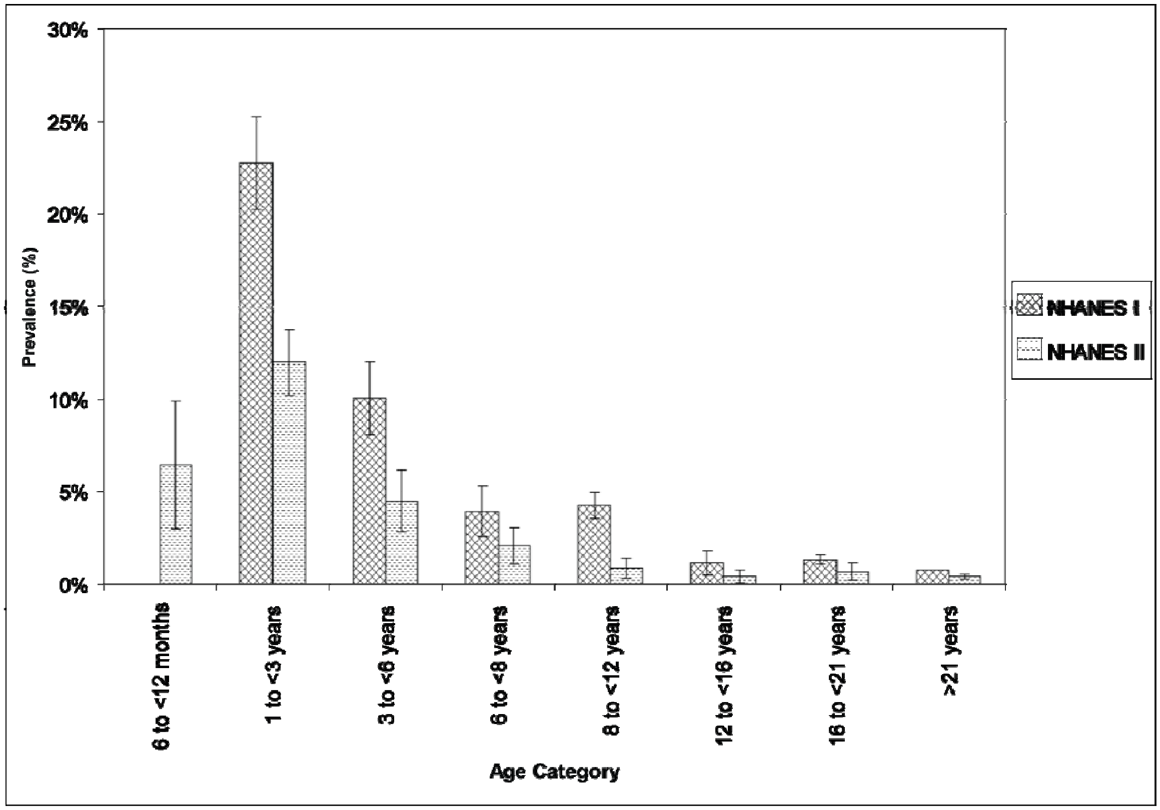


Figure 5-1. Prevalence of Non-Food Substance Consumption by Age, NHANES I and NHANES II.

Source: Gavrelis et al., 2011.

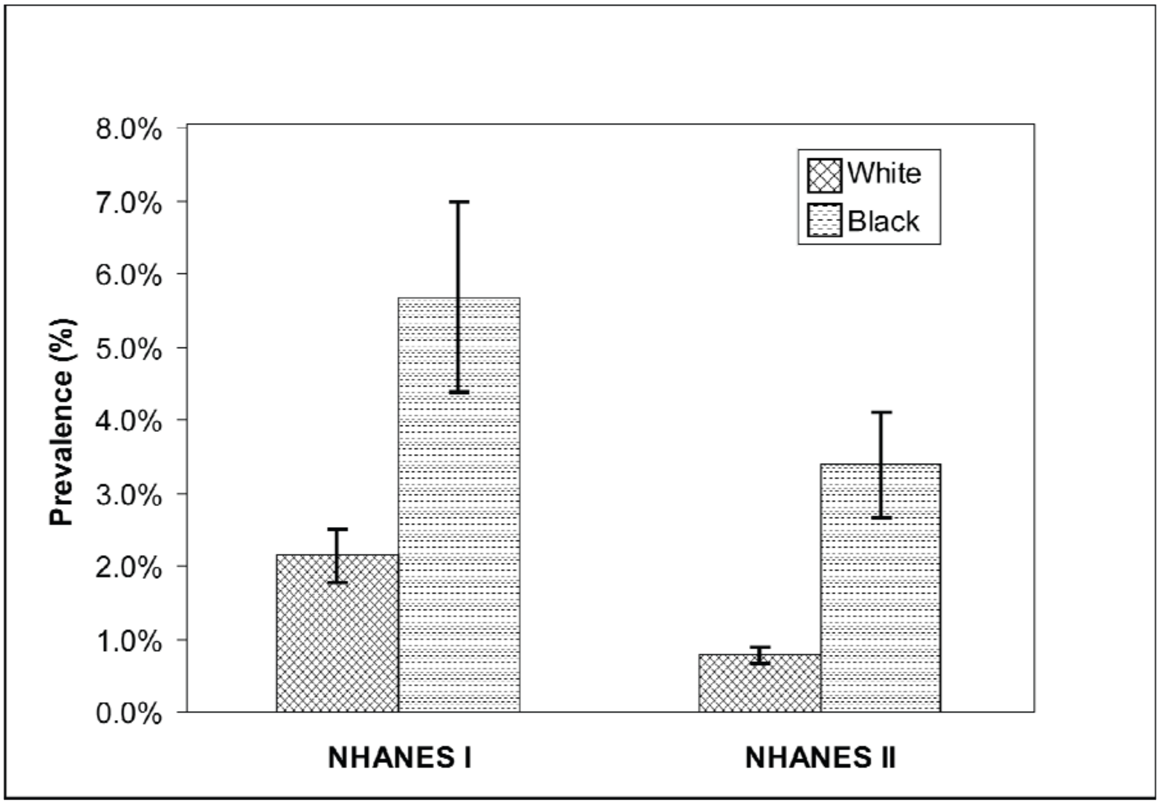
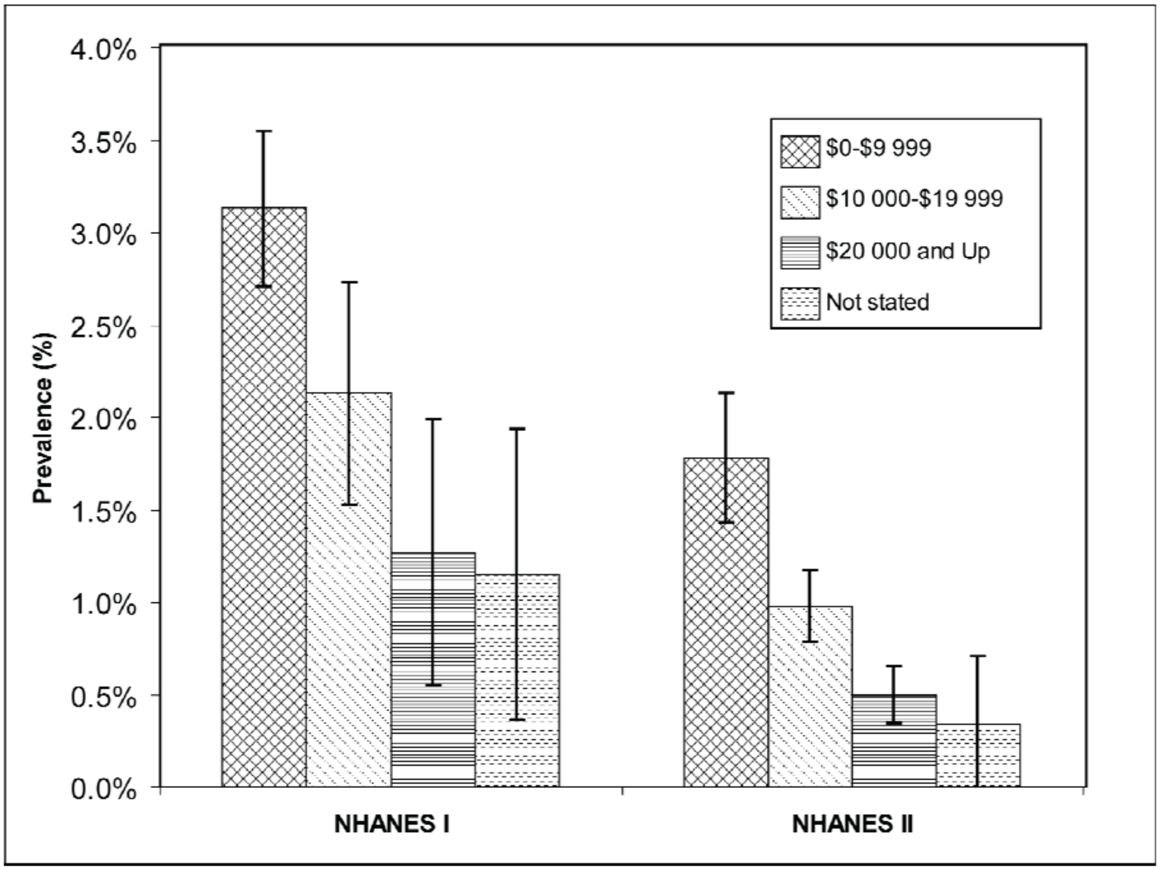


Figure 5-2. Prevalence of Non-Food Substance Consumption by Race, NHANES I and NHANES II.

Source: Gavrelis et al., 2011.



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Source: Gavrelis et al., 2011.

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6. INHALATION RATES

6.1. INTRODUCTION

Ambient and indoor air are potential sources of exposure to toxic substances. Adults and children can be exposed to contaminated air during a variety of activities in different environments. They may be exposed to contaminants in ambient air and may also inhale chemicals from the indoor use of various sources (e.g., stoves, heaters, fireplaces, and consumer products) as well as from those that infiltrate from ambient air.

The Agency defines exposure as the chemical concentration at the boundary of the body (U.S. EPA, 1992). In the case of inhalation, the situation is complicated by the fact that oxygen exchange with carbon dioxide takes place in the distal portion of the lung. The anatomy and physiology of the respiratory system as well as the characteristics of the inhaled agent diminishes the pollutant concentration in inspired air (potential dose) such that the amount of a pollutant that actually enters the body through the upper respiratory tract (especially the nasal-pharyngeal and tracheo-bronchial regions) and lung (internal dose) is less than that measured at the boundary of the body. A detailed discussion of this concept can be found in *Guidelines for Exposure Assessment* (U.S. EPA, 1992). Suggestions for further reading on the anatomy and physiology of the respiratory system include Phalen (2009), Bates (1989), Cherniak (1972), Forster (1986), and West (1974, 1987). When constructing risk assessments that concern the inhalation route of exposure, one must be aware of any adjustments that have been employed in the estimation of the pollutant concentration to account for this reduction in potential dose.

There are also a number of resources available in the literature describing various approaches and techniques related to inhalation rate estimates, including Ridley et al. (2008), Ridley and Olds (2008), Speakman and Selman (2003), Thompson et al. (2009), and Westerterp (2003).

Inclusion of this chapter in the *Exposure Factors Handbook* does not imply that assessors will always need to select and use inhalation rates when evaluating exposure to air contaminants. For example, it is unnecessary to calculate inhaled dose when using dose-response factors from the Integrated Risk Information System (IRIS) (U.S. EPA, 1994), because the IRIS methodology accounts for inhalation rates in the development of "dose-response" relationships. Information in this chapter may be used by toxicologists in their derivation of human equivalent concentrations (HECs), where adjustments are usually required to account for differences in exposure scenarios or populations (U.S. EPA, 1994). Inhalation dosimetry and the factors affecting the disposition of particles and gases that may be deposited or taken up in the respiratory tract are discussed in more detail in the U.S. Environmental Protection Agency's (EPA's) report on *Methods for Derivation of Inhalation Reference Concentrations (RfCs) and Application of Inhalation Dosimetry* (U.S. EPA, 1994). When using IRIS for inhalation risk assessments, "dose-response" relationships require only an average air concentration to evaluate health concerns:

- For non-carcinogens, IRIS uses Reference Concentrations (RfCs), which are expressed in concentration units. Hazard is evaluated by comparing the inspired air concentration to the RfC.
- For carcinogens, IRIS uses unit risk values, which are expressed in inverse concentration units. Risk is evaluated by multiplying the unit risk by the inspired air concentration.

Detailed descriptions of the IRIS methodology for derivation of inhalation RfCs can be found in two methods manuals produced by the Agency (U.S. EPA, 1992, 1994).

The Superfund Program has also updated its approach for determining inhalation risk, eliminating the use of inhalation rates when evaluating exposure to air contaminants (U.S. EPA, 2008). The current methodology recommends that risk assessors use the concentration of the chemical in air as the exposure metric (e.g., mg/m^3), instead of the intake of a contaminant in air based on inhalation rate and body weight (e.g., mg/kg-day).

Due to their size, physiology, behavior, and activity level, the inhalation rates of children differ from those of adults. Infants and children have a higher resting metabolic rate and oxygen consumption rate per unit of body weight than adults because of their rapid growth and relatively larger lung surface area (SA) per unit of body weight. For example, the oxygen consumption rate for a resting infant between 1 week and 1 year of age is 7 milliliters per kilogram of body weight (mL/kg) per minute, while the rate for an adult under the same conditions is 3−5 mL/kg per minute (WHO, 1986). Thus, while greater amounts of air and pollutants are inhaled by adults than children over similar time periods on an absolute basis, the relative volume of air passing through the lungs of a resting infant is up to twice that of a resting adult on a body-weight basis. It should be noted that lung volume is correlated, among other factors, with a person's height. Also, people living in higher altitudes have larger lung capacity than those living at sea level.

Children's inhalation dosimetry and health effects were topics of discussion at a U.S. Environmental Protection Agency workshop held in June 2006 (Foos and Sonawane, 2008). Age-related differences in lung structure and function, breathing patterns, and how these affect the inhaled dose and the deposition of particles in the lung are important factors in assessing risks from inhalation exposures (Foos et al., 2008). Children more often than adults, breathe through their mouths and, therefore, may have a lesser nasal contribution to breathing during rest and while performing various activities. The uptake of particles in the nasal airways is also less efficient in children (Bennett et al., 2008). Thus, the deposition of particles in the lower respiratory tract may be greater in children (Foos et al., 2008). In addition, the rate of fine particle deposition has been significantly correlated with increased body mass index (BMI), an important point as childhood obesity becomes a greater issue (Bennett and Zeman, 2004).

Recommended inhalation rates (both long- and short-term) for adults and children are provided in Section 6.2, along with the confidence ratings for these recommendations, which are based on four key studies identified by U.S. EPA for this factor. Long-term inhalation is repeated exposure for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days). Long-term inhalation rates for adults and children (including infants) are presented as daily rates (m^3/day). Short-term exposure is repeated exposure for more than 24 hours, up to 30 days. Short-term inhalation rates are reported for adults and children (including infants) performing various activities in m^3/minute. Following the recommendations, the available studies (both key and relevant studies) on inhalation rates are summarized.

6.2. RECOMMENDATIONS

The recommended inhalation rates for adults and children are based on three recent studies (Brochu et al., 2006a; Stifelman, 2007; U.S. EPA, 2009), as well as an additional study of children (Arcus-Arth and Blaisdell, 2007). These studies represent an improvement upon those previously used for recommended inhalation rates in earlier versions of this handbook, because they use a large data set that is representative of the United States as a whole and consider the correlation between body weight and inhalation rate.

The selection of inhalation rates to be used for exposure assessments depends on the age of the exposed population and the specific activity levels of this population during various exposure scenarios. Table 6-1 presents the recommended long-term values for adults and children (including infants) for use in various exposure scenarios. For children, the age groups included are from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005a). Section 6.3.5 describes how key studies were combined to derive the mean and 95th percentile inhalation rate values and the concordance between the age groupings used for adults and children in this chapter and the original age groups in the key studies.

As shown in Table 6-1, the daily average inhalation rates for long-term exposures for children (males and females combined, unadjusted for body weight) range from 3.5 m^3/day for children from 1 to <3 months to 16.3 m^3/day for children aged 16 to <21 years. Mean values for adults range from 12.2 m^3/day (81 years and older) to 16.0 m^3/day (31 to <51 years). The 95th percentile values for children range from 5.8 m^3/day (1 to <3 months) to 24.6 m^3/day (16 to <21 years) and for adults range from 15.7 m^3/day (81 years and older) to 21.4 m^3/day (31 to <41 years). The mean and 95th percentile values shown in Table 6-1 represent averages of the inhalation rate data from the key studies for which data were available for selected age groups.

It should be noted that there may be a high degree of uncertainty associated with the upper percentiles. These values represent unusually high estimates of caloric intake per day and are not representative of the average adult or child. For example, using Layton's equation (Layton, 1993) for estimating metabolically consistent inhalation rates to calculate caloric equivalence (see Section 6.4.9), the 95th percentile value for 16 to <21-year-old children is greater than 4,000 kcal/day (Stifelman, 2003). All of the 95th percentile values listed in Table 6-1 represent unusually high inhalation rates for long-term exposures, even for the upper end of the distribution, but were included in this handbook to provide exposure assessors a sense of the possible range of inhalation rates for adults and children. These values should be used with caution when estimating long-term exposures.

Short-term mean and 95th percentile data in m^3/minute are provided in Table 6-2 for males and females combined for adults and children for whom activity patterns are known. These values represent averages of the activity level data from the one key study from which short-term inhalation rate data were available (U.S. EPA, 2009).

Table 6-3 shows the confidence ratings for the inhalation rate recommendations. Tables 6-4, 6-6 through 6-8, 6-10, 6-14, 6-15, and 6-17 through 6-20 provide multiple percentiles for long- and short-term inhalation rates for both males and females.

Table 6-1. Recommended Long-Term Exposure Values for Inhalation (Males and Females Combined)

Age Group[a]	Mean (m^3/day)	Sources Used for Means	95th Percentile[b] (m^3/day)	Sources Used for 95th Percentiles	Multiple Percentiles
Birth to <1 month	3.6	c	7.1	c	See Tables 6-4, 6-6 through 6-8, 6-10, 6-14, 6-15 (none available for Stifelman, 2007)
1 to <3 months	3.5	c, d	5.8	c, d	
3 to <6 months	4.1	c, d	6.1	c, d	
6 to <12 months	5.4	c, d	8.0	c, d	
Birth to <1 year	5.4	c, d, e, f	9.2	c, d, e	
1 to <2 years	8.0	c, d, e, f	12.8	c, d, e	
2 to <3 years	8.9	c, d, e, f	13.7	c, d, e	
3 to <6 years	10.1	c, d, e, f	13.8	c, d, e	
6 to <11 years	12.0	c, d, e, f	16.6	c, d, e	
11 to <16 years	15.2	c, d, e, f	21.9	c, d, e	
16 to <21 years	16.3	c, d, e, f	24.6	c, d, e	
21 to <31 years	15.7	d, e, f	21.3	d, e	
31 to <41 years	16.0	d, e, f	21.4	d, e	
41 to <51 years	16.0	d, e, f	21.2	d, e	
51 to <61 years	15.7	d, e, f	21.3	d, e	
61 to <71 years	14.2	d, e, f	18.1	d, e	
71 to <81 years	12.9	d, e	16.6	d, e	
≥81 years	12.2	d, e	15.7	d, e	

[a] When age groupings in the original reference did not match the U.S. EPA groupings used for this handbook, means from all age groupings in the original reference that overlapped U.S. EPA's age groupings by more than one year were averaged, weighted by the number of observations contributed from each age group. Similar calculations were performed for the 95th percentiles. See Table 6-25 for concordance with U.S. EPA age groupings.

[b] Some 95th percentile values may be unrealistically high and not representative of the average person.

[c] Arcus-Arth and Blaisdell, 2007.

[d] Brochu et al., 2006a.

[e] U.S. EPA, 2009.

[f] Stifelman, 2007.

Table 6-2. Recommended Short-Term Exposure Values for Inhalation (Males and Females Combined)

Activity Level	Age Group (years)	Mean (m^3/minute)	95th Percentile (m^3/minute)	Multiple Percentiles
Sleep or Nap	Birth to <1	3.0E−03	4.6E−03	
	1 to <2	4.5E−03	6.4E−03	
	2 to <3	4.6E−03	6.4E−03	
	3 to <6	4.3E−03	5.8E−03	
	6 to <11	4.5E−03	6.3E−03	
	11 to <16	5.0E−03	7.4E−03	
	16 to <21	4.9E−03	7.1E−03	
	21 to <31	4.3E−03	6.5E−03	
	31 to <41	4.6E−03	6.6E−03	
	41 to <51	5.0E−03	7.1E−03	
	51 to <61	5.2E−03	7.5E−03	
	61 to <71	5.2E−03	7.2E−03	
	71 to <81	5.3E−03	7.2E−03	
	≥81	5.2E−03	7.0E−03	
Sedentary/ Passive	Birth to <1	3.1E−03	4.7E−03	
	1 to <2	4.7E−03	6.5E−03	
	2 to <3	4.8E−03	6.5E−03	
	3 to <6	4.5E−03	5.8E−03	See Tables 6-17 and 6-20
	6 to <11	4.8E−03	6.4E−03	
	11 to <16	5.4E−03	7.5E−03	
	16 to <21	5.3E−03	7.2E−03	
	21 to <31	4.2E−03	6.5E−03	
	31 to <41	4.3E−03	6.6E−03	
	41 to <51	4.8E−03	7.0E−03	
	51 to <61	5.0E−03	7.3E−03	
	61 to <71	4.9E−03	7.3E−03	
	71 to <81	5.0E−03	7.2E−03	
	≥81	4.9E−03	7.0E−03	
Light Intensity	Birth to <1	7.6E−03	1.1E−02	
	1 to <2	1.2E−02	1.6E−02	
	2 to <3	1.2E−02	1.6E−02	
	3 to <6	1.1E−02	1.4E−02	
	6 to <11	1.1E−02	1.5E−02	
	11 to <16	1.3E−02	1.7E−02	
	16 to <21	1.2E−02	1.6E−02	

Table 6-2. Recommended Short-Term Exposure Values for Inhalation (Males and Females Combined) (continued)

Activity Level	Age Group (year)	Mean (m^3/minute)	95th Percentile (m^3/minute)	Multiple Percentiles
Light Intensity (continued)	21 to <31	1.2E−02	1.6E−02	
	31 to <41	1.2E−02	1.6E−02	
	41 to <51	1.3E−02	1.6E−02	
	51 to <61	1.3E−02	1.7E−02	
	61 to <71	1.2E−02	1.6E−02	
	71 to <81	1.2E−02	1.5E−02	
	≥81	1.2E−02	1.5E−02	
Moderate Intensity	Birth to <1	1.4E−02	2.2E−02	
	1 to <2	2.1E−02	2.9E−02	
	2 to <3	2.1E−02	2.9E−02	
	3 to <6	2.1E−02	2.7E−02	
	6 to <11	2.2E−02	2.9E−02	
	11 to <16	2.5E−02	3.4E−02	
	16 to <21	2.6E−02	3.7E−02	
	21 to <31	2.6E−02	3.8E−02	
	31 to <41	2.7E−02	3.7E−02	
	41 to <51	2.8E−02	3.9E−02	
	51 to <61	2.9E−02	4.0E−02	
	61 to <71	2.6E−02	3.4E−02	
	71 to <81	2.5E−02	3.2E−02	
	≥81	2.5E−02	3.1E−02	
High Intensity	Birth to <1	2.6E−02	4.1E−02	
	1 to <2	3.8E−02	5.2E−02	
	2 to <3	3.9E−02	5.3E−02	
	3 to <6	3.7E−02	4.8E−02	
	6 to <11	4.2E−02	5.9E−02	
	11 to <16	4.9E−02	7.0E−02	
	16 to <21	4.9E−02	7.3E−02	
	21 to <31	5.0E−02	7.6E−02	
	31 to <41	4.9E−02	7.2E−02	
	41 to <51	5.2E−02	7.6E−02	
	51 to <61	5.3E−02	7.8E−02	
	61 to <71	4.7E−02	6.6E−02	
	71 to <81	4.7E−02	6.5E−02	
	≥81	4.8E−02	6.8E−02	

Source: U.S. EPA, 2009.

Table 6-3. Confidence in Recommendations for Long- and Short-Term Inhalation Rates

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The survey methodology and data analysis was adequate. Measurements were made by indirect methods. The studies analyzed existing primary data.	
Minimal (or defined) Bias	Potential bias within the studies was fairly well documented.	
Applicability and Utility		High
Exposure Factor of Interest	The studies focused on inhalation rates and factors influencing them.	
Representativeness	The studies focused on the U.S. population. A wide range of age groups were included.	
Currency	The studies were published during 2006 and 2009 and represent current exposure conditions.	
Data-Collection Period	The data-collection period for the studies may not be representative of long-term exposures.	
Clarity and Completeness		Medium
Accessibility	All key studies are available from the peer-reviewed literature.	
Reproducibility	The methodologies were clearly presented; enough information was included to reproduce most results.	
Quality Assurance	Information on ensuring data quality in the key studies was limited.	
Variability and Uncertainty		Medium
Variability in Population	In general, the key studies addressed variability in inhalation rates based on age and activity level. Although some factors affecting inhalation rate, such as body mass, are discussed, other factors (e.g., ethnicity) are omitted.	
Uncertainty	Multiple sources of uncertainty exist for these studies. Assumptions associated with energy expenditure (EE)-based estimation procedures are a source of uncertainty in inhalation rate estimates.	
Evaluation and Review		High
Peer Review	Three of the key studies appeared in peer-reviewed journals, and one key study is a U.S. EPA peer-reviewed report.	
Number and Agreement of Studies	There are four key studies. The results of studies from different researchers are in general agreement.	
Overall Rating		**Medium**

6.3. KEY INHALATION RATE STUDIES

6.3.1. Brochu et al. (2006a)—Physiological Daily Inhalation Rates for Free-Living Individuals Aged 1 Month to 96 Years, Using Data from Doubly Labeled Water Measurements: A Proposal for Air Quality Criteria, Standard Calculations, and Health Risk Assessment

Brochu et al. (2006a) calculated physiological daily inhalation rates (PDIRs) for 2,210 individuals aged 3 weeks to 96 years using the reported disappearance rates of oral doses of doubly labeled water (DLW) (^2H_2O and $H_2{}^{18}O$) in urine, monitored by gas-isotope-ratio mass spectrometry for an aggregate period of more than 30,000 days. DLW data were complemented with indirect calorimetry and nutritional balance measurements.

In the DLW method, the disappearance of the stable isotopes deuterium (^2H) and heavy oxygen-18 (^{18}O) are monitored in urine, saliva, or blood samples over a long period of time (from 7 to 21 days) after subjects receive oral doses of ^2H_2O and $H_2{}^{18}O$. The disappearance rate of ^2H reflects water output and that of ^{18}O represents water output plus carbon dioxide (CO_2) production rates. The CO_2 production rate is then calculated by finding the difference between the two disappearance rates. Total daily energy expenditures (TDEEs) are determined from CO_2 production rates using classic respirometry formulas, in which values for the respiratory quotient ($RQ = CO_{2\ produced}/O_{2\ consumed}$) are derived from the composition of the diet during the period of time of each study. The DLW method also allows for measurement of the energy cost of growth (ECG). TDEE and ECG measurements can be converted into PDIR values using the following equation developed by Layton (1993):

$$PDIR = (TDEE + ECG) \times H \times VQ \times 10^{-3} \quad \text{(Eqn. 6-1)}$$

where:

PDIR	=	physiological daily inhalation rates (m^3/day);
TDEE	=	total daily energy expenditure (kcal/day);
ECG	=	stored daily energy cost for growth (kcal/day);
H	=	oxygen uptake factor, volume of 0.21 L of oxygen (at standard temperature and pressure, dry air) consumed to produce 1 kcal of energy expended;
VQ	=	ventilatory equivalent (ratio of the minute volume [V_E] at body temperature pressure saturation to the oxygen uptake rate [VO_2] at standard temperature and pressure, dry air) $V_E/VO_2 = 27$; and
10^{-3}	=	conversion factor (L/m^3).

Brochu et al. (2006a) calculated daily inhalation rates (DIRs) (expressed in m^3/day and m^3/kg-day) for the following age groups and physiological conditions: (1) healthy newborns aged 3 to 5 weeks old (*N* = 33), (2) healthy normal-weight males and females aged 2.6 months to 96 years (*N* = 1,252), (3) low-BMI subjects (underweight women, *N* = 17; adults from less affluent societies *N* = 59) and (4) overweight/obese individuals (*N* = 679), as well as (5) athletes, explorers, and soldiers when reaching very high energy expenditures (*N* = 170). Published data on BMI, body weight, basal metabolic rate (BMR), ECG, and TDEE measurements (based on DLW method and indirect calorimetry) for subjects aged 2.6 months to 96 years were used. Data for underweight, healthy normal-weight, and overweight/obese individuals were gathered and defined according to BMI cutoffs. Data for newborns were included regardless of BMI values because they were clinically evaluated as being healthy infants.

Tables 6-4 to 6-8 present the distribution of daily inhalation rates for normal-weight and overweight/obese individuals by sex and age groups. Table 6-9 presents mean inhalation rates for newborns. Due to the insufficient number of subjects, no distributions were derived for this group.

An advantage of this study is that data are provided for age groups of less than 1 year. A limitation of this study is that data for individuals with pre-existing medical conditions were lacking.

6.3.2. Arcus-Arth and Blaisdell (2007)—Statistical Distributions of Daily Breathing Rates for Narrow Age Groups of Infants and Children

Arcus-Arth and Blaisdell (2007) derived daily breathing rates for narrow age ranges of children using the metabolic conversion method of Layton (1993) and energy intake (EI) data adjusted to represent the U.S. population from the Continuing Survey of Food Intake for Individuals (CSFII) 1994−1996, 1998. Normalized (m^3/kg-day) and non-normalized (m^3/day) breathing rates for children 0−18 years of age were derived using the general equation developed by Layton (1993) to calculate energy-dependent inhalation rates:

$$V_E = H \times VQ \times EE \qquad \text{(Eqn. 6-2)}$$

where:

V_E = volume of air breathed per day (m^3/day),
H = volume of oxygen consumed to produce 1 kcal of energy (m^3/kcal),
VQ = ratio of the volume of air to the volume of oxygen breathed per unit time (unitless), and
EE = energy (kcal) expended per day.

Arcus-Arth and Blaisdell (2007) calculated *H* values of 0.22 and 0.21 for infants and non-infant children, respectively, using the 1977−1978 Nationwide Food Consumption Survey (NFCS) and CSFII data sets. Ventilatory equivalent (VQ) data, including those for infants, were obtained from 13 studies that reported VQ data for children aged 4−8 years. Separate preadolescent (4−8 years) and adolescent (9−18 years) VQ values were calculated in addition to separate VQ values for adolescent boys and girls. Two-day-averaged daily EI values reported in the CSFII data set were used as a surrogate for EE. CSFII records that did not report body weight and those for children who consumed breast milk or were breast-fed were excluded from their analyses. The EIs of children 9 years of age and older were multiplied by 1.2, the value calculated by Layton (1993) to adjust for potential bias related to under-reporting of dietary intakes by older children. For infants, EI values were adjusted by subtracting the amount of energy put into storage by infants as estimated by Scrimshaw et al. (1996). Self-reported body weights for each individual from the CSFII data set were used to calculate non-normalized (m^3/day) and normalized (m^3/kg-day) breathing rates, which decreased the variability in the resulting breathing rate data. Daily breathing rates were grouped into three 1-month groups for infants, 1-year age groups for children 1 to 18 years of age, and the age groups recommended by U.S. EPA *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (U.S. EPA, 2005b) to receive greater weighting for mutagenic carcinogens (0 to <2 years of age, and 2 to <16 years of age). Data were also presented for adolescent boys and girls, aged 9 to 18 years (see Table 6-10). For each age and age-sex group, Arcus-Arth and Blaisdell (2007) calculated the arithmetic mean, standard error of the mean, percentiles (50th, 90th, and 95th), geometric mean, standard deviation, and best-fit parametric models of the breathing rate distributions. Overall, the CSFII-derived non-normalized breathing rates progressively increased with age from infancy through 18 years of age, while normalized breathing rates progressively decreased. The data are presented in Table 6-11 in units of m^3/day. There were statistical differences between boys and girls 9 to 18 years of age, both for these years combined ($p < 0.00$) and for each year of age separately ($p < 0.05$). The authors reasoned that since the fat-free mass (basically muscle mass) of boys typically increases during adolescence, and because fat-free mass is highly correlated to basal metabolism which accounts for the majority of EE, non-normalized breathing rates for adolescent boys may be expected to increase with increasing age. Table 6-11 presents the mean and 95th percentile values for males and females combined, averaged to fit within the standard U.S. EPA age groups.

The CSFII-derived mean breathing rates derived by Arcus-Arth and Blaisdell (2007) were compared to the mean breathing rates estimated in studies that utilized DLW technique EE data that had been coupled with the Layton (1993) method. Infants' breathing rates estimated using the CSFII data were 15 to 27% greater than the comparison DLW EE breathing rates. In contrast, the children's CSFII breathing rates ranged from 23% less to 14% greater than comparison rates. Arcus-Arth and Blaisdell (2007) concluded that taking into account the differences in methods, data, and some age definitions between the two sets of breathing rates, the CSFII and comparison rates were similar across age groups.

An advantage of this study is that it provides breathing rates specific to narrow age ranges, which can be useful for assessing inhalation dose during periods of greatest susceptibility. However, the study is limited by the potential for misreporting, underestimating, or overestimating of food intake data in the CSFII. In addition to underreporting of food intake by adolescents, EI values for younger children may be under- or overestimated. Overweight children (or their parents) may also under-report food intakes. In addition, adolescents who misreport food intake may have also misreported body weights.

6.3.3. Stifelman (2007)—Using Doubly-Labeled Water Measurements of Human Energy Expenditure to Estimate Inhalation Rates

Stifelman (2007) estimated inhalation rates using DLW energy data. The DLW method administers two forms of stable isotopically labeled water: deuterium-labeled (^2H_2O) and ^{18}oxygen-labeled ($H_2{}^{18}O$). The difference in disappearance rates between the two isotopes represents the energy expended over a period of 1−3 half-lives of the labeled water (Stifelman, 2007). The resulting duration of observation is typically 1−3 weeks, depending on the size and activity level.

The DLW database contains subjects from areas around the world and represents diversity in ethnicity, age, activity, body type, and fitness level. DLW data have been compiled by the Institute of Medicine (IOM) Panel on Macronutrients and the Food and Agriculture Organization of the United Nations. Stifelman (2007) used the equation of Layton (1993) to convert the recommended energy levels of IOM for the active to very-active people to their equivalent inhalation rates. The IOM reports recommend energy expenditure levels organized by sex, age, and body size (Stifelman, 2007).

The equivalent inhalation rates are shown in Table 6-12. Shown in Table 6-13 are the mean values for the IOM "active" energy level category, averaged to fit within the standard U.S. EPA age groups. Stifelman (2007) noted that the estimates based on the DLW are consistent with previous findings of Layton (1993) and the *Exposure Factors Handbook* (U.S. EPA, 1997) and that inhalation rates based on the IOM active classification are consistent with the mean inhalation rate in the handbook.

The advantages of this study are that the inhalation rates were estimated using the DLW data from a large data set. Stifelman (2007) noted that DLW methods are advantageous; the data are robust, measurements are direct and avoid errors associated with indirect measurements (heart rate [HR]), subjects are free-living, and the period of observation is longer than what is possible from staged activity measures. Observations over a longer period of time reduce the uncertainties associated with using short duration studies to infer long-term inhalation rates. A limitation with the study is that the inhalation rates that are presented are for active/very active persons only.

6.3.4. U.S. EPA (2009)—Metabolically Derived Human Ventilation Rates: A Revised Approach Based Upon Oxygen Consumption Rates

U.S. EPA (2009) conducted a study to ascertain inhalation rates for children and adults. Specifically, U.S. EPA sought to improve upon the methodology used by Layton (1993) and other studies that relied upon the VQ and a linear relationship between oxygen consumption and fitness rate. A revised approach, developed by U.S. EPA's National Exposure Research Laboratory, was used, in which an individual's inhalation rate was derived from his or her assumed oxygen consumption rate. U.S. EPA applied this revised approach using body-weight data from the 1999−2002 National Health and Nutrition Examination Survey (NHANES) and metabolic equivalents of work (METS) data from U.S. EPA's Consolidated Human Activity Database (CHAD). In this database, metabolic cost is given in units of "METS" or "metabolic equivalents of work," an energy expenditure metric used by exercise physiologists and clinical nutritionists to represent activity levels. An activity's METS value represents a dimensionless ratio of its metabolic rate (energy expenditure) to a person's resting, or BMR.

NHANES provided age, sex, and body-weight data for 19,022 individuals from throughout the United States. From these data, BMR was estimated using an age-specific linear equation used in the *Exposure Factors Handbook* (U.S. EPA, 1997), and in several other studies and reference works.

The CHAD database is a compilation of several databases of human activity patterns. U.S. EPA used one of these studies, the National Human Activity Pattern Survey (NHAPS), as its source for METS values because it was more representative of the entire U.S. population than the other studies in the database. The NHAPS data set included activity data for 9,196 individuals, each of which provided 24 hours of activity pattern data using a diary-based questionnaire. While NHAPS was identified as the best available data source for activity patterns, there were some shortcomings in the quality of the data. Study respondents did not provide body weights; instead, body weights were simulated using statistical sampling. Also, the NHAPS data extracted from CHAD could not be corrected to account for non-random sampling of study participants and survey days.

NHANES and NHAPS data were grouped according to the age categories presented elsewhere in this handbook, with the exception that children under the age of 1 year were placed into a single category to preserve an adequate sample size within the category. For each NHANES participant, a "simulated" 24-hour activity pattern was generated by randomly sampling activity patterns from the set of NHAPS participants with the same sex and age category as the NHANES participant. Twenty such patterns were selected at random for each NHANES participant, resulting in 480 hours of simulated activity data for each NHANES participant. The data were then scaled down to a 24-hour time frame to yield an average 24-hour activity pattern for each of the 19,022 NHANES individuals.

Each activity was assigned a METS value based on statistical sampling of the distribution assigned by CHAD to each activity code. For most codes, these distributions were not age dependent, but age was a factor for some activities for which intensity level varies strongly with age. Using statistical software, equations for METS based on normal, lognormal, exponential, triangular, and uniform distributions were generated as needed for the various activity codes. The METS values were then translated into EE by multiplying the METS by the BMR, which was calculated as a linear function of body weight. The oxygen consumption rate (VO_2) was calculated by multiplying EE by *H*, the volume of oxygen consumed per unit of energy. VO_2 was calculated both as volume per time and as volume per time per unit of body weight.

The inhalation rate for each activity within the 24-hour simulated activity pattern for each individual was estimated as a function of VO_2, body weight, age, and sex. Following this, the average inhalation rate was calculated for each individual for the entire 24-hour period, as well as for four separate classes of activities based on METS value (sedentary/passive [METS less than or equal to 1.5], light intensity [METS greater than 1.5 and less than or equal to 3.0], moderate intensity [METS greater than 3.0 and less than or equal to 6.0], and high intensity [METS greater than 6.0]). Data for individuals were then used to generate summary tables based on sex and age categories.

U.S. EPA (2009) also conducted a validation exercise using the Air Pollutants Exposure Model to estimate ventilation rates (VRs) and compared results with recently published estimates of ventilation rates from Brochu et al. (2006a, b) and Arcus-Arth and Blaisdell (2007). The results compared reasonably well when ventilation rates were normalized by BMI.

Tables 6-14 through 6-22 present data from this study. Tables 6-14 and 6-15 present, for male and female subjects, respectively, summary statistics for daily average inhalation rate by age category on a volumetric (m^3/day) and body-weight adjusted (m^3/day-kg) basis. Table 6-16 presents the mean and 95th percentile values for males, females, and males and females combined. Tables 6-17 through 6-20 present, for male and female subjects, respectively, mean ventilation rates by age category on a volumetric (m^3/minute) and body-weight adjusted (m^3/minute-kg) basis for the five different activity level ranges described above. Tables 6-21 and 6-22 present the number of hours spent per day at each activity level by males and females.

An advantage of this study is the large sample size. In addition, the data sets used, NHAPS and NHANES, are representative of the U.S. general population. One limitation is that the NHAPS data are more than 15 years old. Also, day-to-day variability cannot be characterized because data were collected over a 24-hour period. There is also uncertainty in the METs randomization, all of which were noted by the authors. In addition, the approach does not take into consideration correlations that may exist between body weight and activity patterns. Therefore, high physical activity levels can be associated with individuals of high body weight, leading to unrealistically high inhalation rates at the upper percentile levels. The validation exercise presented in U.S. EPA (2009) used normal-weight individuals. It is unclear if similar results would be obtained for overweight individuals.

6.3.5. Key Studies Combined

In order to provide the recommended long-term inhalation rates shown in Table 6-1**,** data from the four key studies were combined. Mean and 95th percentile inhalation rate values for the four key studies are shown in Tables 6-23 and 6-24, respectively. The data from each study were averaged by sex and grouped according to the age groups selected for use in this handbook, when possible. Table 6-25 shows concordance between the age groupings used in this handbook and the original age groups in the key studies.

6.4. RELEVANT INHALATION RATE STUDIES

6.4.1. International Commission on Radiological Protection (ICRP) (1981)—Report of the Task Group on Reference Man

The International Commission on Radiological Protection (ICRP, 1981) estimated daily inhalation rates for reference adult males and females, children (10 years old), infants (1 year old), and newborn babies by using a time-activity-ventilation approach.

This approach for estimating an inhalation rate over a specified period of time was based on calculating a time weighted average of inhalation rates associated with physical activities of varying durations (see Table 6-26). ICRP (1981) compiled reference values (see Table 6-27) of minute volume/inhalation rates from various literature sources. ICRP (1981) assumed that the daily activities of a reference male, female, and child (10 years of age) consisted of 8 hours of rest and 16 hours of light activities. It was also assumed that for adults only, the 16 hours of light activities were divided evenly between occupational and non-occupational activities. It was assumed that a day consisted of 14 hours resting and 10 hours light activity for an infant (1 year). A newborn's daily activities consisted of 23 hours resting and 1-hour light activity. The estimated inhalation rates were 22.8 m^3/day for adult males, 21.1 m^3/day for adult females, 14.8 m^3/day for children (age 10 years), 3.76 m^3/day for infants (age 1 year), and 0.78 m^3/day for newborns (see Table 6-26).

The advantages of this study are that they account fairly well for time and activity, and are sex specific. A limitation associated with this study is that it is almost 30 years old. In addition, the validity and accuracy of the inhalation rate data used in the compilation of reference values were not specified. This introduces some degree of uncertainty in the results obtained. Also, the approach used required that assumptions be made regarding the hours spent by various age/sex cohorts in specific activities. These assumptions may over-/under-estimate the inhalation rates obtained.

6.4.2. U.S. EPA (1985)—Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessment

The U.S. EPA (1985) compiled measured values of minute ventilation for various age/sex cohorts from early studies. The data compiled by the U.S. EPA (1985) for each of the age/sex cohorts were obtained at various activity levels (see Table 6-28). These levels were categorized as light, moderate, or heavy according to the criteria developed by the U.S. EPA Office of Environmental Criteria and Assessment for the Ozone Criteria Document. These criteria were developed for a reference male adult with a body weight of 70 kg (U.S. EPA, 1985). Table 6-29 details the estimated minute ventilation rates for adult males based on these activity level categories.

Table 6-28 presents a summary of inhalation rates by age and activity level. A description of activities included in each activity level is also presented in Table 6-28. Table 6-28 indicates that at rest, the average adult inhalation rate is 0.5 m^3/hour. Table 6-28 indicates that at rest, the mean inhalation rate for children, ages 6 and 10 years, is 0.4 m^3/hour. Table 6-30 presents activity pattern data aggregated for three microenvironments by activity level for all age groups. The total average hours spent indoors was 20.4, outdoors was 1.77, and in a transportation vehicle was 1.77. Based on the data presented in Tables 6-28 and 6-30, a daily inhalation rate was calculated for adults and children by using a time-activity-ventilation approach. These data are presented for adults and children in Table 6-31. The calculated average daily inhalation rate is 16 m^3/day for adults. The average daily inhalation rate for 6- and 10-year-old children is 16.74 and 21.02 m^3/day, respectively.

Limitations associated with this study are its age and that many of the values used in the data compilation were from early studies. The accuracy and/or validity of the values used and data collection method were not presented in U.S. EPA (1985). This introduces uncertainty in the results obtained. An advantage of this study is that the data are actual measurement data for a large number of adults and children.

6.4.3. Shamoo et al. (1990)—Improved Quantitation of Air Pollution Dose Rates by Improved Estimation of Ventilation Rate

Shamoo et al. (1990) conducted a study to develop and validate new methods to accurately estimate ventilation rates for typical individuals during their normal activities. Two practical approaches were tested for estimating ventilation rates indirectly: (1) volunteers were trained to estimate their own VR at various controlled levels of exercise; and (2) individual VR and HR relationships were determined in another set of volunteers during supervised exercise sessions (Shamoo et al., 1990). In the first approach, the training session involved 9 volunteers (3 females and 6 males) from 21 to 37 years old. Initially the subjects were trained on a treadmill with regularly increasing speeds. VR measurements were recorded during the last minute of the 3-minute interval at each speed. VR was reported to the subjects as low (1.4 m^3/hour), medium (1.5−2.3 m^3/hour), heavy (2.4−3.8 m^3/hour), and very heavy (3.8 m^3/hour or higher) (Shamoo et al., 1990).

Following the initial test, treadmill training sessions were conducted on a different day in which 7 different speeds were presented, each for 3 minutes in arbitrary order. VR was measured, and the subjects were given feedback with the four ventilation ranges provided previously. After resting, a treadmill testing session was conducted in which seven speeds were presented in different arbitrary order from the training session. VR was measured, and each subject estimated their own ventilation level at each speed. The correct level was then revealed to each subject after his/her own estimate. Subsequently, two 3-hour outdoor supervised exercise sessions were conducted in the summer on 2 consecutive days. Each hour consisted of 15 minutes each of rest, slow walking, jogging, and fast walking. The subjects' ventilation level and VR were recorded; however, no feedback was given to the subjects. Electrocardiograms were recorded via direct connection or telemetry, and HR was measured concurrently with ventilation measurement for all treadmill sessions.

The second approach consisted of two protocol phases (indoor/outdoor exercise sessions and field testing). Twenty outdoor adult workers between 19 and 50 years old were recruited. Indoor and outdoor supervised exercises similar to the protocols in the first approach were conducted; however, there were no feedbacks. Also, in this approach, electrocardiograms were recorded, and HR was measured concurrently with VR. During the field testing phase, subjects were trained to record their activities during three different 24-hour periods during 1 week. These periods included their most active working and non-working days. HR was measured quasi-continuously during the 24-hour periods that activities were recorded. The subjects recorded in a diary all changes in physical activity, location, and exercise levels during waking hours. Self-estimated activities in supervised exercises and field studies were categorized as slow (resting, slow walking or equivalent), medium (fast walking or equivalent), and fast (jogging or equivalent).

Inhalation rates were not presented in this study. In the first approach, about 68% of all self-estimates were correct for the 9 subjects sampled (Shamoo et al., 1990). Inaccurate self-estimates occurred in the younger male population who were highly physically fit and were competitive aerobic trainers. This subset of the sample population tended to underestimate their own physical activity levels at higher VR ranges. Shamoo et al. (1990) attributed this to a "macho effect," in which these younger male subjects were reluctant to report "very heavy" exercise even when it was obvious to an observer, because they considered it an admission of poor physical condition. In the second approach, a regression analysis was conducted that related the logarithm of VR to HR. The logarithm of VR correlated better with HR than VR itself (Shamoo et al., 1990).

Limitations associated with this study are its age and that the population sampled is not representative of the general U.S. population. Also, ventilation rates were not presented. Training individuals to estimate their VR may contribute to uncertainty in the results because the estimates are subjective. Another limitation is that calibration data were not obtained at extreme conditions; therefore, the VR/HR relationship obtained may be biased. An additional limitation is that training subjects may be too labor-intensive for widespread use in exposure assessment studies. An advantage of this study is that HR recordings are useful in predicting ventilation rates, which, in turn, are useful in estimating exposure.

6.4.4. Shamoo et al. (1991)—Activity Patterns in a Panel of Outdoor Workers Exposed to Oxidant Pollution

Shamoo et al. (1991) investigated summer activity patterns in 20 adult volunteers with potentially high exposure to ambient oxidant pollution. The selected volunteer subjects were 15 men and 5 women ages 19−50 years from the Los Angeles area. All volunteers worked outdoors at least 10 hours per week. The experimental approach involved two stages: (1) indirect objective estimation of VR from HR measurements, and (2) self-estimation of inhalation/ventilation rates recorded by subjects in diaries during their normal activities.

The approach consisted of calibrating the relationship between VR and HR for each test subject in controlled exercise; monitoring by subjects of their own normal activities with diaries and electronic HR recorders; and then relating VR with the activities described in the diaries (Shamoo et al., 1991). Calibration tests were conducted for indoor and outdoor supervised exercises to determine individual relationships between VR and HR. Indoors, each subject was tested on a treadmill at rest and at increasing speeds. HR and VR were measured at the third minute at each 3-minute interval speed. In addition, subjects were tested while walking a 90-meter course in a corridor at 3 self-selected speeds (normal, slower than normal, and faster than normal) for 3 minutes.

Two outdoor testing sessions (1 hour each) were conducted for each subject, 7 days apart. Subjects exercised on a 260-meter asphalt course. A session involved 15 minutes each of rest, slow walking, jogging, and fast walking during the first hour. The sequence was also repeated during the second hour. HR and VR measurements were recorded starting at the 8th minute of each 15-minute segment. Following the calibration tests, a field study was conducted in which subjects self-monitored their activities by filling out activity diary booklets, self-estimated their breathing rates, and their HR. Breathing rates were defined as sleep; slow (slow or normal walking); medium (fast walking); and fast (running) (Shamoo et al., 1991). Changes in location, activity, or breathing rates during three 24-hour periods within a week were recorded. These periods included their most active working and non-working days. Each subject wore Heart Watches, which recorded their HR once per minute during the field study. Ventilation rates were estimated for the following categories: sleep, slow, medium, and fast.

Calibration data were fit to the equation log (VR) = intercept + (slope × HR), each individual's intercept and slope were determined separately to provide a specific equation that predicts each subject's VR from measured HR (Shamoo et al., 1991). The average measured VRs were 0.48, 0.90, 1.68, and 4.02 m^3/hour for rest, slow walking or normal walking, fast walking, and jogging, respectively (Shamoo et al., 1991). Collectively, the diary recordings showed that sleep occupied about 33% of the subject's time; slow activity 59%; medium activity 7%; and fast activity 1%. The diary data covered an average of 69 hours per subject (Shamoo et al., 1991). Table 6-32 presents the distribution pattern of predicted ventilation rates and equivalent ventilation rates (EVR) obtained at the four activity levels. EVR was defined as the VR per square meter of body surface area, and also as a percentage of the subjects average VR over the entire field monitoring period (Shamoo et al., 1991). The overall mean predicted VR was 0.42 m^3/hour for sleep; 0.71 m^3/hour for slow activity; 0.84 m^3/hour for medium activity; and 2.63 m^3/hour for fast activity.

Table 6-33 presents the mean predicted VR and standard deviation, and the percentage of time spent in each combination of VR, activity type (essential and non-essential), and location (indoor and outdoor). Essential activities include income-related work, household chores, child care, study and other school activities, personal care, and destination-oriented travel. Non-essential activities include sports and active leisure, passive leisure, some travel, and social or civic activities (Shamoo et al., 1991). Table 6-33 shows that inhalation rates were higher outdoors than indoors at slow, medium, and fast activity levels. Also, inhalation rates were higher for outdoor non-essential activities than for indoor non-essential activity levels at slow, medium, and fast self-reported breathing rates (see Table 6-33).

An advantage of this study is that subjective activity diary data can provide exposure modelers with useful rough estimates of VR for groups of generally healthy people. A limitation of this study is its age and that the results obtained show high within-person and between-person variability in VR at each diary-recorded level, indicating that VR estimates from diary reports could potentially be substantially misleading in individual cases. Another limitation of this study is that elevated HR data of slow activity at the second hour of the exercise session reflect persistent effects of exercise and/or heat stress. Therefore, predictions of VR from the VR/HR relationship may be biased.

6.4.5. Linn et al. (1992)—Documentation of Activity Patterns in "High-risk" Groups Exposed to Ozone in the Los Angeles Area

Linn et al. (1992) conducted a study that estimated the inhalation rates for "high-risk" population groups exposed to ozone in their daily activities in the Los Angeles area. The population surveyed consisted of seven subject panels: Panel 1: 20 healthy outdoor workers (15 males, 5 females, ages 19−50 years); Panel 2: 17 healthy elementary school students (5 males, 12 females, ages 10−12 years); Panel 3: 19 healthy high school students (7 males, 12 females, ages 13−17 years); Panel 4: 49 asthmatic adults (clinically mild, moderate, and severe, 15 males, 34 females, ages 18−50 years); Panel 5: 24 asthmatic adults from 2 neighborhoods of contrasting O_3 air quality (10 males, 14 females, ages 19−46 years); Panel 6: 13 young asthmatics (7 males, 6 females, ages 11−16 years); and Panel 7: construction workers (7 males, ages 26−34 years). An initial calibration test was conducted, followed by a training session. Finally, a field study that involved the subjects collecting their own HRs and diary data was conducted. During the calibration tests, VR, breathing rate, and HR were measured simultaneously at each exercise level. From the calibration data, an equation was developed using linear regression analysis to predict VR from measured HR.

In the field study, each subject (except construction workers) recorded in diaries their daily activities, change in locations (indoors, outdoors, or in a vehicle), self-estimated breathing rates during each activity/location, and time spent at each activity/location. Healthy subjects recorded their HR once every 60 seconds using a Heart Watch, an automated system consisting of a transmitter and receiver worn on the body. Asthmatic subjects recorded their diary information once every hour. Subjective breathing rates were defined as slow (walking at their normal pace), medium (faster than normal walking), and fast (running or similarly strenuous exercise). Table 6-34 presents the calibration and field protocols for self-monitoring of activities for each subject panel.

Table 6-35 presents the mean, 99th percentile, and mean VR at each subjective activity level (slow, medium, fast). The mean and 99th percentile VR were derived from all HR recordings that appeared to be valid, without considering the diary data. Each of the three activity levels was determined from both the concurrent diary data and HR recordings by direct calculation or regression. The mean VR for healthy adults was 0.78 m^3/hour, while the mean VR for asthmatic adults was 1.02 m^3/hour (see Table 6-35). The preliminary data for construction workers indicated that during a 10-hour work shift, their mean VR (1.50 m^3/hour) exceeded the VRs of all other subject panels (see Table 6-35). The authors reported that the diary data showed that on a typical day, most individuals spent most of their time indoors at slow activity level. During slow activity, asthmatic subjects had higher VRs than healthy subjects (see Table 6-35). The authors also reported that in every panel, the predicted VR correlated significantly with the subjective estimates of activity levels.

A limitation of this study is that calibration data may overestimate the predictive power of HR during actual field monitoring. The wide variety of exercises in everyday activities may result in greater variation of the VR-HR relationship than was calibrated. Another limitation is the small sample size of each population surveyed. An advantage of this study is that diary data can provide rough estimates of ventilation patterns, which are useful in exposure assessments. Another advantage is that inhalation rates were presented for various populations (i.e., healthy outdoor adult workers, healthy children, asthmatics, and construction workers).

6.4.6. Shamoo et al. (1992)—Effectiveness of Training Subjects to Estimate Their Level of Ventilation

Shamoo et al. (1992) conducted a study where nine non-sedentary subjects in good health were trained on a treadmill to estimate their own ventilation rates at four activity levels: low, medium, heavy, and very heavy. The purpose of the study was to train the subjects' self-estimation of ventilation in the field and to assess the effectiveness of the training (Shamoo et al., 1992). The subjects included 3 females and 6 males between 21 to 37 years of age. The tests were conducted in four stages. First, an initial treadmill pretest was conducted indoors at various speeds until the four ventilation levels were experienced by each subject; VR was measured and feedback was given to the subjects. Second, two treadmill training sessions, which involved seven 3-minute segments of varying speeds based on initial tests, were conducted; VR was measured and feedback was given to the subjects. Another similar session was conducted; however, the subjects estimated their own ventilation level during the last 20 seconds of each segment and VR was measured during the last minute of each segment. Immediate feedback was given to the subject's estimate; and the third and fourth stages involved 2 outdoor sessions of 3 hours each. Each hour comprised 15 minutes each of rest, slow walking, jogging, and fast walking. The subjects estimated their own ventilation level at the middle of each segment. The subject's estimate was verified by a respirometer, which measured VR in the middle of each 15-minute activity. No feedback was given to the subject. The overall percent correct score obtained for all ventilation levels was 68% (Shamoo et al., 1992). Therefore, Shamoo et al. (1992) concluded that this training protocol was effective in training subjects to correctly estimate their minute ventilation levels.

For this handbook, inhalation rates were analyzed from the raw data provided by Shamoo et al. (1992). Table 6-36 presents the mean inhalation rates obtained from this analysis at four ventilation levels in two microenvironments (i.e., indoors and outdoors) for all subjects. The mean inhalation rates for all subjects were 0.93, 1.92, 3.01, and 4.80 m^3/hour for low, medium, heavy, and very heavy activities, respectively.

Limitations of this study are its age and the population sample size used in this study was small and was not selected to represent the general U.S. population. The training approach employed may not be cost effective because it was labor intensive; therefore, this approach may not be viable in field studies especially for field studies within large sample sizes.

6.4.7. Spier et al. (1992)—Activity Patterns in Elementary and High School Students Exposed to Oxidant Pollution

Spier et al. (1992) investigated the activity patterns of 17 elementary school students (10−12 years old) and 19 high school students

(13−17 years old) in suburban Los Angeles from late September to October (oxidant pollution season). Calibration tests were conducted in supervised outdoor exercise sessions. The exercise sessions consisted of 5 minutes each of rest, slow walking, jogging, and fast walking. HR and VR were measured during the last 2 minutes of each exercise. Individual VR and HR relationships for each individual were determined by fitting a regression line to HR values and log VR values. Each subject recorded their daily activities, changes in location, and breathing rates in diaries for 3 consecutive days. Self-estimated breathing rates were recorded as slow (slow walking), medium (walking faster than normal), and fast (running). HR was recorded once per minute during the 3 days using a Heart Watch. VR values for each self-estimated breathing rate and activity type were estimated from the HR recordings by employing the VR and HR equation obtained from the calibration tests.

The data shown in Table 6-37 represent HR distribution patterns and corresponding predicted VR for each age group during hours spent awake. At the same self-reported activity levels for both age groups, inhalation rates were higher for outdoor activities than for indoor activities. The total number of hours spent indoors was higher for high school students (21.2 hours) than for elementary school students (19.6 hours). The converse was true for outdoor activities: 2.7 hours for high school students and 4.4 hours for elementary school students (see Table 6-38). Table 6-39 describes the distribution patterns of daily inhalation rates for elementary and high school students grouped by activity level.

A limitation of this study is the small sample size. The results may not be representative of all children in these age groups. Another limitation is that the accuracy of the self-estimated breathing rates reported by younger age groups is uncertain. This may affect the validity of the data set generated. An advantage of this study is that inhalation rates were determined for children and adolescents.

6.4.8. Adams (1993)—Measurement of Breathing Rate and Volume in Routinely Performed Daily Activities, Final Report

Adams (1993) conducted research to accomplish two main objectives: (1) identification of mean and ranges of inhalation rates for various age/sex cohorts and specific activities, and (2) derivation of simple linear and multiple regression equations that could be used to predict inhalation rates through other measured variables: breathing frequency (f_B) and oxygen consumption. A total of 160 subjects participated in the primary study. There were four age-dependent groups: (1) children 6 to 12.9 years old, (2) adolescents between 13 and 18.9 years old, (3) adults between 19 and 59.9 years old, and (4) seniors >60 years old (Adams, 1993). An additional 40 children from 6 to 12.9 years old and 12 young children from 3 to 5.9 years old were identified as subjects for pilot testing purposes.

Resting protocols conducted in the laboratory for all age groups consisted of three phases (25 minutes each) of lying, sitting, and standing. The phases were categorized as resting and sedentary activities. Two active protocols—moderate (walking) and heavy (jogging/running) phases—were performed on a treadmill over a progressive continuum of intensity levels made up of 6-minute intervals at three speeds ranging from slow to moderately fast. All protocols involved measuring VR, HR, f_B, and VO_2. Measurements were taken in the last 5 minutes of each phase of the resting protocol and the last 3 minutes of the 6-minute intervals at each speed designated in the active protocols.

In the field, all children completed spontaneous play protocols. The older adolescent population (16 to 18 years) completed car driving and riding, car maintenance (males), and housework (females) protocols. All adult females (19 to 60 years) and most of the senior (60 to 77 years) females completed housework, yardwork, and car driving and riding protocols. Adult and senior males completed car driving and riding, yardwork, and mowing protocols. HR, VR, and f_B were measured during each protocol. Most protocols were conducted for 30 minutes. All the active field protocols were conducted twice.

During all activities in either the laboratory or field protocols, VR for the children's group revealed no significant sex differences, but those for the adult groups demonstrated sex differences. Therefore, inhalation rate (IR) data presented in Tables 6-40 and 6-41 were categorized as young children, children (no sex), and adult female, and adult male, and adult combined by activity type (lying, sitting, standing, walking, and running). These categorized data from Tables 6-40 and 6-41 are summarized as inhalation rates in Tables 6-42 and 6-43. Table 6-42 shows the laboratory protocols. Table 6-43 presents the mean inhalation rates by group and for moderate activity levels in field protocols. A comparison of the data shown in Tables 6-42 and 6-43 suggest that during light and sedentary activities in laboratory and field protocols, similar inhalation rates were obtained for adult females and adult males. Accurate predictions of inhalation rates across all population groups and activity types were obtained by including body SA, HR, and breathing frequency in multiple regression analysis (Adams, 1993). Adams (1993) calculated SA from measured height and body weight using the equation:

$$SA = Height^{(0.725)} \times Weight^{(0.425)} \times 71.84 \quad \text{(Eqn. 6-3)}$$

A limitation associated with this study is that the population does not represent the general U.S. population. Also, the classification of activity types (i.e., laboratory and field protocols) into activity levels may bias the inhalation rates obtained for various age/sex cohorts. Age groups for which data are provided are limited and do not conform to U.S. EPA's recommended age groups for children. The estimated rates were based on short-term data and may not reflect long-term patterns.

6.4.9. Layton (1993)—Metabolically Consistent Breathing Rates for Use in Dose Assessments

Layton (1993) presented a method for estimating metabolically consistent inhalation rates for use in quantitative dose assessments of airborne radionuclides. Generally, the approach for estimating the breathing rate for a specified time frame was to calculate a time-weighted-average of ventilation rates associated with physical activities of varying durations. However, in this study, breathing rates were calculated on the basis of oxygen consumption associated with energy expenditures for short (hours) and long (weeks and months) periods of time, using the following general equation to calculate energy-dependent inhalation rates:

$$V_E = E \times H \times VQ \quad \text{(Eqn. 6-4)}$$

where:

- V_E = ventilation rate (m^3/minute or m^3/day);
- E = energy expenditure rate; [kilojoules/minute (KJ/minute) or megajoules/hour (MJ/hour)];
- H = volume of oxygen (at standard temperature and pressure, dry air consumed in the production of 1 kilojoule [KJ] of energy expended [L/KJ or m^3/MJ]); and
- VQ = ventilatory equivalent (ratio of minute volume [m^3/minute] to oxygen uptake [m^3/minute]) unitless.

Layton (1993) used three approaches to estimate daily chronic (long term) inhalation rates for different age/sex cohorts of the U.S. population using this methodology.

<u>First Approach</u>

Inhalation rates were estimated by multiplying average daily food-energy intakes (EFDs) for different age/sex cohorts, *H*, and VQ, as shown in the equation above. The average food-energy intake data (see Table 6-44) are based on approximately 30,000 individuals and were obtained from the 1977−1978 USDA-NFCS. The food-energy intakes were adjusted upwards by a constant factor of 1.2 for all individuals 9 years and older. This factor compensated for a consistent bias in USDA-NFCS that was attributed to under-reporting of the foods consumed or the methods used to ascertain dietary intakes. Layton (1993) used a weighted average oxygen uptake of 0.05 L O_2/KJ, which was determined from data reported in the 1977−1978 USDA-NFCS and the second NHANES (NHANES II). The survey sample for NHANES II was approximately 20,000 participants. A VQ of 27 used in the calculations was calculated as the geometric mean of VQ data that were obtained from several studies.

The inhalation rate estimation techniques are shown in the footnotes in Table 6-45. Table 6-46 presents the daily inhalation rate for each age/sex cohort. As shown in Table 6-45, the highest daily inhalation rates were 10 m^3/day for children between the ages of 6 and 8 years, 17 m^3/day for males between 15 and 18 years, and 13 m^3/day for females between 9 and 11 years. Estimated average lifetime inhalation rates for males and females are 14 m^3/day and 10 m^3/day, respectively (see Table 6-45). Inhalation rates were also calculated for active and inactive periods for the various age/sex cohorts.

The inhalation rate for inactive periods was estimated by multiplying the BMR times *H* times VQ. BMR was defined as "the minimum amount of energy required to support basic cellular respiration while at rest and not actively digesting food" (Layton, 1993). The inhalation rate for active periods was calculated by multiplying the inactive inhalation rate by the ratio of the rate of energy expenditure during active hours to the estimated BMR. This ratio is presented as *F* in Table 6-45. Table 6-45 also presents these data for active and inactive inhalation rates. For children, inactive and active inhalation rates ranged from 2.35 to 5.95 m^3/day and from 6.35 to 13.09 m^3/day, respectively. For adult males (19 to

64 years old), the average inactive and active inhalation rates were approximately 10 and 19 m^3/day, respectively. Also, the average inactive and active inhalation rates for adult females (19 to 64 years old) were approximately 8 and 12 m^3/day, respectively.

Second Approach

Inhalation rates were calculated as the product of the BMR of the population cohorts, the ratio of total daily energy expenditure to daily BMR, *H*, and VQ. The BMR data obtained from the literature were statistically analyzed, and regression equations were developed to predict BMR from body weights of various age/sex cohorts. Table 6-46 presents the statistical data used to develop the regression equations. Table 6-47 presents the data obtained from the second approach. Inhalation rates for children (6 months−10 years) ranged from 7.3−9.3 m^3/day for male and 5.6−8.6 m^3/day for female children; for older children (10−18 years), inhalation rates were 15 m^3/day for males and 12 m^3/day for females. Adult females (18 years and older) ranged from 9.9−11 m^3/day and adult males (18 years and older) ranged from 13−17 m^3/day. These rates are similar to the daily inhalation rates obtained using the first approach. Also, the inactive inhalation rates obtained from the first approach are lower than the inhalation rates obtained using the second approach. This may be attributed to the BMR multiplier employed in the equation of the second approach to calculate inhalation rates.

Third Approach

Inhalation rates were calculated by multiplying estimated energy expenditures associated with different levels of physical activity engaged in over the course of an average day by VQ and *H* for each age/sex cohort. The energy expenditure associated with each level of activity was estimated by multiplying BMRs of each activity level by the MET and by the time spent per day performing each activity for each age/sex population. The time-activity data used in this approach were obtained from a survey conducted by Sallis et al. (1985) (Layton, 1993). In that survey, the physical-activity categories and associated MET values used were sleep, MET = 1; light-activity, MET = 1.5; moderate activity, MET = 4; hard activity, MET = 6; and very hard activity, MET = 10. The physical activities were based on recall by the test subject (Layton, 1993). The survey sample was 2,126 individuals (1,120 women and 1,006 men) ages 20−74 years that were randomly selected from four communities in California. The body weights were obtained from a study conducted by Najjar and Rowland (1987) that randomly sampled individuals from the U.S. population (Layton, 1993). Table 6-48 presents the daily inhalation rates (V_E) in m^3/day and m^3/hour for adult males and females aged 20−74 years at five physical activity levels. The total daily inhalation rates ranged from 13−17 m^3/day for adult males and 11−15 m^3/day for adult females.

The rates for adult females were higher when compared with the other two approaches. Layton (1993) reported that the estimated inhalation rates obtained from the third approach were particularly sensitive to the MET value that represented the energy expenditures for light activities. Layton (1993) stated further that in the original time-activity survey (i.e., conducted by Sallis et al. [1985]), time spent performing light activities was not presented. Therefore, the time spent at light activities was estimated by subtracting the total time spent at sleep, moderate, heavy, and very heavy activities from 24 hours (Layton, 1993). The range of inhalation rates for adult females were 9.6−11 m^3/day, 9.9−11 m^3/day, and 11−15 m^3/day, for the first, second, and third approaches, respectively. The inhalation rates for adult males ranged from 13−16 m^3/day for the first approach, and 13−17 m^3/day for the second and third approaches.

Inhalation rates were also obtained for short-term exposures for various age/sex cohorts and five energy-expenditure categories (rest, sedentary, light, moderate, and heavy). BMRs were multiplied by the product of MET, *H*, and VQ. Table 6-49 presents the inhalation-rate data obtained for short-term exposures.

The major strengths of the Layton (1993) study are that it obtains similar results using three different approaches to estimate inhalation rates in different age groups and that the populations are large, consisting of men, women, and children. Explanations for differences in results due to metabolic measurements, reported diet, or activity patterns are supported by observations reported by other investigators in other studies. Major limitations of this study are (1) the estimated activity pattern levels are somewhat subjective; (2) the explanation that activity pattern differences are responsible for the lower level obtained with the metabolic approach (25%) compared to the activity pattern approach is not well supported by the data; and (3) different populations were used in each approach, which may have introduced error.

6.4.10. Linn et al. (1993)—Activity Patterns in Ozone Exposed Construction Workers

Linn et al. (1993) estimated the inhalation rates of 19 construction workers who perform heavy outdoor labor before and during a typical work shift. The workers (laborers, iron workers, and carpenters) were employed at a site on a hospital campus in suburban Los Angeles. The construction site included a new hospital building and a separate medical office complex. The study was conducted between mid-July and early November, 1991. During this period, ozone (O_3) levels were typically high. Initially, each subject was calibrated with a 25-minute exercise test that included slow walking, fast walking, jogging, lifting, and carrying. All calibration tests were conducted in the mornings. VR and HR were measured simultaneously during the test. The data were analyzed using least squares regression to derive an equation for predicting VR at a given HR. Following the calibration tests, each subject recorded the type of activities to be performed during their work shift (i.e., sitting/standing, walking, lifting/carrying, and "working at trade"—defined as tasks specific to the individual's job classification). Location, and self-estimated breathing rates ("slow" similar to slow walking, "medium" similar to fast walking, and "fast" similar to running) were also recorded in the diary. During work, an investigator recorded the diary information dictated by the subjects. HR was recorded minute by minute for each subject before work and during the entire work shift. Thus, VR ranges for each breathing rate and activity category were estimated from the HR recordings by employing the relationship between VR and HR obtained from the calibration tests.

A total of 182 hours of HR recordings were obtained during the survey from the 19 volunteers; 144 hours reflected actual working time according to the diary records. The lowest actual working hours recorded was 6.6 hours, and the highest recorded for a complete work shift was 11.6 hours (Linn et al., 1993). Table 6-50 presents summary statistics for predicted VR distributions for outdoor workers, and for job- or site-defined subgroups. The data reflect all recordings before and during work, and at break times. For all subjects, the mean inhalation rate was 1.68 m^3/hour with a standard deviation of ±0.72 (see Table 6-50). Also, for most subjects, the 1^{st} and 99^{th} percentiles of HR were outside of the calibration range. Therefore, corresponding IR percentiles were extrapolated using the calibration data (Linn et al., 1993).

The data shown in Table 6-51 represent distribution patterns of mean inhalation rate for each subject, total subjects, and job- or site-defined subgroups by self-estimated breathing rates (slow, medium, or fast) or by type of job activity. All data include working and non-working hours. The mean inhalation rates for most individuals showed statistically significant increases with higher self-estimated breathing rates or with increasingly strenuous job activity (Linn et al., 1993). Inhalation rates were higher in hospital site workers when compared with office site workers (see Table 6-51). In spite of their higher predicted VR workers at the hospital site reported a higher percentage of slow breathing time (31%) than workers at the office site (20%), and a lower percentage of fast breathing time, 3% and 5%, respectively (Linn et al., 1993). Therefore, individuals whose work was objectively heavier than average (from VR predictions) tended to describe their work as lighter than average (Linn et al., 1993). Linn et al. (1993) also concluded that during an O_3 pollution episode, construction workers should experience similar microenvironmental O_3 exposure concentrations as other healthy outdoor workers, but with approximately twice as high a VR. Therefore, the inhaled dose of O_3 should be almost two times higher for typical heavy-construction workers than for typical healthy adults performing less strenuous outdoor jobs.

Limitations associated with this study are its age and the small sample size. Another limitation of this study is that calibration data were not obtained at extreme conditions. Therefore, it was necessary to predict inhalation rate values that were outside the calibration range. This may introduce an unknown amount of uncertainty to the data set. Subjective self-estimated breathing rates may be another source of uncertainty in the inhalation rates estimated. An advantage is that this study provides empirical data useful in exposure assessments for a population thought to be the most highly exposed common occupational group (outdoor workers).

6.4.11. Rusconi et al. (1994)—Reference Values for Respiratory Rate in the First 3 Years of Life

Rusconi et al. (1994) examined a large number of infants and children in Milano, Italy, in order to determine the reference values for respiratory rate in children aged 15 days to 3 years. A total of 618 infants and children (336 males and 282 females), who did not have respiratory infections or any severe disease, were included in the study. Of the 618, a total of 309 were in good health and were observed in daycare centers, while the remaining 309 were seen in hospitals or as outpatients.

Respiratory rates were recorded twice, 30 to 60 minutes apart, listening to breath sounds for 60 seconds with a stethoscope, when the child was awake and calm and when the child was sleeping quietly (sleep not associated with any spontaneous movement, including eye movements or vocalizations) (see Table 6-52). The children were assessed for 1 year in order to determine the repeatability of the recordings, to compare respiratory rate counts obtained by stethoscope and by observation, and to construct reference percentile curves by age in a large number of subjects.

The authors plotted the differences between respiratory rate counts determined by stethoscope at 30- to 60-minute intervals against their mean count in waking and sleeping subjects. The standard deviation of the differences between the two counts was 2.5 and 1.7 breaths/minute, respectively, for waking and sleeping children. This standard deviation yielded 95% repeatability coefficients of 4.9 breaths/minute when the infants and children were awake and 3.3 breaths/minute when they were asleep.

In both waking and sleeping states, the respiratory rate counts determined by stethoscope were found to be higher than those obtained by observation. The mean difference was 2.6 and 1.8 breaths per minute, respectively, in waking and sleeping states. The mean respiratory rate counts were significantly higher in infants and children at all ages when awake and calm than when asleep. A decrease in respiratory rate with increasing age was seen in waking and sleeping infants and children. A scatter diagram of respiratory rate counts by age in waking and sleeping subjects showed that the pattern of respiratory rate decline with age was similar in both states, but it was much faster in the first few months of life. The authors constructed centile curves by first log-transforming the data and then applying a second degree polynormal curve, which allowed excellent fitting to observed data. Figures 6-1 and 6-2 show smoothed percentiles by age in waking and sleeping subjects, respectively. The variability of respiratory rate among subjects was higher in the first few months of life, which may be attributable to biological events that occur during these months, such as maturation of the neurologic control of breathing and changes in lung and chest wall compliance and lung volumes.

An advantage of this study is that it provides distribution data for respiratory rate for children from infancy (less than 2 months) to 36 months old. The main limitation of this study is that data are provided in breaths/minute for awake and asleep subjects. Activity pattern data for the awake subjects are limited, which prevents characterization of breathing rates for various levels of exertion. These data are not U.S. data; U.S. distributions were not available. Although, there is no reason to believe that the respiratory rates for Italian children would be different from that of U.S. children, this study only provided data for a narrow range of activities.

6.4.12. Price et al. (2003)—Modeling Interindividual Variation in Physiological Factors Used in PBPK Models of Humans

Price et al. (2003) developed a database of values for physiological parameters often used in physiologically based pharmacokinetic (PBPK) models. The database consisted of approximately 31,000 records containing information on volumes and masses of selected organs and tissues, blood flows for the organ and tissues, and total resting cardiac output and average inhalation rates. Records were created based on data from the NHANES III survey.

The study authors note that the database provides a source of data for human physiological parameters where the parameter values for an individual are correlated with one another and capture interindividual variation in populations of a specific sex, race, and age range. A publicly available computer program, Physiological Parameters for PBPK Modeling, was also developed to randomly retrieve records from the database for groups of individuals of specified age ranges, sex, and ethnicities (The Lifeline Group, 2007). Price et al. (2003) recommends that output sets be used as inputs to Monte Carlo-based PBPK models of interindividual variation in dose. A limitation of this study is that these data have not been validated against actual physiological data. Ideally, the database records would have been obtained from detailed physiological analyses of individuals, however, such a survey was not conducted for this study.

6.4.13. Brochu et al. (2006b)—Physiological Daily Inhalation Rates for Free-Living Pregnant and Lactating Adolescents and Women Aged 11 to 55 Years, Using Data from Doubly Labeled Water Measurements for Use in Health Risk Assessment

PDIRs were determined by Brochu et al. (2006b) for underweight, normal-weight, and overweight/obese pregnant and lactating females aged 11 to 55 years using published data on total daily energy expenditures, and energy costs for growth, pregnancy and lactation (breast-energy output and maternal milk-energy synthesis) in free-living females. These data were obtained using the DLW methodology in which disappearance rates of predetermined doses of DLW (^2H_2O and $H_2{}^{18}O$) in urine from non-pregnant and non-lactating females (N = 357) and normal-weight males (N = 131) as well as saliva from gravid and breast-feeding females (N = 91) were monitored by gas-isotope-ratio mass spectrometry.

PDIRs were calculated for underweight, normal-weight, and overweight/obese females aged 11 to 55 years in pre-pregnancy, at Weeks 9, 22, and 36 during pregnancy, and Weeks 6 and 27 postpartum. Weight groups were determined by BMI cutoffs settled by the Institute of Medicine for pre-pregnant females. Underweight, normal-weight, and overweight/obese individuals were defined as those having BMIs lower than 19.8 kg/m^2, between 19.8 and 26 kg/m^2, and greater than 26 kg/m^2, respectively. Parameters used for breast-energy output and the extra energy cost for milk synthesis were 539.29 ± 106.26 kcal/day and 107.86 ± 21.25 kcal/day, respectively. Monte Carlo simulations were necessary to integrate total daily energy requirements of non-pregnant and non-lactating females into energy costs and weight changes at the 9th, 22nd, and 36th weeks of pregnancy and at the 6th and 27th postpartum weeks. A total of 108 sets of 5,000 energetic data were run, resulting in a simulation of 540,000 data, pertaining to 45,000 simulated subjects. Means, standard deviations, and percentiles of energetic values in kcal/day and kcal/kg-day for males and females were converted into PDIRs in m^3/day and m^3/kg-day by using the equation developed by Layton (1993).

Tables 6-53, 6-54, and 6-55 present the distribution of physiological daily inhalation rate percentiles in m^3/day for underweight, normal-weight, and overweight/obese females, respectively, during pregnancy and postpartum weeks. Tables 6-56, 6-57, and 6-58 present physiological daily inhalation rate percentiles in m^3/kg-day for the same categories. PDIRs for under-, normal-, and overweight/obese pregnant and lactating females were higher than those for males reported in Brochu et al. (2006a). In normal-weight subjects, inhalation rates are higher by 18 to 41% throughout pregnancy and 23 to 39% during postpartum weeks: actual values were higher in females by 1.13 to 2.01 m^3/day at the 9th week of pregnancy, 3.74 to 4.53 m^3/day at the 22nd week, and 4.41 to 5.20 m^3/day at the 36th week, and by 4.43 to 5.30 m^3/day at the 6th postpartum week and 4.22 to 5.11 m^3/day at the 27th postpartum week. The highest 99th percentiles were found to be 0.622 m^3/kg-day in pregnant females and 0.647 m^3/kg-day in lactating females. By comparison, the highest 99th percentile value for individuals aged 2.6 months to 96 years was determined to be 0.725 m^3/kg-day (Brochu et al., 2006a). The authors concluded that air quality criteria and standard calculations based on the latter value for non-carcinogenic toxic compounds should, therefore, be protective for virtually all pregnant and lactating females. Brochu et al. (2006b) also noted that the default assumption used by IRIS to derive HECs (total respiratory tract surface of an adult human male of 54.3 m^2 is exposed to a total daily air intake of 20 m^3) would underestimate exposures to pregnant or lactating females since approximately one pregnant or lactating female out of two is exposed to a total daily air intake of 20 m^3 up to the highest 99th percentile of 47.3 m^3.

An advantage of this study is that it includes pregnant and lactating females, and that data are provided for adolescents aged 11 years and older. A limitation of this study is that the study population was partially drawn from Canada and may not represent the general U.S. population. Also, age groups for adolescents for which data are provided do not conform to U.S. EPA's recommended age groups for children.

6.4.14. Allan et al. (2009)—Inhalation Rates for Risk Assessments Involving Construction Workers in Canada

Allan et al. (2009) generated probability density distributions by performing a Monte Carlo simulation to describe inhalation rates for Canadian male and female construction workers. Construction workers in this study were those involved in the construction or physical maintenance of buildings, structures, or other facilities, and their ages ranged from 16 to 65 years. Information regarding activity patterns and/or inhalation rates was obtained from published literature and used to estimate male construction workers' hourly inhalation rates. Female construction worker inhalation rates were estimated using the ratio of general public female-to-male inhalation rates and male construction workers' hourly inhalation rates. Published energy expenditure and inhalation rates were compared by occupation within the construction industry, and these data were used to develop trade-specific scaling factors. All inhalation rates were developed as probability density functions through Monte Carlo simulation. Ten thousand iterations of random sampling were performed, and at the end of the simulation, the results for all 10,000 iterations were summarized into frequency histograms. The mean, standard deviation, and percentiles were calculated based on the frequency counts.

Inhalation rates for male construction workers were represented by a log normal distribution, with a mean rate of 1.40 ± 0.51 m^3/hour. Hourly inhalation rates for female construction workers were scaled down from those of their male counterparts, based on relative awake-time inhalation rates for men and women in the general public. Inhalation rates for female construction workers were also represented by a log normal distribution, with a mean rate of 1.25 ± 0.66 m^3/hour. Construction trade-specific scaling factors were developed and ranged from 0.78 for electricians to 1.11 for ironworkers.

An advantage of this study is that it provides estimated inhalation rates for a population of construction workers. A limitation of this study is that the construction workers in this study were solely male construction workers; no females were among the cohorts monitored.

6.5. REFERENCES FOR CHAPTER 6

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Table 6-4. Distribution Percentiles of Physiological Daily Inhalation Rates (PDIRs) (m^3/day) for Free-Living Normal-Weight Males and Females Aged 2.6 Months to 96 Years

Age Group (years)	*N*	Body Weight[a] (kg) Mean ± SD	Physiological Daily Inhalation Rates[b] (m^3/day) Mean ± SD	Percentile[c] 5th	10th	25th	50th	75th	90th	95th	99th
Males											
0.22 to <0.5	32	6.7 ± 1.0	3.38 ± 0.72	2.19	2.46	2.89	3.38	3.87	4.30	4.57	5.06
0.5 to <1	40	8.8 ± 1.1	4.22 ± 0.79	2.92	3.21	3.69	4.22	4.75	5.23	5.51	6.05
1 to <2	35	10.6 ± 1.1	5.12 ± 0.88	3.68	3.99	4.53	5.12	5.71	6.25	6.56	7.16
2 to <5	25	15.3 ± 3.4	7.60 ± 1.28	5.49	5.95	6.73	7.60	8.47	9.25	9.71	10.59
5 to <7	96	19.8 ± 2.1	8.64 ± 1.23	6.61	7.06	7.81	8.64	9.47	10.21	10.66	11.50
7 to <11	38	28.9 ± 5.6	10.59 ± 1.99	7.32	8.04	9.25	10.59	11.94	13.14	13.87	15.22
11 to <23	30	58.6 ± 13.9	17.23 ± 3.67	11.19	12.53	14.75	17.23	19.70	21.93	23.26	25.76
23 to <30	34	70.9 ± 6.5	17.48 ± 2.81	12.86	13.88	15.59	17.48	19.38	21.08	22.11	24.02
30 to <40	41	71.5 ± 6.8	16.88 ± 2.50	12.77	13.68	15.20	16.88	18.57	20.09	21.00	22.70
40 to <65	33	71.1 ± 7.2	16.24 ± 2.67	11.84	12.81	14.44	16.24	18.04	19.67	20.64	22.46
65 to ≤96	50	68.9 ± 6.7	12.96 ± 2.48	8.89	9.79	11.29	12.96	14.63	16.13	17.03	18.72
Females											
0.22 to <0.5	53	6.5 ± 0.9	3.26 ± 0.66	2.17	2.41	2.81	3.26	3.71	4.11	4.36	4.81
0.5 to <1	63	8.5 ± 1.0	3.96 ± 0.72	2.78	3.05	3.48	3.96	4.45	4.88	5.14	5.63
1 to <2	66	10.6 ± 1.3	4.78 ± 0.96	3.20	3.55	4.13	4.78	5.43	6.01	6.36	7.02
2 to <5	36	14.4 ± 3.0	7.06 ± 1.16	5.15	5.57	6.28	7.06	7.84	8.54	8.97	9.76
5 to <7	102	19.7 ± 2.3	8.22 ± 1.31	6.06	6.54	7.34	8.22	9.11	9.90	10.38	11.27
7 to <11	161	28.3 ± 4.4	9.84 ± 1.69	7.07	7.68	8.70	9.84	10.98	12.00	12.61	13.76
11 to <23	87	50.0 ± 8.9	13.28 ± 2.60	9.00	9.94	11.52	13.28	15.03	16.61	17.56	19.33
23 to <30	68	59.2 ± 6.6	13.67 ± 2.28	9.91	10.74	12.13	13.67	15.21	16.59	17.42	18.98
30 to <40	59	58.7 ± 5.9	13.68 ± 1.76	10.78	11.42	12.49	13.68	14.87	15.94	16.58	17.78
40 to <65	58	58.8 ± 5.1	12.31 ± 2.07	8.91	9.66	10.92	12.31	13.70	14.96	15.71	17.12
65 to ≤96	45	57.2 ± 7.3	9.80 ± 2.17	6.24	7.02	8.34	9.80	11.27	12.58	13.37	14.85

[a] Measured body weight. Normal-weight individuals defined according to the BMI cut-offs.

[b] Physiological daily inhalation rates were calculated using the following equation: $(TDEE + ECG) \times H \times (V_E/VO_2) \times 10^{-3}$, where $H = 0.21$ L of O_2/Kcal, $V_E/VO_2 = 27$ (Layton, 1993) and ECG = stored daily energy cost for growth (kcal/day).

[c] Percentiles based on a normal distribution assumption for age groups.

N = Number of individuals.
SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-5. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Free-Living Normal-Weight Males, Females, and Males and Females Combined

Age Group[a, b]	*N*	Mean[c]	95th, c
Males			
1 to <3 months	32	3.38	4.57
3 to <6 months	32	3.38	4.57
6 to <12 months	40	4.22	5.51
Birth to <1 year	72	3.85	5.09
1 to <2 years	35	5.12	6.56
2 to <3 years	25	7.60	9.71
3 to <6 years	25	7.60	9.71
6 to <11 years	38	10.59	13.87
11 to <16 years	30	17.23	23.26
16 to <21 years	30	17.23	23.26
21 to <31 years	64	17.36	22.65
31 to <41 years	41	16.88	21.00
41 to <51 years	33	16.24	20.64
51 to <61 years	33	16.24	20.64
61 to <71 years	83	14.26	18.47
71 to <81 years	50	12.96	17.03
≥81 years	50	12.96	17.03
Females			
1 to <3 months	53	3.26	4.36
3 to <6 months	53	3.26	4.36
6 to <12 months	63	3.96	5.14
Birth to <1 year	116	3.64	4.78
1 to <2 years	66	4.78	6.36
2 to <3 years	36	7.06	8.97
3 to <6 years	36	7.06	8.97
6 to <11 years	161	9.84	12.61
11 to <16 years	87	13.28	17.56
16 to <21 years	87	13.28	17.56
21 to <31 years	155	13.45	17.50
31 to <41 years	59	13.68	16.58
41 to <51 years	58	12.31	15.71
51 to <61 years	58	12.31	15.71
61 to <71 years	103	11.21	14.69
71 to <81 years	45	9.80	13.37
≥81 years	45	9.80	13.37

Table 6-5. Mean and 95th Percentile Inhalation Rate Values (m³/day) for Free-Living Normal-Weight Males, Females, and Males and Females Combined (continued)

Age Group[a,b]	*N*	Mean[c]	95[th,c]
Males and Females Combined			
1 to <3 months	85	3.31	4.44
3 to <6 months	85	3.31	4.44
6 to <12 months	103	4.06	5.28
Birth to <1 years	188	3.72	4.90
1 to <2 years	101	4.90	6.43
2 to <3 years	61	7.28	9.27
3 to <6 years	61	7.28	9.27
6 to <11 years	199	9.98	12.85
11 to <16 years	117	14.29	19.02
16 to <21 years	117	14.29	19.02
21 to <31 years	219	14.59	19.00
31 to <41 years	100	14.99	18.39
41 to <51 years	91	13.74	17.50
51 to <61 years	91	13.74	17.50
61 to <71 years	186	12.57	16.37
71 to <81 years	95	11.46	15.30
≥81 years	95	11.46	15.30

[a] No other age groups from Table 6-4 (Brochu et al., 2006a) fit into the U.S. EPA age groupings.
[b] See Table 6-25 for concordance with U.S. EPA age groupings.
[c] Weighted (where possible) average of reported study means and 95th percentiles.

N = Number of individuals.

Source: Brochu et al., 2006a.

Table 6-6. Distribution Percentiles of Physiological Daily Inhalation Rates (PDIRs) (m^3/day) for Free-Living Normal-Weight and Overweight/Obese Males and Females Aged 4 to 96 Years

Age Group (years)	*N*	Body Weight[a] (kg) Mean ± SD	Physiological Daily Inhalation Rates[b] (m^3/day)								
			Mean ± SD	Percentile[c]							
				5th	10th	25th	50th	75th	90th	95th	99th
Males—Normal-weight											
4 to <5.1	77	19.0 ± 1.9	7.90 ± 0.97	6.31	6.66	7.25	7.90	8.56	9.15	9.50	10.16
5.1 to <9.1	52	22.6 ± 3.5	9.14 ± 1.44	6.77	7.29	8.17	9.14	10.11	10.99	11.51	12.49
9.1 to <18.1	36	41.4 ± 12.1	13.69 ± 3.95	7.19	8.63	11.02	13.69	16.35	18.75	20.19	22.88
18.1 to <40.1	98	71.3 ± 6.1	17.41± 2.70	12.96	13.94	15.58	17.41	19.23	20.87	21.85	23.69
40.1 to <70.1	34	70.0 ± 7.8	15.60 ± 2.89	10.85	11.89	13.65	15.60	17.54	19.30	20.34	22.31
70.1 to ≤96	38	68.9 ± 6.8	12.69 ± 2.33	8.85	9.70	11.11	12.69	14.26	15.68	16.53	18.12
Males—Overweight/obese											
4 to <5.1	54	26.5 ± 4.9	9.59 ± 1.26	7.52	7.98	8.74	9.59	10.44	11.21	11.66	12.52
5.1 to <9.1	40	32.5 ± 9.2	10.88 ± 2.49	6.78	7.69	9.20	10.88	12.56	14.07	14.98	16.68
9.1 to <18.1	33	55.8 ± 10.8	14.52 ± 1.98	11.25	11.98	13.18	14.52	15.85	17.06	17.78	19.13
18.1 to <40.1	52	98.1 ± 25.2	20.39 ± 3.62	14.44	15.75	17.95	20.39	22.83	25.03	26.35	28.81
40.1 to <70.1	81	93.2 ± 14.9	17.96 ± 3.71	11.85	13.20	15.45	17.96	20.46	22.71	24.06	26.59
70.1 to ≤96	32	82.3 ± 10.3	14.23 ± 2.94	9.40	10.46	12.25	14.23	16.21	18.00	19.06	21.07
Females—Normal-weight											
4 to <5.1	82	18.7 ± 2.0	7.41 ± 0.91	5.92	6.25	6.80	7.41	8.02	8.57	8.90	9.52
5.1 to <9.1	151	25.5 ± 4.1	9.39 ± 1.62	6.72	7.31	8.30	9.39	10.48	11.47	12.05	13.16
9.1 to <18.1	124	42.7 ± 11.1	12.04 ± 2.86	7.34	8.38	10.11	12.04	13.97	15.70	16.74	18.68
18.1 to <40.1	135	59.1 ± 6.3	13.73 ± 2.01	10.41	11.15	12.37	13.73	15.09	16.31	17.04	18.41
40.1 to <70.1	79	59.1 ± 5.3	11.93 ± 2.16	8.38	9.16	10.47	11.93	13.38	14.69	15.48	16.95
70.1 to ≤96	24	54.8 ± 7.5	8.87 ± 1.79	5.92	6.57	7.66	8.87	10.07	11.16	11.81	13.03
Females—Overweight/obese											
4 to <5.1	56	26.1 ± 5.5	8.70 ± 1.13	6.84	7.26	7.94	8.70	9.47	10.15	10.56	11.33
5.1 to <9.1	68	34.6 ± 9.9	10.55 ± 2.23	6.88	7.69	9.05	10.55	12.06	13.41	14.22	15.75
9.1 to <18.1	68	59.2 ± 12.8	14.27 ± 2.70	9.83	10.81	12.45	14.27	16.09	17.73	18.71	20.55
18.1 to <40.1	76	84.4 ± 16.3	15.66 ± 2.11	12.18	12.95	14.23	15.66	17.08	18.36	19.13	20.57
40.1 to <70.1	91	81.7 ± 17.2	13.01 ± 2.82	8.37	9.40	11.11	13.01	14.91	16.62	17.64	19.56
70.1 to ≤96	28	69.0 ± 7.8	10.00 ± 1.78	7.07	7.71	8.80	10.00	11.20	12.28	12.93	14.14

[a] Measured body weight. Normal-weight and overweight/obese males defined according to the BMI cut-offs.
[b] Physiological daily inhalation rates were calculated using the following equation: $(TDEE + ECG) \times H \times (V_E/VO_2) \times 10^{-3}$, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), *TDEE* = total daily energy expenditure (kcal/day) and *ECG* = stored daily energy cost for growth (kcal/day).
[c] Percentiles based on a normal distribution assumption for age groups.

N = Number of individuals.
SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-7. Distribution Percentiles of Physiological Daily Inhalation Rates (PDIRs) per Unit of Body Weight (m^3/kg-day) for Free-Living Normal-Weight Males and Females Aged 2.6 Months to 96 Years

Age Group (years)	Physiological Daily Inhalation Rates[a] (m^3/kg-day)								
		Percentile[b]							
	Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
Males									
0.22 to <0.5	0.51 ± 0.09	0.36	0.39	0.45	0.51	0.57	0.63	0.66	0.73
0.5 to <1	0.48 ± 0.07	0.36	0.39	0.43	0.48	0.53	0.57	0.60	0.64
1 to <2	0.48 ± 0.06	0.38	0.41	0.44	0.48	0.52	0.56	0.58	0.62
2 to <5	0.44 ± 0.04	0.38	0.39	0.42	0.44	0.47	0.50	0.51	0.54
5 to <7	0.42 ± 0.05	0.34	0.35	0.38	0.42	0.45	0.48	0.49	0.52
7 to <11	0.37 ± 0.06	0.27	0.29	0.33	0.37	0.41	0.45	0.47	0.52
11 to <23	0.30 ± 0.05	0.22	0.24	0.27	0.30	0.33	0.36	0.38	0.41
23 to <30	0.25 ± 0.04	0.18	0.20	0.22	0.25	0.27	0.30	0.31	0.34
30 to <40	0.24 ± 0.03	0.18	0.19	0.21	0.24	0.26	0.28	0.29	0.32
40 to <65	0.23 ± 0.04	0.16	0.18	0.20	0.23	0.26	0.28	0.30	0.33
65 to ≤96	0.19 ± 0.03	0.14	0.15	0.17	0.19	0.21	0.23	0.24	0.26
Females									
0.22 to <0.5	0.50 ± 0.09	0.35	0.39	0.44	0.50	0.57	0.62	0.66	0.72
0.5 to <1	0.46 ± 0.06	0.36	0.38	0.42	0.46	0.51	0.55	0.57	0.61
1 to <2	0.45 ± 0.08	0.33	0.35	0.40	0.45	0.50	0.55	0.58	0.63
2 to <5	0.44 ± 0.07	0.32	0.35	0.39	0.44	0.49	0.53	0.56	0.61
5 to <7	0.40 ± 0.05	0.32	0.33	0.36	0.40	0.43	0.46	0.47	0.51
7 to <11	0.35 ± 0.06	0.25	0.27	0.31	0.35	0.39	0.43	0.45	0.50
11 to <23	0.27 ± 0.05	0.19	0.21	0.24	0.27	0.30	0.33	0.35	0.38
23 to <30	0.23 ± 0.04	0.16	0.18	0.20	0.23	0.26	0.29	0.30	0.33
30 to <40	0.24 ± 0.04	0.18	0.19	0.21	0.24	0.26	0.28	0.29	0.32
40 to <65	0.21 ± 0.04	0.15	0.16	0.19	0.21	0.24	0.26	0.27	0.30
65 to ≤96	0.17 ± 0.04	0.11	0.13	0.15	0.17	0.20	0.22	0.23	0.26

a Physiological daily inhalation rates were calculated using the following equation: $(TDEE + ECG) \times H \times (V_E/VO_2) \times 10^{-3}$, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), *TDEE* = total daily energy expenditure (kcal/day) and *ECG* = stored daily energy cost for growth (kcal/day).

b Percentiles based on a normal distribution assumption for age groups.

SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-8. Distribution Percentiles of Physiological Daily Inhalation Rates (PDIRs) (m^3/kg-day) for Free-Living Normal-Weight and Overweight/Obese Males and Females Aged 4 to 96 Years

Age Group (years)	Physiological Daily Inhalation Rates[a] (m^3/kg-day)								
	Mean ± SD	Percentile[b] 5th	10th	25th	50th	75th	90th	95th	99th
Males—Normal-weight									
4 to <5.1	0.42 ± 0.04	0.35	0.36	0.39	0.42	0.45	0.47	0.49	0.52
5.1 to <9.1	0.41 ± 0.06	0.31	0.34	0.37	0.41	0.45	0.48	0.50	0.54
9.1 to <18.1	0.33 ± 0.05	0.26	0.27	0.30	0.33	0.37	0.40	0.41	0.45
18.1 to <40.1	0.25± 0.04	0.18	0.20	0.22	0.25	0.27	0.29	0.31	0.33
40.1 to <70.1	0.22 ± 0.04	0.16	0.17	0.20	0.22	0.25	0.28	0.29	0.32
70.1 to ≤96	0.19 ± 0.03	0.13	0.14	0.16	0.19	0.21	0.23	0.24	0.26
Males—Overweight/obese									
4 to <5.1	0.37 ± 0.04	0.30	0.31	0.34	0.37	0.40	0.42	0.44	0.47
5.1 to <9.1	0.35 ± 0.08	0.22	0.25	0.29	0.35	0.40	0.45	0.47	0.53
9.1 to <18.1	0.27 ± 0.04	0.20	0.22	0.24	0.27	0.29	0.32	0.33	0.36
18.1 to <40.1	0.21 ± 0.04	0.15	0.17	0.19	0.21	0.22	0.26	0.27	0.30
40.1 to <70.1	0.19 ± 0.03	0.14	0.15	0.17	0.19	0.22	0.24	0.25	0.28
70.1 to ≤96	0.17 ± 0.03	0.12	0.13	0.15	0.17	0.19	0.21	0.22	0.24
Females—Normal-weight									
4 to <5.1	0.40 ± 0.05	0.32	0.34	0.37	0.40	0.43	0.46	0.48	0.51
5.1 to <9.1	0.37 ± 0.06	0.27	0.29	0.33	0.37	0.41	0.45	0.47	0.52
9.1 to <18.1	0.29 ± 0.06	0.20	0.22	0.25	0.29	0.33	0.36	0.38	0.42
18.1 to <40.1	0.23 ± 0.04	0.17	0.19	0.21	0.23	0.26	0.28	0. 30	0.32
40.1 to <70.1	0.20 ± 0.04	0.14	0.15	0.18	0.20	0.23	0.25	0.27	0.29
70.1 to ≤96	0.16 ± 0.04	0.11	0.12	0.14	0.16	0.19	0.20	0.22	0.24
Females—Overweight/obese									
4 to <5.1	0.34 ± 0.04	0.27	0.28	0.31	0.34	0.37	0.40	0.41	0.44
5.1 to <9.1	0.32 ± 0.07	0.21	0.23	0.27	0.32	0.36	0.40	0.43	0.47
9.1 to <18.1	0.25 ± 0.05	0.17	0.18	0.21	0.25	0.28	0.31	0.33	0.36
18.1 to <40.1	0.19 ± 0.03	0.14	0.15	0.17	0.19	0.21	0.22	0.23	0.25
40.1 to <70.1	0.16 ± 0.03	0.11	0.12	0.14	0.16	0.18	0.20	0.21	0.23
70.1 to ≤96	0.15 ± 0.03	0.10	0.11	0.13	0.15	0.16	0.18	0.19	0.21

[a] Physiological daily inhalation rates were calculated using the following equation: ($TDEE + ECG$) × H × (V_E/VO_2) × 10^{-3}, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), $TDEE$ = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

[b] Percentiles based on a normal distribution assumption for age groups.

SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-9. Physiological Daily Inhalation Rates (PDIRs) for Newborns Aged 1 Month or Less

Age Group	*N*	Body Weight (kg) Mean ± SD	Physiological Daily Inhalation Rates[a] Mean ± SD (m^3/day)	(m^3/kg-day)
21 days (3 weeks)	13[b,c]	1.2 ± 0.2	0.85 ± 0.17[d]	0.74 ± 0.09[d]
32 days (~1 month)	10[e,f]	4.7 ± 0.7	2.45 ± 0.59[g]	0.53 ± 0.10[g]
33 days (~1 month)	10[b,f]	4.8 ± 0.3	2.99 ± 0.47[g]	0.62 ±0.09[g]

[a] Physiological daily inhalation rates were calculated using the following equation: $(TDEE + ECG) \times H \times (V_E/VO_2) \times 10^{-3}$, where H = 0.21 L of O_2/Kcal, V_E/VO_2 = 27 (Layton, 1993), *TDEE* = total daily energy expenditure (kcal/day) and *ECG* = stored daily energy cost for growth (kcal/day).
[b] Formula-fed infants.
[c] Healthy infants with very low birth weight.
[d] TDEEs based on nutritional balance measurements during 3-day periods.
[e] Breast-fed infants.
[f] Infants evaluated as being clinically healthy and neither underweight or overweight.
[g] TDEEs based on ^2H_2O and $H_2{}^{18}O$ disappearance rates from urine.

N = Number of individuals.
SD = Standard deviation.

Source: Brochu et al., 2006a.

Table 6-10. Non-Normalized Daily Inhalation Rates (m^3/day) Derived Using Layton's (1993) Method and CSFII Energy Intake Data

Age	Sample Size (Non-Weighted)	Mean	SEM	Percentiles 50th	90th	95th	SE of 95th Percentile
Infancy							
0 to 2 months	182	3.63	0.14	3.30	5.44	7.10	0.64
3 to 5 months	294	4.92	0.14	4.56	6.86	7.72	0.48
6 to 8 months	261	6.09	0.15	5.67	8.38	9.76	0.86
9 to 11 months	283	7.41	0.20	6.96	10.21	11.77	-
0 to 11 months	1,020	5.70	0.10	5.32	8.74	9.95	0.55
Children							
1 year	934	8.77	0.08	8.30	12.19	13.79	0.25
2 years	989	9.76	0.10	9.38	13.56	14.81	0.35
3 years	1,644	10.64	0.10	10.28	14.59	16.03	0.27
4 years	1,673	11.40	0.09	11.05	15.53	17.57	0.23
5 years	790	12.07	0.13	11.56	15.72	18.26	0.47
6 years	525	12.25	0.18	11.95	16.34	17.97	0.87
7 years	270	12.86	0.21	12.51	16.96	19.06	1.27
8 years	253	13.05	0.25	12.42	17.46	19.02	1.08
9 years	271	14.93	0.29	14.45	19.68	22.45[a]	1.35
10 years	234	15.37	0.35	15.19	20.87	22.90[a]	1.02
11 years	233	15.49	0.32	15.07	21.04	23.91[a]	1.62
12 years	170	17.59	0.54	17.11	25.07[a]	29.17[a]	1.61
13 years	194	15.87	0.44	14.92	22.81[a]	26.23[a]	1.11
14 years	193	17.87	0.62	15.90	25.75[a]	29.45[a]	4.38
15 years	185	18.55	0.55	17.91	28.11[a]	29.93[a]	1.79
16 years	201	18.34	0.54	17.37	27.56	31.01	2.07
17 years	159	17.98	0.96	15.90	31.42[a]	36.69[a]	-
18 years	135	18.59	0.78	17.34	28.80[a]	35.24[a]	4.24
Adolescent Boys							
9 to 18 years	983	19.27	0.28	17.96	28.78	32.82	1.39
Adolescent Girls							
9 to 18 years	992	14.27	0.22	13.99	21.17	23.30	0.61
U.S. EPA Cancer Guidelines' Age Groups with Greater Weighting							
0 through 1 year	1,954	7.50	0.08	7.19	11.50	12.86	0.17
2 through 15 years	7,624	14.09	0.12	13.13	20.99	23.88	0.50

[a] FASEB/LSRO (1995) convention, adopted by CSFII, denotes a value that might be less statistically reliable than other estimates due to small cell size.
\- Denotes unable to calculate.

SEM = Standard error of the mean.
SE = Standard error.

Source: Arcus-Arth and Blaisdell, 2007.

Table 6-11. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Males and Females Combined

Age Group[a,b]	Sample Size	Mean[c]	95th[th,c]
Birth to <1 month	182	3.63	7.10
1 to <3 months	182	3.63	7.10
3 to <6 months	294	4.92	7.72
6 to <12 months	544	6.78	10.81
Birth to <1 year	1,020	5.70	9.95
1 to <2 years	934	8.77	13.79
2 to <3 years	989	9.76	14.81
3 to <6 years	4,107	11.22	17.09
6 to <11 years	1,553	13.42	19.86
11 to <16 years	975	16.98	27.53
16 to <21 years	495	18.29	33.99

a No other age groups from Table 6-10 (Arcus-Arth and Blaisdell, 2007) fit into the U.S. EPA age groupings.
b See Table 6-25 for concordance with U.S. EPA age groupings.
c Weighted (where possible) average of reported study means and 95th percentiles.

Source: Arcus-Arth and Blaisdell, 2007.

Table 6-12. Summary of Institute of Medicine (IOM) Energy Expenditure Recommendations for Active and Very Active People with Equivalent Inhalation Rates

	Males		Females	
Age (years)	Energy Expenditure (kcal/day)	Inhalation Rate (m^3/day)	Energy Expenditure (kcal/day)	Inhalation Rate (m^3/day)
<1	607	3.4	607	3.4
1	869	4.9	869	4.9
2	1,050	5.9	977	5.5
3	1,485−1,683	8.4−9.5	1,395−1,649	7.9−9.3
4	1,566−1,783	8.8−10.1	1,475−1,750	8.3−9.9
5	1,658−1,894	9.4−10.7	1,557−1,854	8.8−10.5
6	1,742−1,997	9.8−11.3	1,642−1,961	9.3−11.1
7	1,840−2,115	10.4−11.9	1,719−2,058	9.7−11.6
8	1,931−2,225	10.9−12.6	1,810−2,173	10.2−12.3
9	2,043−2,359	11.5−13.3	1,890−2,273	10.7−12.8
10	2,149−2,486	12.1−14.0	1,972−2,376	11.1−13.4
11	2,279−2,640	12.9−14.9	2,071−2,500	11.7−14.1
12	2,428−2,817	13.7−15.9	2,183−2,640	12.3−14.9
13	2,618−3,038	14.8−17.2	2,281−2,762	12.9−15.6
14	2,829−3,283	16.0−18.5	2,334−2,831	13.2−16.0
15	3,013−3,499	17.0−19.8	2,362−2,870	13.3−16.2
16	3,152−3,663	17.8−20.7	2,368−2,883	13.4−16.3
17	3,226−3,754	18.2−21.2	2,353−2,871	13.3−16.2
18	2,823−3,804	18.4−21.5	2,336−2,858	13.2−16.1
19 to 30	3,015−3,490	17.0−19.7	2,373−2,683	13.4−15.2
31 to 50	2,862−3,338	16.2−18.9	2,263−2,573	12.8−14.5
51 to 70	2,671−3,147	15.1−17.8	2,124−2,435	12.0−13.8

Source: Stifelman, 2007.

Table 6-13. Mean Inhalation Rate Values (m^3/day) for Males, Females, and Males and Females Combined[a]

Age Group[b,c] (years)	Males[d]	Females[d]	Combined[d]
Birth to <1	3.4	3.4	3.4
1 to <2	4.9	4.9	4.9
2 to <3	5.9	5.5	5.7
3 to <6	9.5	9.1	9.3
6 to <11	11.8	11.2	11.5
11 to <16	16.1	14.0	15.0
16 to <21	19.3	14.6	17.0
21 to <31	18.4	14.3	16.3
31 to <41	17.6	13.7	15.6
41 to <51	17.6	13.7	15.6
51 to <61	16.5	12.9	14.7
61 to <71	16.5	12.9	14.7

[a] Inhalation rates are for IOM Physical Activity Level (PAL) category "active"; the total number of subjects for all PAL categories was 3,007. Sample sizes were not reported.
[b] Age groups from Table 6-12 were regrouped to fit into the U.S. EPA age groupings.
[c] See Table 6-25 for concordance with U.S. EPA age groupings.
[d] Weighted (where possible) average of reported study means.

Source: Stifelman, 2007.

Table 6-14. Descriptive Statistics for Daily Average Inhalation Rate in Males, by Age Category[a]

Age Group (years)	*N*	Daily Average Inhalation Rate, Unadjusted for Body Weight (m^3/day)								
		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Birth to <1	419	8.76	4.78	5.70	7.16	8.70	10.43	11.92	12.69	17.05
1 to <2	308	13.49	9.73	10.41	11.65	13.12	15.02	17.02	17.90	24.24
2 to <3	261	13.23	9.45	10.21	11.43	13.19	14.50	16.27	17.71	28.17
3 to <6	540	12.64	10.43	10.87	11.39	12.59	13.64	14.63	15.41	19.53
6 to <11	940	13.42	10.08	10.68	11.74	13.09	14.73	16.56	17.73	24.97
11 to <16	1,337	15.32	11.40	12.11	13.28	14.79	16.82	19.54	21.21	28.54
16 to <21	1,241	17.21	12.60	13.41	14.49	16.63	19.17	21.93	23.37	39.21
21 to <31	701	18.82	12.69	13.56	15.49	18.17	21.24	24.57	27.13	43.42
31 to <41	728	20.29	14.00	14.96	16.96	19.83	23.01	26.77	28.90	40.72
41 to <51	753	20.94	14.66	15.54	17.50	20.59	23.89	26.71	28.37	45.98
51 to <61	627	20.91	14.99	16.07	17.60	20.40	23.16	27.01	29.09	38.17
61 to <71	678	17.94	13.91	14.50	15.88	17.60	19.54	21.77	23.50	28.09
71 to <81	496	16.34	13.10	13.61	14.66	16.23	17.57	19.43	20.42	24.52
≥81	255	15.15	11.95	12.57	13.82	14.90	16.32	18.01	18.69	22.64
Age Group (years)	***N***	**Daily Average Inhalation Rate, Adjusted for Body Weight (m^3/day-kg)**								
		Mean	Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Birth to <1	419	1.09	0.91	0.94	1.00	1.09	1.16	1.26	1.29	1.48
1 to <2	308	1.19	0.96	1.02	1.09	1.17	1.26	1.37	1.48	1.73
2 to <3	261	0.95	0.78	0.82	0.87	0.94	1.01	1.09	1.13	1.36
3 to <6	540	0.70	0.52	0.56	0.61	0.69	0.78	0.87	0.92	1.08
6 to <11	940	0.44	0.32	0.34	0.38	0.43	0.50	0.55	0.58	0.80
11 to <16	1,337	0.29	0.21	0.22	0.25	0.28	0.32	0.36	0.38	0.51
16 to <21	1,241	0.23	0.17	0.18	0.20	0.23	0.25	0.28	0.30	0.39
21 to <31	701	0.23	0.16	0.17	0.19	0.22	0.26	0.30	0.32	0.51
31 to <41	728	0.24	0.16	0.18	0.20	0.23	0.27	0.31	0.34	0.46
41 to <51	753	0.24	0.17	0.18	0.20	0.23	0.28	0.32	0.34	0.47
51 to <61	627	0.24	0.16	0.18	0.20	0.24	0.27	0.30	0.34	0.43
61 to <71	678	0.21	0.17	0.18	0.19	0.20	0.22	0.24	0.25	0.32
71 to <81	496	0.20	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.31
≥81	255	0.20	0.17	0.18	0.19	0.20	0.22	0.23	0.25	0.28

[a] Individual daily averages are weighted by their 4-year sampling weights as assigned within NHANES 1999−2002 when calculating the statistics in this table. Inhalation rate was estimated using a multiple linear regression model.

N = Number of individuals.
BW = Body weight.

Source: U.S. EPA, 2009.

Table 6-15. Descriptive Statistics for Daily Average Inhalation Rate in Females, by Age Category[a]

Age Group (years)	*N*	Daily Average Inhalation Rate, Unadjusted for Body Weight (m^3/day)								
			Percentiles							
		Mean	5th	10th	25th	50th	75th	90th	95th	Maximum
Birth to <1	415	8.52	4.84	5.49	6.84	8.41	9.78	11.65	12.66	26.25
1	245	13.31	9.09	10.12	11.25	13.03	14.64	17.45	18.62	24.77
2	255	12.74	8.91	10.07	11.38	12.60	13.95	15.58	16.36	23.01
3 to <6	543	12.17	9.88	10.38	11.20	12.02	13.02	14.03	14.93	19.74
6 to <11	894	12.41	9.99	10.35	11.02	11.95	13.42	15.13	16.34	20.82
11 to <16	1,451	13.44	10.47	11.12	12.04	13.08	14.54	16.26	17.41	26.58
16 to <21	1,182	13.59	9.86	10.61	11.78	13.20	15.02	17.12	18.29	30.11
21 to <31	1,023	14.57	10.15	10.67	11.94	14.10	16.62	19.32	21.14	30.23
31 to <41	869	14.98	11.07	11.81	13.02	14.69	16.32	18.50	20.45	28.28
41 to <51	763	16.20	12.11	12.57	14.16	15.88	17.96	19.92	21.34	35.88
51 to <61	622	16.19	12.33	12.96	14.07	15.90	17.80	19.93	21.21	25.70
61 to <71	700	12.99	10.40	10.77	11.78	12.92	13.91	15.39	16.14	20.33
71 to <81	470	12.04	9.89	10.20	10.89	11.82	12.96	14.11	15.19	17.70
≥81	306	11.15	9.19	9.46	10.14	11.02	11.87	12.84	13.94	16.93
		Daily Average Inhalation Rate, Adjusted for Body Weight (m^3/day-kg)								
			Percentiles							
Age Group (years)	*N*	Mean	5th	10th	25th	50th	75th	90th	95th	Maximum
Birth to <1	415	1.14	0.91	0.97	1.04	1.13	1.24	1.33	1.38	1.60
1	245	1.20	0.97	1.01	1.10	1.18	1.30	1.41	1.46	1.73
2	255	0.95	0.82	0.84	0.89	0.96	1.01	1.07	1.10	1.23
3 to <6	543	0.69	0.48	0.54	0.60	0.68	0.77	0.88	0.92	1.12
6 to <11	894	0.43	0.28	0.31	0.36	0.43	0.49	0.55	0.58	0.75
11 to <16	1,451	0.25	0.19	0.20	0.22	0.24	0.28	0.31	0.34	0.47
16 to <21	1,182	0.21	0.16	0.17	0.19	0.21	0.23	0.27	0.28	0.36
21 to <31	1,023	0.21	0.14	0.16	0.18	0.20	0.23	0.26	0.28	0.40
31 to <41	869	0.21	0.14	0.15	0.18	0.20	0.23	0.27	0.30	0.43
41 to <51	763	0.22	0.15	0.16	0.19	0.21	0.25	0.28	0.31	0.41
51 to <61	622	0.22	0.15	0.16	0.18	0.21	0.24	0.28	0.30	0.40
61 to <71	700	0.18	0.14	0.15	0.16	0.17	0.19	0.21	0.22	0.27
71 to <81	470	0.18	0.14	0.15	0.16	0.17	0.19	0.21	0.23	0.34
≥81	306	0.18	0.14	0.15	0.16	0.18	0.20	0.21	0.22	0.28

[a] Individual daily averages are weighted by their 4-year sampling weights as assigned within NHANES 1999−2002 when calculating the statistics in this table. Inhalation rate was estimated using a multiple linear regression model.

N = Number of individuals.

Source: U.S. EPA, 2009.

Table 6-16. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Males, Females, and Males and Females Combined

Age Group (years)	*N*	Mean	95th
Males			
Birth to <1	419	8.76	12.69
1 to <2	308	13.49	17.90
2 to <3	261	13.23	17.71
3 to <6	540	12.64	15.41
6 to <11	940	13.42	17.73
11 to <16	1,337	15.32	21.21
16 to <21	1,241	17.21	23.37
21 to <31	701	18.82	27.13
31 to <41	728	20.29	28.90
41 to <51	753	20.94	28.37
51 to <61	627	20.91	29.09
61 to <71	678	17.94	23.50
71 to <81	496	16.34	20.42
≥81	255	15.15	18.69
Females			
Birth to <1	415	8.52	12.66
1 to <2	245	13.31	18.62
2 to <3	255	12.74	16.36
3 to <6	543	12.17	14.93
6 to <11	894	12.41	16.34
11 to <16	1,451	13.44	17.41
16 to <21	1,182	13.59	18.29
21 to <31	1,023	14.57	21.14
31 to <41	869	14.98	20.45
41 to <51	763	16.20	21.34
51 to <61	622	16.19	21.21
61 to <71	700	12.99	16.14
71 to <81	470	12.04	15.19
≥81	306	11.15	13.94

Table 6-16. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Males, Females, and Males and Females Combined (continued)

Age Group (years)	*N*	Mean	95th
Males and Females Combined[a]			
Birth to <1	834	8.64	12.67
1 to <2	553	13.41	18.22
2 to <3	516	12.99	17.04
3 to <6	1,083	12.40	15.17
6 to <11	1,834	12.93	17.05
11 to <16	2,788	14.34	19.23
16 to <21	2,423	15.44	20.89
21 to <31	1,724	16.30	23.57
31 to <41	1,597	17.40	24.30
41 to <51	1,516	18.55	24.83
51 to <61	1,249	18.56	25.17
61 to <71	1,378	15.43	19.76
71 to <81	966	14.25	17.88
≥81	561	12.97	16.10

[a] Weighted average of reported male and female means and 95th percentiles.

N = Number of individuals.

Source: U.S. EPA, 2009.

Table 6-17. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
Sleep or nap (Activity ID = 14500)										
Birth to <1	419	3.08E−03	1.66E−03	1.91E−03	2.45E−03	3.00E−03	3.68E−03	4.35E−03	4.77E−03	7.19E−03
1	308	4.50E−03	3.11E−03	3.27E−03	3.78E−03	4.35E−03	4.95E−03	5.90E−03	6.44E−03	1.00E−02
2	261	4.61E−03	3.01E−03	3.36E−03	3.94E−03	4.49E−03	5.21E−03	6.05E−03	6.73E−03	8.96E−03
3 to <6	540	4.36E−03	3.06E−03	3.30E−03	3.76E−03	4.29E−03	4.86E−03	5.54E−03	5.92E−03	7.67E−03
6 to <11	940	4.61E−03	3.14E−03	3.39E−03	3.83E−03	4.46E−03	5.21E−03	6.01E−03	6.54E−03	9.94E−03
11 to <16	1,337	5.26E−03	3.53E−03	3.78E−03	4.34E−03	5.06E−03	5.91E−03	6.94E−03	7.81E−03	1.15E−02
16 to <21	1,241	5.31E−03	3.55E−03	3.85E−03	4.35E−03	5.15E−03	6.09E−03	6.92E−03	7.60E−03	1.28E−02
21 to <31	701	4.73E−03	3.16E−03	3.35E−03	3.84E−03	4.56E−03	5.42E−03	6.26E−03	6.91E−03	1.12E−02
31 to <41	728	5.16E−03	3.37E−03	3.62E−03	4.23E−03	5.01E−03	5.84E−03	6.81E−03	7.46E−03	1.09E−02
41 to <51	753	5.65E−03	3.74E−03	4.09E−03	4.73E−03	5.53E−03	6.47E−03	7.41E−03	7.84E−03	1.08E−02
51 to <61	627	5.78E−03	3.96E−03	4.20E−03	4.78E−03	5.57E−03	6.54E−03	7.74E−03	8.26E−03	1.18E−02
61 to <71	678	5.98E−03	4.36E−03	4.57E−03	5.13E−03	5.81E−03	6.68E−03	7.45E−03	7.93E−03	1.23E−02
71 to <81	496	6.07E−03	4.26E−03	4.55E−03	5.17E−03	6.00E−03	6.77E−03	7.65E−03	8.33E−03	1.05E−02
≥81	255	5.97E−03	4.20E−03	4.49E−03	5.23E−03	5.90E−03	6.68E−03	7.36E−03	7.76E−03	1.00E−02
Sedentary and Passive Activities (METS ≤1.5—Includes Sleep or Nap)										
Birth to <1	419	3.18E−03	1.74E−03	1.99E−03	2.50E−03	3.10E−03	3.80E−03	4.40E−03	4.88E−03	7.09E−03
1	308	4.62E−03	3.17E−03	3.50E−03	3.91E−03	4.49E−03	5.03E−03	5.95E−03	6.44E−03	9.91E−03
2	261	4.79E−03	3.25E−03	3.66E−03	4.10E−03	4.69E−03	5.35E−03	6.05E−03	6.71E−03	9.09E−03
3 to <6	540	4.58E−03	3.47E−03	3.63E−03	4.07E−03	4.56E−03	5.03E−03	5.58E−03	5.82E−03	7.60E−03
6 to <11	940	4.87E−03	3.55E−03	3.78E−03	4.18E−03	4.72E−03	5.40E−03	6.03E−03	6.58E−03	9.47E−03
11 to <16	1,337	5.64E−03	4.03E−03	4.30E−03	4.79E−03	5.43E−03	6.26E−03	7.20E−03	7.87E−03	1.11E−02

Table 6-17. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute)							Maximum
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	
16 to <21	1,241	5.76E−03	4.17E−03	4.42E−03	4.93E−03	5.60E−03	6.43E−03	7.15E−03	7.76E−03	1.35E−02
21 to <31	701	5.11E−03	3.76E−03	3.99E−03	4.33E−03	5.00E−03	5.64E−03	6.42E−03	6.98E−03	1.03E−02
31 to <41	728	5.57E−03	3.99E−03	4.42E−03	4.86E−03	5.45E−03	6.17E−03	6.99E−03	7.43E−03	1.00E−02
41 to <51	753	6.11E−03	4.65E−03	4.92E−03	5.37E−03	6.02E−03	6.65E−03	7.46E−03	7.77E−03	1.05E−02
51 to <61	627	6.27E−03	4.68E−03	5.06E−03	5.50E−03	6.16E−03	6.89E−03	7.60E−03	8.14E−03	1.04E−02
61 to <71	678	6.54E−03	5.02E−03	5.31E−03	5.85E−03	6.47E−03	7.12E−03	7.87E−03	8.22E−03	1.09E−02
71 to <81	496	6.65E−03	5.26E−03	5.55E−03	5.96E−03	6.59E−03	7.18E−03	7.81E−03	8.26E−03	9.9E−03
≥81	255	6.44E−03	5.09E−03	5.37E−03	5.82E−03	6.43E−03	7.01E−03	7.57E−03	7.90E−03	9.13E−03
Light Intensity Activities (1.5< METS ≤3.0)										
Birth to <1	419	7.94E−03	4.15E−03	5.06E−03	6.16E−03	7.95E−03	9.57E−03	1.08E−02	1.19E−02	1.55E−02
1	308	1.16E−02	8.66E−03	8.99E−03	9.89E−03	1.14E−02	1.29E−02	1.44E−02	1.58E−02	2.11E−02
2	261	1.17E−02	8.52E−03	9.14E−03	9.96E−03	1.14E−02	1.30E−02	1.47E−02	1.53E−02	1.90E−02
3 to <6	540	1.14E−02	9.20E−03	9.55E−03	1.02E−02	1.11E−02	1.23E−02	1.34E−02	1.40E−02	1.97E−02
6 to <11	940	1.16E−02	8.95E−03	9.33E−03	1.02E−02	1.13E−02	1.28E−02	1.46E−02	1.56E−02	2.18E−02
11 to <16	1,337	1.32E−02	9.78E−03	1.03E−02	1.13E−02	1.28E−02	1.47E−02	1.64E−02	1.87E−02	2.69E−02
16 to <21	1,241	1.34E−02	1.00E−02	1.05E−02	1.15E−02	1.30E−02	1.50E−02	1.70E−02	1.80E−02	2.91E−02
21 to <31	701	1.30E−02	9.68	1.02E−02	1.13E−02	1.24E−02	1.40E−02	1.65E−02	1.77E−02	2.72E−02
31 to <41	728	1.36E−02	1.06E−02	1.11E−02	1.20E−02	1.33E−02	1.48E−02	1.65E−02	1.81E−02	2.55E−02
41 to <51	753	1.44E−02	1.12E−02	1.18E−02	1.30E−02	1.41E−02	1.56E−02	1.74E−02	1.83E−02	2.30E−02
51 to <61	627	1.46E−02	1.11E−02	1.16E−02	1.30E−02	1.44E−02	1.59E−02	1.80E−02	1.94E−02	2.55E−02
61 to <71	678	1.41E−02	1.11E−02	1.17E−02	1.27E−02	1.39E−02	1.54E−02	1.69E−02	1.80E−02	2.05E−02
71 to <81	496	1.39E−02	1.12E−02	1.17E−02	1.27E−02	1.37E−02	1.50E−02	1.62E−02	1.69E−02	2.00E−02
≥81	255	1.38E−02	1.10E−02	1.17E−02	1.26E−02	1.38E−02	1.47E−02	1.60E−02	1.67E−02	2.07E−02

Table 6-17. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute)							Maximum
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	
Moderate Intensity Activities (3.0< METS ≤6.0)										
Birth to <1	419	1.45E−02	7.41E−03	8.81E−03	1.15E−02	1.44E−02	1.70E−02	2.01E−02	2.25E−02	3.05E−02
1	308	2.14E−02	1.45E−02	1.59E−02	1.80E−02	2.06E−02	2.41E−02	2.69E−02	2.89E−02	3.99E−02
2	261	2.15E−02	1.54E−02	1.67E−02	1.84E−02	2.08E−02	2.41E−02	2.69E−02	2.97E−02	5.09E−02
3 to <6	540	2.10E−02	1.63E−02	1.72E−02	1.87E−02	2.06E−02	2.29E−02	2.56E−02	2.71E−02	3.49E−02
6 to <11	940	2.23E−02	1.64E−02	1.72E−02	1.93E−02	2.16E−02	2.50E−02	2.76E−02	2.95E−02	4.34E−02
11 to <16	1,337	2.64E−02	1.93E−02	2.05E−02	2.26E−02	2.54E−02	2.92E−02	3.38E−02	3.69E−02	5.50E−02
16 to <21	1,241	2.90E−02	2.03E−02	2.17E−02	2.45E−02	2.80E−02	3.17E−02	3.82E−02	4.21E−02	6.74E−02
21 to <31	701	2.92E−02	1.97E−02	2.10E−02	2.42E−02	2.79E−02	3.30E−02	3.88E−02	4.31E−02	7.17E−02
31 to <41	728	3.03E−02	2.14E−02	2.27E−02	2.51E−02	2.91E−02	3.41E−02	3.96E−02	4.35E−02	5.77E−02
41 to <51	753	3.16E−02	2.26E−02	2.44E−02	2.72E−02	3.04E−02	3.51E−02	4.03E−02	4.50E−02	6.34E−02
51 to <61	627	3.27E−02	2.24E−02	2.40E−02	2.80E−02	3.14E−02	3.70E−02	4.17E−02	4.58E−02	7.05E−02
61 to <71	678	2.98E−02	2.25E−02	2.40E−02	2.61E−02	2.92E−02	3.23E−02	3.69E−02	4.00E−02	5.23E−02
71 to <81	496	2.93E−02	2.28E−02	2.39E−02	2.61E−02	2.88E−02	3.20E−02	3.57E−02	3.73E−02	4.49E−02
≥81	255	2.85E−02	2.25E−02	2.34E−02	2.55E−02	2.82E−02	3.10E−02	3.34E−02	3.55E−02	4.11E−02

Table 6-17. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
High Intensity (METS >6.0)										
Birth to <1	183	2.75E−02	1.51E−02	1.73E−02	2.06E−02	2.78E−02	3.25E−02	3.84E−02	4.22E−02	5.79E−02
1	164	4.03E−02	2.83E−02	3.17E−02	3.47E−02	3.98E−02	4.43E−02	5.16E−02	5.59E−02	6.07E−02
2	162	4.05E−02	2.82E−02	2.97E−02	3.45E−02	4.06E−02	4.62E−02	5.19E−02	5.51E−02	9.20E−02
3 to <6	263	3.90E−02	2.95E−02	3.14E−02	3.40E−02	3.78E−02	4.32E−02	4.89E−02	5.22E−02	6.62E−02
6 to <11	637	4.36E−02	3.07E−02	3.28E−02	3.58E−02	4.19E−02	4.95E−02	5.66E−02	6.24E−02	8.99E−02
11 to <16	1,111	5.08E−02	3.43E−02	3.68E−02	4.15E−02	4.91E−02	5.74E−02	6.63E−02	7.29E−02	1.23E−01
16 to <21	968	5.32E−02	3.60E−02	3.83E−02	4.35E−02	5.05E−02	5.93E−02	7.15E−02	8.30E−02	1.30E−01
21 to <31	546	5.39E−02	3.36E−02	3.80E−02	4.48E−02	5.15E−02	6.16E−02	7.24E−02	8.21E−02	1.12E−01
31 to <41	567	5.43E−02	3.78E−02	4.04E−02	4.54E−02	5.21E−02	6.12E−02	7.14E−02	7.74E−02	1.04E−01
41 to <51	487	5.73E−02	3.83E−02	4.25E−02	4.83E−02	5.52E−02	6.45E−02	7.56E−02	8.44E−02	1.10E−01
51 to <61	452	5.84E−02	3.90E−02	4.16E−02	4.87E−02	5.59E−02	6.60E−02	7.86E−02	8.65E−02	1.41E−01
61 to <71	490	5.41E−02	3.63E−02	3.95E−02	4.52E−02	5.24E−02	6.08E−02	7.20E−02	7.52E−02	1.02E−01
71 to <81	343	5.25E−02	3.70E−02	3.95E−02	4.41E−02	5.00E−02	5.90E−02	6.76E−02	7.65E−02	9.73E−02
≥81	168	5.33E−02	3.54E−02	3.92E−02	4.55E−02	5.09E−02	6.12E−02	6.96E−02	7.71E−02	9.68E−02

[a] An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999−2002.

N = Number of individuals.
MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-18. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg)							
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	Maximum
Sleep or nap (Activity ID = 14500)										
Birth to <1	419	3.85E−04	2.81E−04	3.01E−04	3.37E−04	3.80E−04	4.27E−04	4.65E−04	5.03E−04	6.66E−04
1	308	3.95E−04	2.95E−04	3.13E−04	3.45E−04	3.84E−04	4.41E−04	4.91E−04	5.24E−04	6.26E−04
2	261	3.30E−04	2.48E−04	2.60E−04	2.89E−04	3.26E−04	3.62E−04	4.05E−04	4.42E−04	5.38E−04
3 to <6	540	2.43E−04	1.60E−04	1.74E−04	1.98E−04	2.37E−04	2.79E−04	3.14E−04	3.50E−04	4.84E−04
6 to <11	940	1.51E−04	1.02E−04	1.09E−04	1.25E−04	1.48E−04	1.74E−04	2.00E−04	2.15E−04	3.02E−04
11 to <16	1,337	9.80E−05	6.70E−05	7.20E−05	8.10E−05	9.40E−05	1.10E−04	1.29E−04	1.41E−04	2.08E−04
16 to <21	1,241	7.10E−05	4.70E−05	5.20E−05	6.10E−05	6.90E−05	8.00E−05	9.00E−05	9.80E−05	1.47E−04
21 to <31	701	5.80E−05	3.80E−05	4.20E−05	4.80E−05	5.60E−05	6.60E−05	7.60E−05	8.30E−05	1.32E−04
31 to <41	728	6.10E−05	3.80E−05	4.30E−05	5.00E−05	6.00E−05	7.00E−05	8.00E−05	8.60E−05	1.27E−04
41 to <51	753	6.50E−05	4.40E−05	4.70E−05	5.40E−05	6.40E−05	7.40E−05	8.60E−05	9.20E−05	1.37E−04
51 to <61	627	6.60E−05	4.50E−05	4.90E−05	5.50E−05	6.40E−05	7.60E−05	8.60E−05	9.30E−05	1.41E−04
61 to <71	678	6.90E−05	5.10E−05	5.40E−05	6.00E−05	6.80E−05	7.60E−05	8.60E−05	9.30E−05	1.17E−04
71 to <81	496	7.50E−05	5.50E−05	5.80E−05	6.40E−05	7.30E−05	8.30E−05	9.30E−05	9.90E−05	1.25E−04
≥81	255	8.00E−05	6.10E−05	6.40E−05	7.10E−05	7.80E−05	8.80E−05	9.70E−05	1.11E−04	1.22E−04
Sedentary and Passive Activities (METS ≤1.5—Includes Sleep or Nap)										
Birth to <1	419	3.97E−04	3.03E−04	3.17E−04	3.51E−04	3.91E−04	4.37E−04	4.70E−04	4.98E−04	6.57E−04
1	308	4.06E−04	3.21E−04	3.31E−04	3.63E−04	3.97E−04	4.48E−04	4.88E−04	5.25E−04	6.19E−04
2	261	3.43E−04	2.74E−04	2.86E−04	3.09E−04	3.40E−04	3.69E−04	4.05E−04	4.46E−04	5.10E−04
3 to <6	540	2.55E−04	1.78E−04	1.93E−04	2.15E−04	2.50E−04	2.88E−04	3.27E−04	3.46E−04	4.54E−04
6 to <11	940	1.60E−04	1.13E−04	1.18E−04	1.35E−04	1.57E−04	1.80E−04	2.09E−04	2.18E−04	2.89E−04
11 to <16	1,337	1.05E−04	7.70E−05	8.00E−05	8.80E−05	1.01E−04	1.18E−04	1.35E−04	1.42E−04	1.95E−04

Table 6-18. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)										
Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg)							Maximum
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	
16 to <21	1,241	7.70E−05	5.50E−05	6.00E−05	6.80E−05	7.60E−05	8.50E−05	9.50E−05	1.02E−04	1.32E−04
21 to <31	701	6.20E−05	4.70E−05	4.90E−05	5.50E−05	6.10E−05	6.90E−05	7.70E−05	8.20E−05	1.18E−04
31 to <41	728	6.60E−05	4.60E−05	5.00E−05	5.70E−05	6.50E−05	7.40E−05	8.20E−05	8.60E−05	1.19E−04
41 to <51	753	7.10E−05	5.40E−05	5.70E−05	6.20E−05	7.00E−05	7.80E−05	8.60E−05	9.10E−05	1.29E−04
51 to <61	627	7.20E−05	5.50E−05	5.80E−05	6.30E−05	7.10E−05	7.90E−05	8.80E−05	9.20E−05	1.35E−04
61 to <71	678	7.60E−05	6.10E−05	6.40E−05	6.90E−05	7.50E−05	8.10E−05	8.90E−05	9.40E−05	1.11E−04
71 to <81	496	8.20E−05	6.70E−05	7.00E−05	7.50E−05	8.10E−05	8.80E−05	9.40E−05	9.80E−05	1.15E−04
≥81	255	8.60E−05	7.10E−05	7.50E−05	8.00E−05	8.60E−05	9.20E−05	9.90E−05	1.06E−04	1.15E−04
Light Intensity Activities (1.5< METS ≤3.0)										
Birth to <1	419	9.88E−04	7.86E−04	8.30E−04	8.97E−04	9.72E−04	1.07E−03	1.17E−03	1.20E−03	1.44E−03
1	308	1.02E−03	8.36E−04	8.59E−04	9.18E−04	1.01E−03	1.10E−03	1.22E−03	1.30E−03	1.49E−03
2	261	8.37E−04	6.83E−04	7.16E−04	7.61E−04	8.26E−04	8.87E−04	9.95E−04	1.03E−03	1.18E−03
3 to <6	540	6.33E−04	4.41E−04	4.80E−04	5.44E−04	6.26E−04	7.11E−04	7.94E−04	8.71E−04	1.08E−03
6 to <11	940	3.84E−04	2.67E−04	2.86E−04	3.24E−04	3.77E−04	4.37E−04	4.93E−04	5.29E−04	7.09E−04
11 to <16	1,337	2.46E−04	1.76E−04	1.87E−04	2.09E−04	2.38E−04	2.82E−04	3.11E−04	3.32E−04	4.42E−04
16 to <21	1,241	1.79E−04	1.37E−04	1.44E−04	1.56E−04	1.78E−04	1.99E−04	2.18E−04	2.30E−04	3.32E−04
21 to <31	701	1.58E−04	1.24E−04	1.30E−04	1.42E−04	1.54E−04	1.71E−04	1.90E−04	2.07E−04	2.90E−04
31 to <41	728	1.61E−04	1.18E−04	1.28E−04	1.40E−04	1.57E−04	1.77E−04	1.98E−04	2.09E−04	2.81E−04
41 to <51	753	1.66E−04	1.26E−04	1.33E−04	1.47E−04	1.64E−04	1.81E−04	2.00E−04	2.14E−04	3.32E−04
51 to <61	627	1.67E−04	1.27E−04	1.35E−04	1.48E−04	1.65E−04	1.83E−04	2.01E−04	2.16E−04	2.87E−04
61 to <71	678	1.64E−04	1.37E−04	1.41E−04	1.50E−04	1.63E−04	1.75E−04	1.87E−04	1.95E−04	2.69E−04
71 to <81	496	1.71E−04	1.43E−04	1.48E−04	1.58E−04	1.70E−04	1.82E−04	1.95E−04	2.03E−04	2.63E−04
≥81	255	1.85E−04	1.52E−04	1.60E−04	1.68E−04	1.83E−04	1.98E−04	2.12E−04	2.24E−04	2.47E−04

Table 6-18. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
Moderate Intensity Activities (3.0< METS ≤6.0)										
Birth to <1	419	1.80E−03	1.40E−03	1.49E−03	1.62E−03	1.78E−03	1.94E−03	2.18E−03	2.28E−03	3.01E−03
1	308	1.88E−03	1.41E−03	1.50E−03	1.65E−03	1.82E−03	2.02E−03	2.34E−03	2.53E−03	3.23E−03
2	261	1.55E−03	1.21E−03	1.28E−03	1.40E−03	1.54E−03	1.66E−03	1.84E−03	2.02E−03	2.29E−03
3 to <6	540	1.17E−03	8.05E−04	8.83E−04	9.99E−04	1.12E−03	1.31E−03	1.56E−03	1.68E−03	2.10E−03
6 to <11	940	7.36E−04	5.03E−04	5.45E−04	6.18E−04	7.14E−04	8.34E−04	9.58E−04	1.04E−03	1.43E−03
11 to <16	1,337	4.91E−04	3.59E−04	3.75E−04	4.18E−04	4.73E−04	5.52E−04	6.35E−04	6.81E−04	1.06E−03
16 to <21	1,241	3.87E−04	2.81E−04	2.96E−04	3.34E−04	3.80E−04	4.31E−04	4.86E−04	5.18E−04	7.11E−04
21 to <31	701	3.57E−04	2.43E−04	2.64E−04	2.96E−04	3.45E−04	4.04E−04	4.68E−04	5.09E−04	8.24E−04
31 to <41	728	3.57E−04	2.42E−04	2.65E−04	3.00E−04	3.44E−04	4.00E−04	4.71E−04	5.21E−04	7.62E−04
41 to <51	753	3.66E−04	2.55E−04	2.72E−04	3.10E−04	3.53E−04	4.08E−04	4.69E−04	5.18E−04	7.16E−04
51 to <61	627	3.76E−04	2.59E−04	2.78E−04	3.13E−04	3.66E−04	4.31E−04	4.82E−04	5.49E−04	7.64E−04
61 to <71	678	3.44E−04	2.72E−04	2.84E−04	3.13E−04	3.42E−04	3.71E−04	3.99E−04	4.24E−04	5.73E−04
71 to <81	496	3.60E−04	2.91E−04	3.06E−04	3.28E−04	3.59E−04	3.88E−04	4.18E−04	4.36E−04	5.49E−04
≥81	255	3.83E−04	3.12E−04	3.23E−04	3.47E−04	3.77E−04	4.16E−04	4.47E−04	4.70E−04	5.29E−04

Table 6-18. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Males by Age Category (continued)

Age Group (years)	N	Mean	Average Ventilation Rate (m^3/minute-kg) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
High Intensity (METS >6.0)										
Birth to <1	183	3.48E−03	2.70E−03	2.93E−03	3.10E−03	3.46E−03	3.81E−03	4.14E−03	4.32E−03	5.08E−03
1	164	3.52E−03	2.52E−03	2.89E−03	3.22E−03	3.57E−03	3.91E−03	4.11E−03	4.34E−03	4.86E−03
2	162	2.89E−03	2.17E−03	2.34E−03	2.58E−03	2.87E−03	3.20E−03	3.43E−03	3.54E−03	4.30E−03
3 to <6	263	2.17E−03	1.55E−03	1.66E−03	1.81E−03	2.11E−03	2.50E−03	2.73E−03	2.98E−03	3.62E−03
6 to <11	637	1.41E−03	9.36E−04	1.03E−03	1.19E−03	1.38E−03	1.59E−03	1.83E−03	1.93E−03	2.68E−03
11 to <16	1,111	9.50E−04	6.35E−04	6.96E−04	7.90E−04	9.09E−04	1.09E−03	1.27E−03	1.36E−03	1.98E−03
16 to <21	968	7.11E−04	4.75E−04	5.27E−04	5.99E−04	6.91E−04	8.02E−04	9.17E−04	9.97E−04	1.94E−03
21 to <31	546	6.60E−04	4.49E−04	4.74E−04	5.43E−04	6.44E−04	7.49E−04	8.55E−04	9.73E−04	1.27E−03
31 to <41	567	6.44E−04	4.42E−04	4.70E−04	5.33E−04	6.25E−04	7.31E−04	8.53E−04	9.30E−04	1.23E−03
41 to <51	487	6.55E−04	4.38E−04	4.85E−04	5.48E−04	6.25E−04	7.41E−04	8.56E−04	9.44E−04	1.77E−03
51 to <61	452	6.75E−04	4.46E−04	4.81E−04	5.47E−04	6.43E−04	7.67E−04	9.13E−04	1.02E−03	1.32E−03
61 to <71	490	6.24E−04	4.41E−04	4.70E−04	5.31E−04	6.12E−04	7.03E−04	7.88E−04	8.55E−04	1.08E−03
71 to <81	343	6.46E−04	4.66E−04	5.02E−04	5.53E−04	6.26E−04	7.16E−04	8.49E−04	9.10E−04	1.04E−03
≥81	168	7.16E−04	5.05E−04	5.44E−04	6.02E−04	7.00E−04	8.05E−04	9.42E−04	9.91E−04	1.35E−03

[a] An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999−2002.

N = Number of individuals.
MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-19. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute)							Maximum
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	
Sleep or nap (Activity ID = 14500)										
Birth to <1	415	2.92E−03	1.54E−03	1.72E−03	2.27E−03	2.88E−03	3.50E−03	4.04E−03	4.40E−03	8.69E−03
1	245	4.59E−03	3.02E−03	3.28E−03	3.76E−03	4.56E−03	5.32E−03	5.96E−03	6.37E−03	9.59E−03
2	255	4.56E−03	3.00E−03	3.30E−03	3.97E−03	4.52E−03	5.21E−03	5.76E−03	6.15E−03	9.48E−03
3 to <6	543	4.18E−03	2.90E−03	3.20E−03	3.62E−03	4.10E−03	4.71E−03	5.22E−03	5.73E−03	7.38E−03
6 to <11	894	4.36E−03	2.97E−03	3.17E−03	3.69E−03	4.24E−03	4.93E−03	5.67E−03	6.08E−03	8.42E−03
11 to <16	1,451	4.81E−03	3.34E−03	3.57E−03	3.99E−03	4.66E−03	5.39E−03	6.39E−03	6.99E−03	9.39E−03
16 to <21	1,182	4.40E−03	2.78E−03	2.96E−03	3.58E−03	4.26E−03	5.05E−03	5.89E−03	6.63E−03	1.23E−02
21 to <31	1,023	3.89E−03	2.54E−03	2.74E−03	3.13E−03	3.68E−03	4.44E−03	5.36E−03	6.01E−03	9.58E−03
31 to <41	869	4.00E−03	2.66E−03	2.86E−03	3.31E−03	3.89E−03	4.54E−03	5.28E−03	5.77E−03	8.10E−03
41 to <51	763	4.40E−03	3.00E−03	3.23E−03	3.69E−03	4.25E−03	4.95E−03	5.66E−03	6.25E−03	8.97E−03
51 to <61	622	4.56E−03	3.12E−03	3.30E−03	3.72E−03	4.41E−03	5.19E−03	6.07E−03	6.63E−03	8.96E−03
61 to <71	700	4.47E−03	3.22E−03	3.35E−03	3.78E−03	4.38E−03	4.99E−03	5.72E−03	6.37E−03	9.57E−03
71 to <81	470	4.52E−03	3.31E−03	3.47E−03	3.89E−03	4.40E−03	5.11E−03	5.67E−03	6.06E−03	7.35E−03
≥81	306	4.49E−03	3.17E−03	3.49E−03	3.82E−03	4.39E−03	4.91E−03	5.61E−03	6.16E−03	8.27E−03
Sedentary and Passive Activities (METS ≤1.5—Includes Sleep or Nap)										
Birth to <1	415	3.00E−03	1.60E−03	1.80E−03	2.32E−03	2.97E−03	3.58E−03	4.11E−03	4.44E−03	9.59E−03
1	245	4.71E−03	3.26E−03	3.44E−03	3.98E−03	4.73E−03	5.30E−03	5.95E−03	6.63E−03	9.50E−03
2	255	4.73E−03	3.34E−03	3.53E−03	4.19E−03	4.67E−03	5.25E−03	5.75E−03	6.22E−03	9.42E−03
3 to <6	543	4.40E−03	3.31E−03	3.49E−03	3.95E−03	4.34E−03	4.84E−03	5.29E−03	5.73E−03	7.08E−03
6 to <11	894	4.64E−03	3.41E−03	3.67E−03	4.04E−03	4.51E−03	5.06E−03	5.88E−03	6.28E−03	8.31E−03
11 to <16	1,451	5.21E−03	3.90E−03	4.16E−03	4.53E−03	5.09E−03	5.68E−03	6.53E−03	7.06E−03	9.07E−03

Table 6-19. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute) Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
16 to <21	1,182	4.76E−03	3.26E−03	3.56E−03	4.03E−03	4.69E−03	5.32E−03	6.05E−03	6.60E−03	1.18E−02
21 to <31	1,023	4.19E−03	3.04E−03	3.19E−03	3.55E−03	4.00E−03	4.63E−03	5.38E−03	6.02E−03	9.22E−03
31 to <41	869	4.33E−03	3.22E−03	3.45E−03	3.77E−03	4.24E−03	4.80E−03	5.33E−03	5.79E−03	7.70E−03
41 to <51	763	4.75E−03	3.60E−03	3.82E−03	4.18E−03	4.65E−03	5.19E−03	5.74E−03	6.26E−03	8.70E−03
51 to <61	622	4.96E−03	3.78E−03	4.00E−03	4.36E−03	4.87E−03	5.44E−03	6.06E−03	6.44E−03	8.30E−03
61 to <71	700	4.89E−03	3.81E−03	4.02E−03	4.34E−03	4.81E−03	5.30E−03	5.86E−03	6.29E−03	8.18E−03
71 to <81	470	4.95E−03	4.07E−03	4.13E−03	4.41E−03	4.89E−03	5.42E−03	5.89E−03	6.15E−03	7.59E−03
≥81	306	4.89E−03	3.93E−03	4.10E−03	4.39E−03	4.79E−03	5.25E−03	5.71E−03	6.12E−03	7.46E−03
Light Intensity Activities (1.5< METS ≤3.0)										
Birth to <1	415	7.32E−03	3.79E−03	4.63E−03	5.73E−03	7.19E−03	8.73E−03	9.82E−03	1.08E−02	1.70E−02
1	245	1.16E−02	8.59E−03	8.80E−03	1.00E−02	1.12E−02	1.29E−02	1.52E−02	1.58E−02	2.02E−02
2	255	1.20E−02	8.74E−03	9.40E−03	1.03E−02	1.17E−02	1.32E−02	1.56E−02	1.63E−02	2.36E−02
3 to <6	543	1.09E−02	8.83E−03	9.04E−03	9.87E−03	1.07E−02	1.17E−02	1.29E−02	1.38E−02	1.64E−02
6 to <11	894	1.11E−02	8.51E−03	9.02E−03	9.79E−03	1.08E−02	1.20E−02	1.35E−02	1.47E−02	2.22E−02
11 to <16	1,451	1.20E−02	9.40E−03	9.73E−03	1.06E−02	1.18E−02	1.31E−02	1.47E−02	1.58E−02	2.21E−02
16 to <21	1,182	1.11E−02	8.31E−03	8.73E−03	9.64E−03	1.08E−02	1.23E−02	1.38E−02	1.49E−02	2.14E−02
21 to <31	1,023	1.06E−02	7.75E−03	8.24E−03	9.05E−03	1.02E−02	1.17E−02	1.34E−02	1.43E−02	2.15E−02
31 to <41	869	1.11E−02	8.84E−03	9.30E−03	9.96E−03	1.09E−02	1.19E−02	1.31E−02	1.39E−02	1.74E−02
41 to <51	763	1.18E−02	9.64E−03	1.00E−02	1.07E−02	1.16E−02	1.27E−02	1.39E−02	1.45E−02	1.77E−02
51 to <61	622	1.20E−02	9.76E−03	1.02E−02	1.09E−02	1.18E−02	1.30E−02	1.42E−02	1.49E−02	1.79E−02
61 to <71	700	1.08E−02	8.87E−03	9.28E−03	9.85E−03	1.06E−02	1.17E−02	1.26E−02	1.32E−02	1.74E−02
71 to <81	470	1.08E−02	8.84E−03	9.23E−03	9.94E−03	1.07E−02	1.17E−02	1.25E−02	1.30E−02	1.76E−02

Table 6-19. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
≥81	306	1.04E−02	8.69E−03	8.84E−03	9.36E−03	1.03E−02	1.14E−02	1.21E−02	1.26E−02	1.61E−02
Moderate Intensity Activities (3.0< METS ≤6.0)										
Birth to <1	415	1.40E−02	7.91E−03	9.00E−03	1.12E−02	1.35E−02	1.63E−02	1.94E−02	2.23E−02	4.09E−02
1	245	2.10E−02	1.56E−02	1.63E−02	1.79E−02	2.01E−02	2.35E−02	2.71E−02	2.93E−02	3.45E−02
2	255	2.13E−02	1.42E−02	1.56E−02	1.82E−02	2.15E−02	2.39E−02	2.76E−02	2.88E−02	3.76E−02
3 to <6	543	2.00E−02	1.53E−02	1.63E−02	1.78E−02	1.98E−02	2.16E−02	2.38E−02	2.59E−02	3.29E−02
6 to <11	894	2.10E−02	1.60E−02	1.68E−02	1.85E−02	2.04E−02	2.30E−02	2.61E−02	2.81E−02	4.31E−02
11 to <16	1,451	2.36E−02	1.82E−02	1.95E−02	2.08E−02	2.30E−02	2.54E−02	2.84E−02	3.14E−02	4.24E−02
16 to <21	1,182	2.32E−02	1.66E−02	1.76E−02	1.96E−02	2.24E−02	2.61E−02	3.03E−02	3.20E−02	5.25E−02
21 to <31	1,023	2.29E−02	1.56E−02	1.67E−02	1.90E−02	2.19E−02	2.60E−02	3.00E−02	3.28E−02	5.42E−02
31 to <41	869	2.27E−02	1.69E−02	1.76E−02	1.95E−02	2.20E−02	2.48E−02	2.89E−02	3.11E−02	4.73E−02
41 to <51	763	2.45E−02	1.76E−02	1.89E−02	2.08E−02	2.39E−02	2.74E−02	3.08E−02	3.36E−02	5.07E−02
51 to <61	622	2.52E−02	1.88E−02	1.98E−02	2.18E−02	2.43E−02	2.81E−02	3.19E−02	3.50E−02	4.62E−02
61 to <71	700	2.14E−02	1.69E−02	1.77E−02	1.92E−02	2.09E−02	2.32E−02	2.57E−02	2.73E−02	3.55E−02
71 to <81	470	2.11E−02	1.69E−02	1.76E−02	1.89E−02	2.07E−02	2.29E−02	2.49E−02	2.64E−02	3.44E−02
≥81	306	2.09E−02	1.65E−02	1.75E−02	1.91E−02	2.06E−02	2.25E−02	2.46E−02	2.60E−02	2.93E−02

Table 6-19. Descriptive Statistics for Average Ventilation Rate,[a] Unadjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute) Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
High Intensity (METS >6.0)										
Birth to <1	79	2.42E−02	1.24E−02	1.33E−02	1.72E−02	2.25E−02	2.93E−02	3.56E−02	4.07E−02	7.46E−02
1	55	3.65E−02	2.59E−02	2.62E−02	3.04E−02	3.61E−02	4.20E−02	4.73E−02	4.86E−02	7.70E−02
2	130	3.76E−02	2.90E−02	3.05E−02	3.23E−02	3.64E−02	4.08E−02	4.81E−02	5.14E−02	7.30E−02
3 to <6	347	3.45E−02	2.70E−02	2.82E−02	3.00E−02	3.33E−02	3.76E−02	4.32E−02	4.47E−02	5.66E−02
6 to <11	707	3.94E−02	2.86E−02	3.01E−02	3.37E−02	3.80E−02	4.41E−02	5.05E−02	5.46E−02	8.29E−02
11 to <16	1,170	4.66E−02	3.11E−02	3.38E−02	3.88E−02	4.53E−02	5.29E−02	6.08E−02	6.63E−02	1.02E−01
16 to <21	887	4.41E−02	2.87E−02	3.06E−02	3.65E−02	4.27E−02	5.02E−02	5.82E−02	6.34E−02	1.09E−01
21 to <31	796	4.57E−02	2.88E−02	3.12E−02	3.67E−02	4.31E−02	5.22E−02	6.19E−02	6.89E−02	1.08E−01
31 to <41	687	4.44E−02	3.03E−02	3.29E−02	3.70E−02	4.22E−02	5.05E−02	5.95E−02	6.53E−02	8.95E−02
41 to <51	515	4.70E−02	3.10E−02	3.40E−02	3.84E−02	4.56E−02	5.41E−02	6.15E−02	6.74E−02	8.87E−02
51 to <61	424	4.74E−02	3.15E−02	3.48E−02	3.94E−02	4.57E−02	5.41E−02	6.23E−02	6.88E−02	8.44E−02
61 to <71	465	4.00E−02	2.76E−02	3.06E−02	3.46E−02	3.87E−02	4.53E−02	5.08E−02	5.64E−02	7.13E−02
71 to <81	304	4.06E−02	2.85E−02	3.01E−02	3.43E−02	3.96E−02	4.70E−02	5.20E−02	5.41E−02	7.53E−02
≥81	188	4.19E−02	2.85E−02	3.09E−03	3.44E−02	4.14E−02	4.76E−02	5.56E−02	5.83E−02	7.21E−02

[a] An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999−2002.

N = Number of individuals.
MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-20. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg)							Maximum
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	
Sleep or nap (Activity ID = 14500)										
Birth to <1	415	3.91E−04	2.80E−04	3.01E−04	3.35E−04	3.86E−04	4.34E−04	4.79E−04	5.17E−04	7.39E−04
1	245	4.14E−04	3.15E−04	3.29E−04	3.61E−04	4.05E−04	4.64E−04	5.21E−04	5.36E−04	6.61E−04
2	255	3.42E−04	2.58E−04	2.71E−04	2.93E−04	3.33E−04	3.91E−04	4.25E−04	4.53E−04	4.94E−04
3 to <6	543	2.38E−04	1.45E−04	1.63E−04	1.95E−04	2.33E−04	2.75E−04	3.20E−04	3.53E−04	5.19E−04
6 to <11	894	1.51E−04	8.90E−05	9.70E−05	1.20E−04	1.46E−04	1.76E−04	2.11E−04	2.29E−04	2.97E−04
11 to <16	1,451	9.00E−05	5.90E−05	6.50E−05	7.50E−05	8.70E−05	1.02E−04	1.18E−04	1.30E−04	1.76E−04
16 to <21	1,182	6.90E−05	4.40E−05	4.70E−05	5.70E−05	6.70E−05	8.00E−05	9.30E−05	1.02E−04	1.52E−04
21 to <31	1,023	5.50E−05	3.50E−05	3.80E−05	4.50E−05	5.40E−05	6.50E−05	7.40E−05	8.20E−05	9.80E−05
31 to <41	869	5.60E−05	3.40E−05	3.70E−05	4.50E−05	5.40E−05	6.50E−05	7.60E−05	8.20E−05	1.15E−04
41 to <51	763	6.00E−05	3.90E−05	4.10E−05	4.80E−05	5.70E−05	7.00E−05	8.40E−05	9.00E−05	1.14E−04
51 to <61	622	6.10E−05	3.90E−05	4.20E−05	5.00E−05	5.90E−05	7.10E−05	8.30E−05	8.80E−05	1.35E−04
61 to <71	700	6.10E−05	4.30E−05	4.60E−05	5.20E−05	5.90E−05	6.70E−05	7.60E−05	8.10E−05	1.01E−04
71 to <81	470	6.60E−05	4.70E−05	5.10E−05	5.60E−05	6.40E−05	7.40E−05	8.40E−05	9.00E−05	1.25E−04
≥81	306	7.20E−05	5.10E−05	5.60E−05	6.30E−05	7.00E−05	7.90E−05	9.10E−05	9.60E−05	1.15E−04
Sedentary and Passive Activities (METS ≤1.5—Includes Sleep or Nap)										
Birth to <1	415	4.02E−04	2.97E−04	3.16E−04	3.52E−04	3.96E−04	4.46E−04	4.82E−04	5.19E−04	7.19E−04
1	245	4.25E−04	3.35E−04	3.48E−04	3.76E−04	4.18E−04	4.69E−04	5.12E−04	5.43E−04	6.42E−04
2	255	3.55E−04	2.85E−04	2.96E−04	3.20E−04	3.48E−04	3.91E−04	4.20E−04	4.42E−04	4.85E−04
3 to <6	543	2.51E−04	1.64E−04	1.79E−04	2.11E−04	2.48E−04	2.84E−04	3.28E−04	3.58E−04	4.89E−04
6 to <11	894	1.60E−04	9.90E−05	1.10E−04	1.31E−04	1.57E−04	1.85E−04	2.12E−04	2.34E−04	2.93E−04
11 to <16	1,451	9.70E−05	7.10E−05	7.50E−05	8.30E−05	9.50E−05	1.09E−04	1.23E−04	1.33E−04	1.74E−04

Table 6-20. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
16 to <21	1,182	7.50E−05	5.30E−05	5.70E−05	6.30E−05	7.40E−05	8.50E−05	9.60E−05	1.04E−04	1.41E−04
21 to <31	1,023	6.00E−05	4.30E−05	4.50E−05	5.10E−05	5.90E−05	6.70E−05	7.50E−05	8.00E−05	9.90E−05
31 to <41	869	6.00E−05	4.00E−05	4.20E−05	5.10E−05	5.90E−05	6.90E−05	7.80E−05	8.30E−05	1.05E−04
41 to <51	763	6.50E−05	4.40E−05	4.80E−05	5.50E−05	6.30E−05	7.30E−05	8.30E−05	9.10E−05	1.14E−04
51 to <61	622	6.70E−05	4.60E−05	5.10E−05	5.70E−05	6.50E−05	7.60E−05	8.30E−05	9.00E−05	1.18E−04
61 to <71	700	6.60E−05	5.20E−05	5.40E−05	5.90E−05	6.60E−05	7.20E−05	7.80E−05	8.40E−05	1.04E−04
71 to <81	470	7.20E−05	5.50E−05	6.00E−05	6.50E−05	7.10E−05	7.80E−05	8.80E−05	9.20E−05	1.48E−04
≥81	306	7.80E−05	6.30E−05	6.50E−05	7.00E−05	7.70E−05	8.60E−05	9.30E−05	9.60E−05	1.12E−04
Light Intensity Activities (1.5< METS ≤3.0)										
Birth to <1	415	9.78E−04	7.91E−04	8.17E−04	8.80E−04	9.62E−04	1.05E−03	1.18E−03	1.23E−03	1.65E−03
1	245	1.05E−03	8.45E−04	8.68E−04	9.49E−04	1.04E−03	1.14E−03	1.25E−03	1.27E−03	1.64E−03
2	255	8.97E−04	7.30E−04	7.63E−04	8.19E−04	8.93E−04	9.64E−04	1.04E−03	1.10E−03	1.26E−03
3 to <6	543	6.19E−04	4.48E−04	4.84E−04	5.37E−04	5.99E−04	6.98E−04	7.83E−04	8.28E−04	1.02E−03
6 to <11	894	3.82E−04	2.52E−04	2.70E−04	3.15E−04	3.76E−04	4.42E−04	5.03E−04	5.39E−04	7.10E−04
11 to <16	1,451	2.25E−04	1.63E−04	1.74E−04	1.96E−04	2.17E−04	2.49E−04	2.84E−04	3.05E−04	3.96E−04
16 to <21	1,182	1.74E−04	1.29E−04	1.38E−04	1.54E−04	1.73E−04	1.93E−04	2.13E−04	2.24E−04	2.86E−04
21 to <31	1,023	1.49E−04	1.16E−04	1.23E−04	1.34E−04	1.49E−04	1.63E−04	1.78E−04	1.90E−04	2.27E−04
31 to <41	869	1.54E−04	1.07E−04	1.15E−04	1.33E−04	1.54E−04	1.76E−04	1.92E−04	2.02E−04	2.67E−04
41 to <51	763	1.61E−04	1.14E−04	1.23E−04	1.38E−04	1.58E−04	1.82E−04	2.03E−04	2.16E−04	2.83E−04
51 to <61	622	1.61E−04	1.20E−04	1.27E−04	1.41E−04	1.58E−04	1.80E−04	1.99E−04	2.10E−04	2.65E−04
61 to <71	700	1.47E−04	1.17E−04	1.22E−04	1.32E−04	1.45E−04	1.61E−04	1.73E−04	1.82E−04	2.44E−04
71 to <81	470	1.58E−04	1.24E−04	1.30E−04	1.43E−04	1.56E−04	1.69E−04	1.88E−04	2.02E−04	2.77E−04
≥81	306	1.67E−04	1.31E−04	1.38E−04	1.50E−04	1.64E−04	1.82E−04	1.97E−04	2.08E−04	2.34E−04

Table 6-20. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg) Percentiles							Maximum
			5th	10th	25th	50th	75th	90th	95th	
Moderate Intensity Activities (3.0< METS ≤6.0)										
Birth to <1	415	1.87E−03	1.47E−03	1.52E−03	1.67E−03	1.85E−03	2.01E−03	2.25E−03	2.40E−03	2.83E−03
1	245	1.90E−03	1.52E−03	1.62E−03	1.73E−03	1.87E−03	2.02E−03	2.24E−03	2.37E−03	3.24E−03
2	255	1.60E−03	1.27E−03	1.31E−03	1.44E−03	1.58E−03	1.75E−03	1.92E−03	2.02E−03	2.59E−03
3 to <6	543	1.14E−03	7.92E−04	8.53E−04	9.64E−04	1.11E−03	1.31E−03	1.45E−03	1.56E−03	1.93E−03
6 to <11	894	7.23E−04	4.62E−04	5.12E−04	5.98E−04	7.15E−04	8.38E−04	9.42E−04	1.01E−03	1.37E−03
11 to <16	1,451	4.41E−04	3.17E−04	3.38E−04	3.80E−04	4.31E−04	4.92E−04	5.51E−04	6.11E−04	9.86E−04
16 to <21	1,182	3.65E−04	2.67E−04	2.82E−04	3.10E−04	3.51E−04	4.07E−04	4.63E−04	4.94E−04	6.50E−04
21 to <31	1,023	3.25E−04	2.35E−04	2.45E−04	2.81E−04	3.16E−04	3.60E−04	4.16E−04	4.52E−04	6.57E−04
31 to <41	869	3.16E−04	2.13E−04	2.31E−04	2.68E−04	3.04E−04	3.50E−04	4.10E−04	4.60E−04	7.08E−04
41 to <51	763	3.33E−04	2.21E−04	2.36E−04	2.76E−04	3.25E−04	3.76E−04	4.41E−04	4.88E−04	6.20E−04
51 to <61	622	3.39E−04	2.35E−04	2.54E−04	2.83E−04	3.26E−04	3.83E−04	4.38E−04	4.86E−04	3.69E−04
61 to <71	700	2.92E−04	2.24E−04	2.38E−04	2.59E−04	2.85E−04	3.20E−04	3.51E−04	3.71E−04	5.11E−04
71 to <81	470	3.08E−04	2.40E−04	2.50E−04	2.70E−04	2.99E−04	3.40E−04	3.75E−04	4.07E−04	6.77E−04
≥81	306	3.35E−04	2.47E−04	2.66E−04	2.98E−04	3.33E−04	3.72E−04	4.02E−04	4.20E−04	5.20E−04

Table 6-20. Descriptive Statistics for Average Ventilation Rate,[a] Adjusted for Body Weight, While Performing Activities Within the Specified Activity Category, for Females by Age Category (continued)

Age Group (years)	*N*	Mean	Average Ventilation Rate (m^3/minute-kg) Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
High Intensity (METS >6.0)										
Birth to <1	79	3.26E−03	2.53E−03	2.62E−03	2.89E−03	3.23E−03	3.63E−03	3.96E−03	4.08E−03	5.02E−03
1	55	3.38E−03	2.57E−03	2.75E−03	2.97E−03	3.24E−03	3.71E−03	4.16E−03	4.87E−03	4.88E−03
2	130	2.80E−03	2.20E−03	2.31E−03	2.48E−03	2.81E−03	3.13E−03	3.36E−03	3.48E−03	3.88E−03
3 to <6	347	1.98E−03	1.36E−03	1.51E−03	1.69E−03	1.90E−03	2.19E−03	2.50E−03	2.99E−03	3.24E−03
6 to <11	707	1.33E−03	8.85E−04	9.67E−04	1.12E−03	1.33E−03	1.52E−03	1.72E−03	1.81E−03	2.22E−03
11 to <16	1,170	8.79E−04	5.89E−04	6.25E−04	7.12E−04	8.53E−04	1.01E−03	1.18E−03	1.31E−03	2.05E−03
16 to <21	887	6.96E−04	4.52E−04	4.96E−04	5.67E−04	6.86E−04	7.93E−04	9.16E−04	1.00E−03	1.50E−03
21 to <31	796	6.50E−04	4.17E−04	4.62E−04	5.46E−04	6.27E−04	7.30E−04	8.84E−04	9.39E−04	1.30E−03
31 to <41	687	6.13E−04	3.84E−04	4.20E−04	4.96E−04	5.90E−04	7.08E−04	8.35E−04	9.05E−04	1.55E−03
41 to <51	515	6.35E−04	3.79E−04	4.44E−04	5.17E−04	6.41E−04	7.65E−04	8.79E−04	9.50E−04	1.61E−03
51 to <61	424	6.34E−04	3.93E−04	4.31E−04	5.07E−04	6.12E−04	7.55E−04	8.51E−04	9.28E−04	1.37E−03
61 to <71	465	5.44E−04	3.64E−04	4.04E−04	4.49E−04	5.29E−04	6.10E−04	7.18E−04	8.03E−04	1.11E−03
71 to <81	304	5.94E−04	3.95E−04	4.45E−04	4.98E−04	5.80E−04	6.75E−04	7.76E−04	8.29E−04	1.26E−03
≥81	188	6.66E−04	4.54E−04	4.80E−04	5.43E−04	6.26E−04	7.68E−04	9.32E−04	9.72E−04	1.22E−03

[a] An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999−2002.

N = Number of individuals.
MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-21. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age for Males[a]

Age Group (years)	*N*	Mean	Duration (hours/day) Spent at Activity — Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
Sleep or nap (Activity ID = 14500)										
Birth to <1	419	13.51	12.63	12.78	13.19	13.53	13.88	14.24	14.46	15.03
1	308	12.61	11.89	12.15	12.34	12.61	12.89	13.13	13.29	13.79
2	261	12.06	11.19	11.45	11.80	12.07	12.39	12.65	12.75	13.40
3 to <6	540	11.18	10.57	10.70	10.94	11.18	11.45	11.63	11.82	12.39
6 to <11	940	10.18	9.65	9.75	9.93	10.19	10.39	10.59	10.72	11.24
11 to <16	1,337	9.38	8.84	8.94	9.15	9.38	9.61	9.83	9.95	10.33
16 to <21	1,241	8.69	7.91	8.08	8.36	8.67	9.03	9.34	9.50	10.44
21 to <31	701	8.36	7.54	7.70	8.02	8.36	8.67	9.03	9.23	9.77
31 to <41	728	8.06	7.36	7.50	7.77	8.06	8.36	8.59	8.76	9.82
41 to <51	753	7.89	7.15	7.30	7.58	7.88	8.17	8.48	8.68	9.38
51 to <61	627	7.96	7.29	7.51	7.69	7.96	8.23	8.48	8.66	9.04
61 to <71	678	8.31	7.65	7.78	8.01	8.30	8.6	8.83	9.01	9.66
71 to <81	496	8.51	7.80	8.02	8.27	8.53	8.74	8.99	9.10	9.89
≥81	255	9.24	8.48	8.64	8.97	9.25	9.54	9.74	9.96	10.69
Sedentary and Passive Activities (METS ≤1.5—Includes Sleep or Nap)										
Birth to <1	419	14.95	13.82	14.03	14.49	14.88	15.44	15.90	16.12	17.48
1	308	14.27	13.22	13.33	13.76	14.25	14.74	15.08	15.38	16.45
2	261	14.62	13.52	13.67	14.11	14.54	15.11	15.60	15.77	17.28
3 to <6	540	14.12	13.01	13.18	13.54	14.03	14.53	15.26	15.62	17.29
6 to <11	940	13.51	12.19	12.45	12.86	13.30	13.85	14.82	15.94	19.21
11 to <16	1,337	13.85	12.39	12.65	13.06	13.61	14.30	15.41	16.76	18.79
16 to <21	1,241	13.21	11.39	11.72	12.32	13.08	13.97	14.83	15.44	18.70
21 to <31	701	12.41	10.69	11.06	11.74	12.39	13.09	13.75	14.16	15.35
31 to <41	728	12.31	10.73	10.98	11.61	12.24	12.98	13.63	14.05	15.58
41 to <51	753	12.32	10.56	11.00	11.67	12.30	12.95	13.67	13.98	15.48
51 to <61	627	13.06	11.47	11.86	12.36	13.03	13.72	14.38	14.76	15.95
61 to <71	678	14.49	12.96	13.24	13.76	14.48	15.16	15.72	16.24	17.50
71 to <81	496	15.90	14.22	14.67	15.25	15.94	16.65	17.11	17.46	18.47
≥81	255	16.58	15.13	15.45	15.92	16.64	17.21	17.7	18.06	18.76

Table 6-21. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age for Males[a] (continued)

Age Group (years)	*N*	Mean	Duration (hours/day) Spent at Activity							Maximum
			Percentiles							
			5th	10th	25th	50th	75th	90th	95th	
Light Intensity Activities (1.5< METS ≤3.0)										
Birth to <1	419	5.30	2.97	3.25	3.71	4.52	7.29	8.08	8.50	9.91
1	308	5.52	2.68	2.89	3.37	4.31	8.23	9.04	9.73	10.90
2	261	5.48	3.06	3.26	3.85	4.58	7.58	8.83	9.04	9.92
3 to <6	540	6.60	3.86	4.25	5.16	6.20	8.26	9.31	9.70	10.74
6 to <11	940	7.62	5.07	5.57	6.63	7.63	8.72	9.78	10.12	11.59
11 to <16	1,337	7.50	4.48	5.59	6.75	7.67	8.51	9.19	9.63	10.91
16 to <21	1,241	7.13	4.37	4.97	6.00	7.02	8.29	9.43	10.03	11.50
21 to <31	701	6.09	3.15	3.50	4.20	5.08	8.49	9.96	10.47	12.25
31 to <41	728	5.72	2.80	3.12	3.70	4.64	8.34	9.87	10.49	12.10
41 to <51	753	6.07	2.97	3.41	3.92	4.82	8.56	10.19	10.79	12.68
51 to <61	627	5.64	3.21	3.44	4.03	4.79	7.59	8.94	9.75	12.09
61 to <71	678	5.49	3.50	3.82	4.58	5.29	6.41	7.40	7.95	10.23
71 to <81	496	4.96	3.45	3.75	4.29	4.81	5.59	6.26	6.59	9.90
≥81	255	4.86	3.54	3.71	4.17	4.74	5.39	6.33	6.59	7.56
Moderate Intensity Activities (3.0< METS ≤6.0)										
Birth to <1	419	3.67	0.63	0.97	1.74	4.20	5.20	5.80	6.21	7.52
1	308	4.04	0.45	0.59	1.14	5.29	6.06	6.61	6.94	7.68
2	261	3.83	0.59	0.76	1.23	4.74	5.37	5.82	6.15	7.40
3 to <6	540	3.15	0.55	0.75	1.30	3.80	4.52	5.11	5.32	6.30
6 to <11	940	2.66	0.65	0.92	1.65	2.68	3.57	4.36	4.79	5.95
11 to <16	1,337	2.35	0.88	1.09	1.66	2.30	3.02	3.62	3.89	5.90
16 to <21	1,241	3.35	1.13	1.42	2.19	3.45	4.37	5.24	5.59	6.83
21 to <31	701	5.24	1.15	1.58	2.52	6.01	7.15	7.95	8.39	9.94
31 to <41	728	5.69	1.26	1.65	2.84	6.67	7.75	8.45	8.90	9.87
41 to <51	753	5.40	1.21	1.55	2.39	6.46	7.57	8.40	8.85	10.52
51 to <61	627	5.00	1.29	1.63	2.72	5.68	6.75	7.60	8.01	9.94
61 to <71	678	3.73	1.62	1.97	2.81	3.70	4.67	5.45	6.01	7.45
71 to <81	496	2.87	1.56	1.83	2.28	2.86	3.45	3.95	4.31	5.44
≥81	255	2.35	1.32	1.45	1.79	2.29	2.85	3.28	3.61	4.37

Table 6-21. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age for Males[a] (continued)										
			Duration (hours/day) Spent at Activity							
			Percentiles							
Age Group (years)	*N*	Mean	5th	10th	25th	50th	75th	90th	95th	Maximum
High Intensity (METS >6.0)										
Birth to <1	183	0.20	0.00	0.00	0.01	0.14	0.28	0.50	0.59	0.96
1	164	0.31	0.01	0.01	0.03	0.22	0.56	0.78	0.93	1.52
2	162	0.10	0.00	0.01	0.03	0.05	0.14	0.25	0.33	0.48
3 to <6	263	0.27	0.02	0.03	0.04	0.13	0.33	0.75	1.16	1.48
6 to <11	637	0.32	0.01	0.01	0.03	0.13	0.38	1.10	1.50	3.20
11 to <16	1,111	0.38	0.03	0.04	0.10	0.21	0.47	1.03	1.34	2.35
16 to <21	968	0.40	0.03	0.04	0.14	0.27	0.53	0.99	1.29	2.59
21 to <31	546	0.33	0.02	0.05	0.11	0.27	0.45	0.69	0.85	1.95
31 to <41	567	0.38	0.03	0.07	0.14	0.28	0.51	0.83	1.03	1.77
41 to <51	487	0.34	0.03	0.05	0.09	0.23	0.50	0.78	1.00	2.40
51 to <61	452	0.41	0.03	0.05	0.13	0.34	0.59	0.87	1.13	1.95
61 to <71	490	0.37	0.03	0.05	0.13	0.28	0.49	0.80	1.08	2.21
71 to <81	343	0.39	0.01	0.03	0.10	0.29	0.57	0.90	1.11	2.06
≥81	168	0.32	0.02	0.03	0.08	0.25	0.47	0.71	0.88	1.76

[a] Individual measures are weighted by their 4-year sampling weights as assigned within NHANES 1999−2000 when calculating the statistics in this table. Ventilation rate was estimated using a multiple linear regression model.

N = Number of individuals.
MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-22. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age for Females[a]

Age Group (years)	*N*	Mean	Duration (hours/day) Spent at Activity: Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
Sleep or nap (Activity ID = 14500)										
Birth to <1	415	12.99	12.00	12.16	12.53	12.96	13.44	13.82	14.07	14.82
1	245	12.58	11.59	11.88	12.29	12.63	12.96	13.16	13.31	14.55
2	255	12.09	11.45	11.68	11.86	12.08	12.34	12.57	12.66	13.48
3 to <6	543	11.13	10.45	10.70	10.92	11.12	11.38	11.58	11.75	12.23
6 to <11	894	10.26	9.55	9.73	10.01	10.27	10.54	10.74	10.91	11.43
11 to <16	1,451	9.57	8.82	8.97	9.27	9.55	9.87	10.17	10.31	11.52
16 to <21	1,182	9.08	8.26	8.44	8.74	9.08	9.39	9.79	10.02	11.11
21 to <31	1,023	8.60	7.89	7.99	8.26	8.59	8.90	9.20	9.38	10.35
31 to <41	869	8.31	7.54	7.70	7.98	8.28	8.59	8.92	9.17	10.22
41 to <51	763	8.32	7.58	7.75	7.99	8.31	8.63	8.93	9.13	10.02
51 to <61	622	8.12	7.36	7.53	7.81	8.11	8.43	8.73	8.85	9.29
61 to <71	700	8.40	7.67	7.88	8.15	8.40	8.68	8.93	9.09	9.80
71 to <81	470	8.58	7.85	8.01	8.26	8.55	8.89	9.19	9.46	10.34
≥81	306	9.11	8.35	8.53	8.84	9.10	9.34	9.73	10.04	10.55
Sedentary and Passive Activities (METS ≤1.5—Includes Sleep or Nap)										
Birth to <1	415	14.07	12.86	13.05	13.53	14.08	14.54	15.08	15.49	16.14
1	245	14.32	13.02	13.25	13.73	14.31	14.88	15.36	15.80	16.40
2	255	14.86	13.81	13.95	14.44	14.81	15.32	15.78	16.03	16.91
3 to <6	543	14.27	12.88	13.15	13.56	14.23	14.82	15.43	15.85	17.96
6 to <11	894	13.97	12.49	12.74	13.22	13.82	14.50	15.34	16.36	18.68
11 to <16	1,451	14.19	12.38	12.76	13.34	14.05	14.82	15.87	16.81	19.27
16 to <21	1,182	13.58	11.80	12.17	12.79	13.52	14.29	15.08	15.67	16.96
21 to <31	1,023	12.59	10.97	11.29	11.88	12.60	13.21	13.75	14.19	16.24
31 to <41	869	12.29	10.91	11.14	11.61	12.24	12.91	13.50	13.90	15.18
41 to <51	763	12.22	10.78	11.08	11.56	12.18	12.82	13.40	13.79	15.17
51 to <61	622	12.66	11.08	11.40	12.08	12.64	13.30	13.89	14.12	15.80
61 to <71	700	14.25	12.89	13.16	13.68	14.22	14.86	15.38	15.69	17.14
71 to <81	470	15.38	13.66	14.20	14.76	15.41	16.05	16.62	16.94	17.90
≥81	306	16.48	14.87	15.09	15.80	16.59	17.15	17.71	18.07	19.13

Table 6-22. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age for Females[a] (continued)

Age Group (years)	*N*	Mean	Duration (hours/day) Spent at Activity — Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
Light Intensity Activities (1.5< METS ≤3.0)										
Birth to <1	415	6.00	3.49	3.70	4.26	5.01	8.43	9.31	9.77	10.53
1	245	5.61	2.83	2.94	3.46	4.39	8.28	9.03	9.39	10.57
2	255	5.78	3.20	3.54	4.29	5.33	7.48	8.46	8.74	9.93
3 to <6	543	6.25	3.78	4.10	4.79	5.84	7.86	8.84	9.38	10.32
6 to <11	894	7.27	4.63	5.46	6.33	7.17	8.34	9.42	9.79	11.06
11 to <16	1,451	7.55	4.89	5.62	6.75	7.67	8.55	9.27	9.57	10.85
16 to <21	1,182	6.98	4.60	5.08	5.91	6.85	7.96	9.16	9.57	12.29
21 to <31	1,023	6.42	3.66	4.09	4.84	5.82	8.18	9.56	10.14	12.11
31 to <41	869	6.51	4.06	4.33	5.06	5.98	8.14	9.46	9.93	13.12
41 to <51	763	6.56	3.99	4.30	4.97	5.90	8.40	9.75	10.18	11.83
51 to <61	622	6.52	4.09	4.42	5.19	6.05	7.95	9.12	9.43	11.58
61 to <71	700	6.23	4.40	4.74	5.47	6.23	6.96	7.67	8.17	11.13
71 to <81	470	5.96	4.22	4.51	5.24	5.92	6.63	7.46	7.91	9.43
≥81	306	5.3	3.67	3.96	4.63	5.16	6.00	6.70	7.01	8.78
Moderate Intensity Activities (3.0< METS ≤6.0)										
Birth to <1	415	3.91	0.53	0.74	1.10	4.87	5.77	6.27	6.54	7.68
1	245	4.02	0.52	0.73	1.08	5.14	6.10	7.00	7.37	8.07
2	255	3.27	0.50	0.78	1.22	4.01	4.88	5.35	5.57	6.93
3 to <6	543	3.35	0.70	0.89	1.61	3.88	4.71	5.29	5.65	7.58
6 to <11	894	2.57	0.65	0.95	1.82	2.66	3.41	3.95	4.32	6.10
11 to <16	1,451	2.01	0.89	1.08	1.45	1.96	2.51	3.03	3.28	4.96
16 to <21	1,182	3.26	1.27	1.48	2.21	3.39	4.24	4.74	5.07	6.68
21 to <31	1,023	4.80	1.62	1.94	2.78	5.37	6.42	7.19	7.52	9.21
31 to <41	869	5.00	1.71	2.06	3.09	5.41	6.60	7.31	7.58	9.59
41 to <51	763	5.05	1.75	2.00	2.97	5.48	6.66	7.50	7.97	10.16
51 to <61	622	4.58	1.71	2.13	3.10	4.79	5.98	6.89	7.14	8.97
61 to <71	700	3.31	1.65	1.97	2.56	3.34	4.01	4.61	5.01	6.90
71 to <81	470	2.48	1.19	1.36	1.82	2.48	2.99	3.64	4.01	5.63
≥81	306	2.06	1.01	1.25	1.55	1.99	2.51	3.07	3.44	4.68

Table 6-22. Descriptive Statistics for Duration of Time (hours/day) Spent Performing Activities Within the Specified Activity Category, by Age for Females[a] (continued)

Age Group (years)	*N*	Mean	Duration (hours/day) Spent at Activity — Percentiles 5th	10th	25th	50th	75th	90th	95th	Maximum
High Intensity (METS >6.0)										
Birth to <1	79	0.17	0.03	0.05	0.09	0.14	0.21	0.33	0.40	0.58
1	55	0.22	0.03	0.05	0.09	0.18	0.35	0.40	0.43	0.48
2	130	0.15	0.00	0.01	0.03	0.08	0.16	0.48	0.65	1.01
3 to <6	347	0.19	0.01	0.02	0.05	0.10	0.22	0.46	0.73	1.43
6 to <11	707	0.24	0.02	0.03	0.06	0.12	0.26	0.67	0.98	1.71
11 to <16	1,170	0.30	0.03	0.04	0.08	0.19	0.40	0.66	0.96	3.16
16 to <21	887	0.24	0.01	0.03	0.08	0.18	0.34	0.51	0.60	1.61
21 to <31	796	0.26	0.03	0.05	0.10	0.19	0.36	0.56	0.67	1.40
31 to <41	687	0.25	0.03	0.05	0.09	0.19	0.33	0.52	0.72	1.40
41 to <51	515	0.26	0.03	0.04	0.09	0.20	0.36	0.55	0.68	1.49
51 to <61	424	0.34	0.03	0.04	0.12	0.28	0.50	0.74	0.85	1.58
61 to <71	465	0.32	0.03	0.04	0.10	0.23	0.46	0.68	0.89	1.77
71 to <81	304	0.29	0.03	0.05	0.10	0.25	0.43	0.60	0.71	1.24
≥81	188	0.26	0.02	0.03	0.09	0.21	0.38	0.59	0.71	1.23

[a] Individual measures are weighted by their 4-year sampling weights as assigned within NHANES 1999−2000 when calculating the statistics in this table. Ventilation rate was estimated using a multiple linear regression model.

N = Number of individuals.
MET = Metabolic equivalent.

Source: U.S. EPA, 2009.

Table 6-23. Mean Inhalation Rate Values (m^3/day) from Key Studies for Males and Females Combined

Age Group[a]	U.S. EPA (2009)[b]		Brochu et al. (2006a)[b]		Arcus-Arth and Blaisdell (2007)[b]		Stifelman (2007)[c]		Combined Key Studies[d]	
	N[c]	Mean	*N*	Mean	*N*	Mean	*N*	Mean	*N*	Mean
Birth to <1 month	-	-	-	-	182	3.63	-	-	182	3.63
1 to <3 months	-	-	85	3.31	182	3.63	-	-	267	3.47
3 to <6 months	-	-	85	3.31	294	4.92	-	-	379	4.11
6 to <12 months	-	-	103	4.06	544	6.78	-	-	647	5.42
Birth to <1 year	834	8.64	188	3.72	1,020	5.70	-	3.4	2,042	5.36
1 to <2 years	553	13.41	101	4.90	934	8.77	-	4.9	1,588	7.99
2 to <3 years	516	12.99	61	7.28	989	9.76	-	5.7	1,566	8.93
3 to <6 years	1,083	12.40	61	7.28	4,107	11.22	-	9.3	5,251	10.05
6 to <11 years	1,834	12.93	199	9.98	1,553	13.42	-	11.5	3,586	11.96
11 to <16 years	2,788	14.34	117	14.29	975	16.98	-	15.0	3,880	15.17
16 to <21 years	2,423	15.44	117	14.29	495	18.29	-	17.0	3,035	16.25
21 to <31 years	1,724	16.30	219	14.59	-	-	-	16.3	1,943	15.74
31 to <41 years	1,597	17.40	100	14.99	-	-	-	15.6	1,697	16.00
41 to <51 years	1,516	18.55	91	13.74	-	-	-	15.6	1,607	15.96
51 to <61 years	1,249	18.56	91	13.74	-	-	-	14.7	1,340	15.66
61 to <71 years	1,378	15.43	186	12.57	-	-	-	14.7	1,564	14.23
71 to <81 years	966	14.25	95	11.46	-	-	-	-	1,061	12.86
≥81 years	561	12.97	95	11.46	-	-	-	-	656	12.21

[a] When age groupings in the original reference did not match the U.S. EPA groupings used for this handbook, means from all age groupings in the original reference that overlapped U.S. EPA's age groupings by more than 1 year were averaged, weighted by the number of observations contributed from each age group. See Table 6-25 for concordance with U.S. EPA age groupings.
[b] Weighted (where possible) average of reported study means.
[c] The total number of subjects for Stifelman (2007) was 3,007.
[d] Unweighted average of means from key studies.

Table 6-24. 95th Percentile Inhalation Rate Values (m³/day) from Key Studies for Males and Females Combined										
Age Group[a]	U.S. EPA (2009)[b]		Brochu et al. (2006a)[b]		Arcus-Arth and Blaisdell (2007)[b]		Stifelman (2007)[c]		Combined Key Studies[d]	
	N[a]	95th	*N*	95th	*N*	95th	*N*	95th	*N*	95th
Birth to <1 month	-[b]	-	-	-	182	7.10	-	-	182	7.10
1 to <3 months	-	-	85	4.44	182	7.10	-	-	267	5.77
3 to <6 months	-	-	85	4.44	294	7.72	-	-	379	6.08
6 to <12 months	-	-	103	5.28	544	10.81	-	-	647	8.04
Birth to <1 year	834	12.67	188	4.90	1,020	9.95	-	-	2,042	9.17
1 to <2 years	553	18.22	101	6.43	934	13.79	-	-	1,588	12.81
2 to <3 years	516	17.04	61	9.27	989	14.81	-	-	1,566	13.71
3 to <6 years	1,083	15.17	61	9.27	4,107	17.09	-	-	5,251	13.84
6 to <11 years	1,834	17.05	199	12.85	1,553	19.86	-	-	3,586	16.59
11 to <16 years	2,788	19.23	117	19.02	975	27.53	-	-	3,880	21.93
16 to <21 years	2,423	20.89	117	19.02	495	33.99	-	-	3,035	24.63
21 to <31 years	1,724	23.57	219	19.00	-	-	-	-	1,943	21.29
31 to <41 years	1,597	24.30	100	18.39	-	-	-	-	1,697	21.35
41 to <51 years	1,516	24.83	91	17.50	-	-	-	-	1,607	21.16
51 to <61 years	1,249	25.17	91	17.50	-	-	-	-	1,340	21.33
61 to <71 years	1,378	19.76	186	16.37	-	-	-	-	1,564	18.07
71 to <81 years	966	17.88	95	15.30	-	-	-	-	1,061	16.59
≥81 years	561	16.10	95	15.30	-	-	-	-	656	15.70

a When age groupings in the original reference did not match the U.S. EPA groupings used for this handbook, 95th percentiles from all age groupings in the original reference that overlapped U.S. EPA's age groupings by more than 1 year were averaged, weighted by the number of observations contributed from each age group. See Table 6-25 for concordance with U.S. EPA age groupings.

b Weighted (where possible) average of reported study 95th percentiles.

c The total number of subjects for Stifelman (2007) was 3,007.

d Unweighted average of 95th percentiles from key studies.

Table 6-25. Concordance of Age Groupings Among Key Studies				
Age Group[a]	U.S. EPA (2009)	Brochu (2006a)	Arcus-Arth and Blaisdell (2007)	Stifelman (2007)
Birth to <1 month	—	—	0 to 2 months	—
1 to <3 months	—	0.22 to <0.5 year	0 to 2 months	—
3 to <6 months	—	0.22 to <0.5 year	3 to 5 months	—
6 to <12 months	—	0.5 to <1 year	6 to 8 months	—
	—	—	9 to 11 months	—
Birth to <1 year	Birth to <1 year	0.22 to <0.5 year	0 to 11 months	<1 year
	—	0.5 to <1 year	—	—
1 to <2 years	1 to <2 years	1 to <2 years	1 year	1 year
2 to <3 years	2 to <3 years	2 to <5 years	2 years	2 years
3 to <6 years	3 to <6 years	2 to <5 years	3 years	3 years
	—	—	4 years	4 years
	—	—	5 years	5 years
6 to <11 years	6 to <11 years	7 to <11 years	6 years	6 years
	—	—	7 years	7 years
	—	—	8 years	8 years
	—	—	9 years	9 years
	—	—	10 years	10 years
11 to <16 years	11 to <16 years	11 to <23 years	11 years	11 years
	—	—	12 years	12 years
	—	—	13 years	13 years
	—	—	14 years	14 years
	—	—	15 years	15 years
16 to <21 years	16 to <21 years	11 to <23 years	16 years	16 years
	—	—	17 years	17 years
	—	—	18 years	18 years
	—	—	—	19 to 30 years
21 to <31 years	21 to <31 years	11 to <23 years	—	19 to 30 years
	—	23 to <30 years	—	—
31 to <41 years	31 to <41 years	30 to <40 years	—	31 to 50 years
41 to <51 years	41 to <51 years	40 to <65 years	—	31 to 50 years
51 to <61 years	51 to <61 years	40 to <65 years	—	51 to 70 years
61 to <71 years	61 to <71 years	40 to <65 years	—	51 to 70 years
	—	65 to ≤96 years	—	—
71 to <81 years	71 to <81 years	65 to ≤96 years	—	—
≥81 years	≥81 years	65 to ≤96 years	—	—

[a] When age groups in the original reference did not match the U.S. EPA groupings used for this handbook, statistics were averaged from all age groupings in the original reference that overlapped U.S. EPA's age groupings by more than 1 year, weighted by the number of observations contributed from each age group. For example, Brochu (2006a) contributes its 2 to <5-year age group data to both U.S. EPA's 2 to <3-year and 3 to <6-year age groups.

Table 6-26. Time Weighted Average of Daily Inhalation Rates (DIRs) Estimated from Daily Activities[a]

Subject	Inhalation Rate (m^3/hour) Resting	Inhalation Rate (m^3/hour) Light Activity	DIR[b] (m^3/day)
Adult Man	0.45	1.2	22.8
Adult Woman	0.36	1.14	21.1
Child (10 years)	0.29	0.78	14.8
Infant (1 year)	0.09	0.25	3.76
Newborn	0.03	0.09	0.78

a Assumptions made were based on 8 hr resting and 16 hr light activity for adults and children (10 years); 14 hr resting and 10 hr light activity for infants (1 year); 23 hr resting and 1 hr light activity for newborns.

b

$$DIR = \frac{1}{T}\sum_{i=1}^{K} IR_i t_i$$

DIR = Daily Inhalation Rate,
IR_i = Corresponding inhalation rate at i^{th} activity,
t_i = Hours spent during the i^{th} activity,
k = Number of activity periods, and
T = Total time of the exposure period (i.e., a day).

Source: ICRP, 1981.

Table 6-27. Selected Inhalation Rate Values During Different Activity Levels Obtained from Various Literature Sources

Subject	BW (kg)	Resting			Light Activity			Heavy Work			Maximal Work During Exercise		
		f	VT	V*	f	VT	V*	f	VT	V*	f	VT	V*
Adolescent													
Male, 14−16 years		16	330	5.2							53	2,520	113
Male, 14−15 years	59.4												
Female, 14−16 years		15	300	4.5									
Female, 14−15 years; 164.9 cm L	56										52	1,870	88
Children													
10 year; 140 cm L		16	300	4.8	24	600	14						
Males, 10−11 years	36.5										58	1,330	71
Males, 10−11 years; 140.6 cm L	32.5										61	1,050	61
Females, 4−6 years	20.8										70	600	40
Females, 4−6 years; 111.6 cm L	18.4										66	520	34
Infant, 1 year		30	48	1.4[a]									
Newborn	2.5	34	15	0.5									
20 hours−13 weeks	2.5−5.3										68[b]	51[a,b]	3.5[b]
9.6 hours	3.6	25	21	0.5									
6.6 days	3.7	29	21	0.6									
Adult													
Man	68.5	12	750	7.4	17	1,670	29	21	2,030	43			
1.7 m^2 SA		12	500	6									
30 years; 170 cm L		15	500	7.5	16	1,250	20						
20−33 years	70.4										40	3,050	111
Woman	54	12	340	4.5	19	860	16	30	880	25			
30 years; 160 cm L		15	400	6	20	940	19						
20−25 years; 165.8 cm L	60.3										46	2,100	90
Pregnant (8th month)		16	650	10									

[a] Calculated from $V^* = f \times VT$.
[b] Crying.

BW = body weights.
f = frequency (breaths/minute).
VT = tidal volume (mL).
V* = minute volume (L/minute).
cm L = length/height.

Source: ICRP, 1981.

Table 6-28. Summary of Human Inhalation Rates by Activity Level (m^3/hour)[a]								
	N[b]	Resting[c]	*N*[b]	Light[d]	*N*[b]	Moderate[e]	*N*[b]	Heavy[f]
Child, 6 years	8	0.4	16	0.8	4	2.0	5	2.3
Child, 10 years	10	0.4	40	1.0	29	3.2	43	3.9
Adult male	454	0.7	102	0.8	102	2.5	267	4.8
Adult female	595	0.3	786	0.5	106	1.6	211	2.9
Average adult	1,049	0.5	888	0.6	208	2.1	478	3.9

a Values of inhalation rates for children (male and female) presented in this table represent the mean of values reported for each activity level in 1985.
b Number of observations at each activity level.
c Includes watching television, reading, and sleeping.
d Includes most domestic work, attending to personal needs and care, hobbies, and conducting minor indoor repairs and home improvements.
e Includes heavy indoor cleanup, performance of major indoor repairs and alterations, and climbing stairs.
f Includes vigorous physical exercise and climbing stairs carrying a load.

Source: Adapted from U.S. EPA, 1985.

Table 6-29. Estimated Minute Ventilation Associated with Activity Level for Average Male Adult[a]		
Level of work	L/minute	Representative activities
Light	13	Level walking at 2 mph; washing clothes
Light	19	Level walking at 3 mph; bowling; scrubbing floors
Light	25	Dancing; pushing wheelbarrow with 15-kg load; simple construction; stacking firewood
Moderate	30	Easy cycling; pushing wheelbarrow with 75-kg load; using sledgehammer
Moderate	35	Climbing stairs; playing tennis; digging with spade
Moderate	40	Cycling at 13 mph; walking on snow; digging trenches
Heavy Heavy Very heavy	55 63 72	Cross-country skiing; rock climbing; stair climbing with load; playing squash or handball; chopping with axe
Very heavy	85	Level running at 10 mph; competitive cycling
Severe	100+	Competitive long distance running; cross-country skiing

a Average adult assumed to weigh 70 kg.

Source: Adapted from U.S. EPA, 1985.

Table 6-30. Activity Pattern Data Aggregated for Three Microenvironments by Activity Level for All Age Groups

Microenvironment	Activity Level	Average Hours Per Day in Each Microenvironment at Each Activity Level
Indoors	Resting	9.82
	Light	9.82
	Moderate	0.71
	Heavy	0.10
	TOTAL	20.4
Outdoors	Resting	0.51
	Light	0.51
	Moderate	0.65
	Heavy	0.12
	TOTAL	1.77
In Transportation Vehicle	Resting	0.86
	Light	0.86
	Moderate	0.05
	Heavy	0.0012
	TOTAL	1.77

Source: Adapted from U.S. EPA, 1985.

Table 6-31. Summary of Daily Inhalation Rates (DIRs) Grouped by Age and Activity Level

Subject	Daily Inhalation Rate (m^3/day)[a]				Total Daily IR[b] (m^3/day)
	Resting	Light	Moderate	Heavy	
Child, 6 years	4.47	8.95	2.82	0.50	16.74
Child, 10 years	4.47	11.19	4.51	0.85	21.02
Adult Male	7.83	8.95	3.53	1.05	21.4
Adult Female	3.35	5.59	2.26	0.64	11.8
Adult Average	5.60	6.71	2.96	0.85	16

[a] Daily inhalation rate was calculated using the following equation:

$$IR = \frac{1}{T}\sum_{i=1}^{k} IRt_i$$

IR_i = Inhalation rate at i^{th} activity,
t_i = Hours spent per day during i^{th} activity,
k = Number of activity periods, and
T = Total time of the exposure period (e.g., a day).

[b] Total daily inhalation rate was calculated by summing the specific activity (resting, light, moderate, heavy) and dividing them by the total amount of time spent on all activities.

Source: Generated using the data from U.S. EPA, 1985 as shown in Tables 6-28 and 6-30.

Table 6-32. Distribution Pattern of Predicted Ventilation Rate (VR) and Equivalent Ventilation Rate (EVR) for 20 Outdoor Workers

Self-Reported Activity Level	*N*[c]	VR (m^3/hour)[a] Arithmetic Mean ± SD	VR (m^3/hour)[a] Geometric Mean ± SD	EVR[b] (m^3/hour/m^2 body surface) Arithmetic Mean ± SD	EVR[b] (m^3/hour/m^2 body surface) Geometric Mean ± SD
Sleep	18,597	0.42 ± 0.16	0.39 ± 0.08	0.23 ± 0.08	0.22 ± 0.08
Slow	41,745	0.71 ± 0.4	0.65 ± 0.09	0.38 ± 0.20	0.35 ± 0.09
Medium	3,898	0.84 ± 0.47	0.76 ± 0.09	0.48 ± 0.24	0.44 ± 0.09
Fast	572	2.63 ± 2.16	1.87 ± 0.14	1.42 ± 1.20	1.00 ± 0.14

Percentile Rankings, VR

	1	5	10	50	90	95	99	99.9
Sleep	0.18	0.18	0.24	0.36	0.66	0.72	0.90	1.20
Slow	0.30	0.36	0.36	0.66	1.08	1.32	1.98	4.38
Medium	0.36	0.42	0.48	0.72	1.32	1.68	2.64	3.84
Fast	0.42	0.54	0.60	1.74	5.70	6.84	9.18	10.26

Percentile Rankings, EVR

	1	5	10	50	90	95	99	99.9
Sleep	0.12	0.12	0.12	0.24	0.36	0.36	0.48	0.60
Slow	0.18	0.18	0.24	0.36	0.54	0.66	1.08	2.40
Medium	0.18	0.24	0.30	0.42	0.72	0.90	1.38	2.28
Fast	0.24	0.30	0.36	0.90	3.24	3.72	4.86	5.52

[a] Data presented by Shamoo et al. (1991) in L/minute were converted to m^3/hour.
[b] EVR = VR per square meter of body surface area.
[c] Number of minutes with valid appearing heart rate records and corresponding daily records of breathing rate.

Source: Shamoo et al., 1991.

Table 6-33. Distribution Pattern of Inhalation Rate by Location and Activity Type for 20 Outdoor Workers

Location	Activity Type[a]	Self-reported Activity Level	% of Time	Inhalation rate (m^3/hour)[b] ± SD	% of Avg.[c]
Indoor	Essential	Sleep	28.7	0.42 ± 0.12	69 ± 15
		Slow	29.5	0.72 ± 0.36	106 ± 43
		Medium	2.4	0.72 ± 0.30	129 ± 38
		Fast	0	0	0
Indoor	Non-essential	Slow	20.4	0.66 ± 0.36	98 ± 36
		Medium	0.9	0.78 ± 0.30	120 ± 50
		Fast	0.2	1.86 ± 0.96	278 ± 124
Outdoor	Essential	Slow	11.3	0.78 ± 0.36	117 ± 42
		Medium	1.8	0.84 ± 0.54	130 ± 56
		Fast	0	0	0
Outdoor	Non-essential	Slow	3.2	0.90 ± 0.66	136 ± 90
		Medium	0.8	1.26 ± 0.60	213 ± 91
		Fast	0.7	2.82 ± 2.28	362 ± 275

[a] Essential activities include income-related work, household chores, child care, study and other school activities, personal care, and destination-oriented travel; Non-essential activities include sports and active leisure, passive leisure, some travel, and social or civic activities.

[b] Data presented by Shamoo et al. (1991) in L/min were converted to m^3/hour.

[c] Statistic was calculated by converting each VR for a given subject to a percentage of her/his overall average.

Source: Adapted from Shamoo et al., 1991.

Table 6-34. Calibration and Field Protocols for Self-Monitoring of Activities Grouped by Subject Panels		
Panel	Calibration Protocol	Field Protocol
Panel 1: Healthy Outdoor Workers—15 female, 5 male, age 19−50	Laboratory treadmill exercise tests, indoor hallway walking tests at different self-chosen speeds, 2 outdoor tests consisted of 1-hour cycles each of rest, walking, and jogging.	3 days in 1 typical summer week (included most active workday and most active day off); HR recordings and activity diary during waking hours.
Panel 2: Healthy Elementary School Students—5 male, 12 female, ages 10−12	Outdoor exercises each consisted of 20 minute rest, slow walking, jogging and fast walking.	Saturday, Sunday and Monday (school day) in early autumn; heart rate recordings and activity diary during waking hours and during sleep.
Panel 3: Healthy High School Students—7 male, 12 female, ages 13−17	Outdoor exercises each consisted of 20 minute rest, slow walking, jogging and fast walking.	Same as Panel 2, however, no heart rate recordings during sleep for most subjects.
Panel 4: Adult Asthmatics, clinically mild, moderate, and severe—15 male, 34 female, age 18−50	Treadmill and hallway exercise tests.	1 typical summer week, 1 typical winter week; hourly activity/health diary during waking hours; lung function tests 3 times daily; HR recordings during waking hours on at least 3 days (including most active work day and day off).
Panel 5: Adult Asthmatics from 2 neighborhoods of contrasting O_3 air quality—10 male, 14 female, age 19−46	Treadmill and hallway exercise tests.	Similar to Panel 4, personal NO_2 and acid exposure monitoring included. (Panels 4 and 5 were studied in different years, and had 10 subjects in common).
Panel 6: Young Asthmatics—7 male, 6 female, ages 11−16	Laboratory exercise tests on bicycles and treadmills.	Summer monitoring for 2 successive weeks, including 2 controlled exposure studies with few or no observable respiratory effects.
Panel 7: Construction Workers—7 male, age 26−34	Performed similar exercises as Panel 2 and 3, and also performed job-related tests including lifting and carrying a 9-kg pipe.	HR recordings and diary information during 1 typical summer work day.
Source: Linn et al., 1992.		

Table 6-35. Subject Panel Inhalation Rates by Mean Ventilation Rate (VR), Upper Percentiles, and Self-Estimated Breathing Rates						
		Inhalation Rates (m^3/hour)				
				Mean VR at Activity Levels[b]		
Panel Number and Description	*N*[a]	Mean VR	99th Percentile VR	Slow	Medium	Fast
Healthy						
1—Adults	20	0.78	2.46	0.72	1.02	3.06
2—Elementary School Students	17	0.90	1.98	0.84	0.96	1.14
3—High School Students	19	0.84	2.22	0.78	1.14	1.62
7—Construction Workers[c]	7	1.50	4.26	1.26	1.50	1.68
Asthmatics						
4—Adults	49	1.02	1.92	1.02	1.68	2.46
5—Adults[d]	24	1.20	2.40	1.20	2.04	4.02
6—Elementary and High School Students	13	1.20	2.40	1.20	1.20	1.50

[a] Number of individuals in each survey panel.
[b] Some subjects did not report medium and/or fast activity. Group means were calculated from individual means (i.e., give equal weight to each individual who recorded any time at the indicated activity level).
[c] Construction workers recorded only on 1 day, mostly during work, while others recorded on ≥1 work or school day and ≥1 day off.
[d] Excluding subjects also in Panel 4.

VR = Ventilation rate.

Source: Linn et al., 1992.

Table 6-36. Actual Inhalation Rates Measured at Four Ventilation Levels					
		Mean Inhalation Rate[a] (m^3/hour)			
Subject	**Location**	**Low**	**Medium**	**Heavy**	**Very Heavy**
All subjects	Indoor (treadmill post)	1.23	1.83	3.13	4.13
	Outdoor	0.88	1.96	2.93	4.90
	Total	0.93	1.92	3.01	4.80

[a] Original data were presented in L/minute. Conversion to m^3/hour was obtained as follows:

$L/minute \times 0.001\ m^3/L \times 60\ minute/hour = m^3/hour$

Source: Adapted from Shamoo et al., 1992.

Table 6-37. Distribution of Predicted Inhalation Rates by Location and Activity Levels for Elementary and High School Students

Age (years)	Student	Location	Activity Level	% Recorded Time[a]	Inhalation Rates (m^3/hour) Mean ± SD	Percentile Rankings[b] 1st	50th	99.9th
10−12	EL[c] (N[d] = 17)	Indoors	slow	49.6	0.84 ± 0.36	0.18	0.78	2.34
			medium	23.6	0.96 ± 0.36	0.24	0.84	2.58
			fast	2.4	1.02 ± 0.60	0.24	0.84	3.42
		Outdoors	slow	8.9	0.96 ± 0.54	0.36	0.78	4.32
			medium	11.2	1.08 ± 0.48	0.24	0.96	3.36
			fast	4.3	1.14 ± 0.60	0.48	0.96	3.60
13−17	HS[c] (N[d] = 19)	Indoors	slow	70.7	0.78 ± 0.36	0.30	0.72	3.24
			medium	10.9	0.96 ± 0.42	0.42	0.84	4.02
			fast	1.4	1.26 ± 0.66	0.54	1.08	6.84[e]
		Outdoors	slow	8.2	0.96 ± 0.48	0.42	0.90	5.28
			medium	7.4	1.26 ± 0.78	0.48	1.08	5.70
			fast	1.4	1.44 ± 1.08	0.48	1.02	5.94

[a] Recorded time averaged about 23 hours per elementary school student and 33 hours per high school student over 72-hour periods.
[b] Geometric means closely approximated 50th percentiles; geometric standard deviations were 1.2−1.3 for HR, 1.5−1.8 for VR.
[c] Elementary school student (EL) or high school student (HS).
[d] Number of students that participated in survey.
[e] Highest single value.

SD = Standard deviation.

Source: Spier et al., 1992.

Table 6-38. Average Hours Spent Per Day in a Given Location and Activity Level for Elementary and High School Students

Students	Location	Activity Level: Slow	Medium	Fast	Total Time Spent (hours/day)
Elementary school, ages 10 to 12 years (*N* = 17)	Indoors	16.3	2.9	0.4	19.6
	Outdoors	2.2	1.7	0.5	4.4
High school, ages 13 to 17 years (*N* = 19)	Indoors	19.5	1.5	0.2	21.2
	Outdoors	1.2	1.3	0.2	2.7

N = Number of students that participated in survey.

Source: Spier et al., 1992.

Table 6-39. Distribution Patterns of Daily Inhalation Rates (DIRs) for Elementary (EL) and High School (HS) Students Grouped by Activity Level

Students	Age (years)	Location	Activity Type[a]	Mean IR[b] (m^3/day)	Percentile Rankings: 1st	50th	99.9th
EL (*N*[c] = 17)	10 to 12	Indoor	Light	13.7	2.93	12.71	38.14
			Moderate	2.8	0.70	2.44	7.48
			Heavy	0.4	0.10	0.34	1.37
EL		Outdoor	Light	2.1	0.79	1.72	9.5
			Moderate	1.84	0.41	1.63	5.71
			Heavy	0.57	0.24	0.48	1.80
HS (*N* = 19)	13 to 17	Indoor	Light	15.2	5.85	14.04	63.18
			Moderate	1.4	0.63	1.26	6.03
			Heavy	0.25	0.11	0.22	1.37
HS		Outdoor	Light	1.15	0.5	1.08	6.34
			Moderate	1.64	0.62	1.40	7.41
			Heavy	0.29	0.10	0.20	1.19

[a] For this report, activity type presented in Tables 6-37 and 6-38 was redefined as light activity for slow, moderate activity for medium, and heavy activity for fast.
[b] Daily inhalation rate was calculated by multiplying the hours spent at each activity level (see Table 6-38) by the corresponding inhalation rate (see Table 6-37).
[c] Number of elementary (EL) and high school students (HS).

Source: Adapted from Spier et al., 1992 (Generated using data from Tables 6-37 and 6-38).

Activity	Young Children[a]	Children[a]	Adult Females[a]	Adult Males[a]	Adults (combined)[a]
Lying	6.19E−03	7.51E−03	7.12E−03	8.93E−03	8.03E−03
Sitting	6.48E−03	7.28E−03	7.72E−03	9.30E−03	8.51E−03
Standing	6.76E−03	8.49E−03	8.36E−03	10.65E−03	9.51E−03
Walking					
1.5 mph	1.03E−02	DNP[b]	DNP	DNP	DNP
1.875 mph	1.05E−02	DNP	DNP	DNP	DNP
2.0 mph	DNP	1.41E−02	DNP	DNP	DNP
2.25 mph	1.17E−02	DNP	DNP	DNP	DNP
2.5 mph	DNP	1.56E−02	2.03E−02	2.41E−02	2.22E−02
3.0 mph	DNP	1.78E−02	2.42E−02	DNP	DNP
3.3 mph	DNP	DNP	DNP	2.79E−02	DNP
4.0 mph	DNP	DNP	DNP	3.65E−02	DNP
Running					
3.5 mph	DNP	2.68E−02	DNP	DNP	DNP
4.0 mph	DNP	3.12E−02	4.60E−02[b]	DNP	DNP
4.5 mph	DNP	3.72E−02	4.79E−02[b]	5.73E−02	5.26E−02
5.0 mph	DNP	DNP	5.08E−02[b]	5.85E−02	5.47E−02
6.0 mph	DNP	DNP	DNP	6.57E−02[b]	DNP

Table 6-40. Mean Minute Inhalation Rate (m^3/minute) by Group and Activity for Laboratory Protocols

[a] Young children, male and female 3−5.9 year olds; children, male and female 6−12.9 year olds; adult females, adolescent, young to middle-aged, and older adult females; adult males, adolescent, young to middle-aged, and older adult males. DNP, group did not perform this protocol or *N* was too small for appropriate mean comparisons.

[b] Older adults not included in the mean value since they did not perform running protocol at particular speeds.

Source: Adams, 1993.

Table 6-41. Mean Minute Inhalation Rate (m^3/minute) by Group and Activity for Field Protocols

Activity	Young Children[a]	Children[a]	Adult Females[a]	Adult Males[a]	Adults (combined)[a]
Play	1.13E−02	1.79E−02	DNP	DNP	DNP
Car Driving	DNP	DNP	8.95E−03	1.08E−02	9.87E−03
Car Riding	DNP	DNP	8.19E−03	9.83E−03	9.01E−03
Yardwork	DNP	DNP	1.92E−02[b]	2.61E−02[c]/3.19E−02[d]	2.27E−02[c]/2.56E−02[d]
Housework	DNP	DNP	1.74E−02	DNP	DNP
Car Maintenance	DNP	DNP	DNP	2.32E−02[e]	DNP
Mowing	DNP	DNP	DNP	3.66E−02[b]	DNP
Woodworking	DNP	DNP	DNP	2.44E−02[b]	DNP

[a] Young children, male and female 3−5.9 year olds; children, male and female 6−12.9 year olds; adult females, adolescent, young to middle-aged, and older adult females; adult males, adolescent, young to middle-aged, and older adult males; DNP, group did not perform this protocol or *N* was too small for appropriate mean comparisons.

[b] Adolescents not included in mean value since they did not perform this activity.

[c] Mean value for young to middle-aged adults only.

[d] Mean value for older adults only.

[e] Older adults not included in the mean value since they did not perform this activity.

Source: Adams, 1993.

Table 6-42. Summary of Average Inhalation Rates (m^3/hour) by Age Group and Activity Levels for Laboratory Protocols

Age Group	Activity Level				
	Resting[a]	Sedentary[b]	Light[c]	Moderate[d]	Heavy[e]
Young Children (3−5.9 years) Average inhalation rate (m^3/hour) (*N* = 12, sex not specified)	0.37	0.40	0.65	DNP[f]	DNP
Children (6−12.9 years) Average inhalation rate (m^3/hour) (*N* = 40, 20 male and 20 female)	0.45	0.47	0.95	1.74	2.23
Adults (females) (Adolescent, young to middle aged, and older adult females) (*N* = 37)	0.43	0.48	1.33	2.76	2.96[g]
Adults (males) (Adolescent, young to middle aged, and older adult males) (*N* = 39)	0.54	0.60	1.45	1.93	3.63
Adults (combined) (*N* = 76)	0.49	0.54	1.38	2.35	3.30

a Resting defined as lying (see Table 6-40 for original data).
b Sedentary defined as sitting and standing (see Table 6-40 for original data).
c Light defined as walking at speed level 1.5−3.0 mph (see Table 6-40 for original data).
d Moderate defined as fast walking (3.3−4.0 mph) and slow running (3.5−4.0 mph) (see Table 6-40 for original data).
e Heavy defined as fast running (4.5−6.0 mph) (see Table 6-40 for original data).
f Group did not perform (DNP) this protocol or *N* was too small for appropriate mean comparisons. All young children did not run.
g Older adults not included in mean value since they did not perform running protocols at particular speeds.

Source: Adapted from Adams, 1993.

Table 6-43. Summary of Average Inhalation Rates (m^3/hour) by Age Group And Activity Levels in Field Protocols

Age Group	Sedentary Activity[a]	Light Activity[b]	Moderate Activity[c]
Young Children (3 to 5.9 years) Average inhalation rate (m^3/hour) (*N* = 12, sex not specified)	DNP	DNP[d]	0.68
Children (6 to 12.9 years) Average inhalation rate (m^3/hour) (*N* = 40, 20 male and 20 female)	DNP	DNP	1.07
Adults (females) (Adolescent, young to middle aged, and older adult females) (*N* = 37)	0.51	1.10[e]	DNP
Adults (males) (Adolescent, young to middle aged, and older adult males) (*N* = 39)	0.62	1.40	1.78[f]
Adults (combined) (*N* = 76)	0.57	1.25	DNP

[a] Sedentary activity was defined as car driving and riding (both sexes) (see Table 6-41 for original data).
[b] Light activity was defined as car maintenance (males), housework (females), and yard work (females) (see Table 6-41 for original data).
[c] Moderate activity was defined as mowing (males); wood working (males); yard work (males); and play (children) (see Table 6-41 for original data).
[d] DNP. Group did not perform this protocol or *N* was too small for appropriate mean comparisons.
[e] Older adults not included in mean value since they did not perform this activity.
[f] Adolescents not included in mean value since they did not perform this activity.

N = Number of individuals.

Source: Adams, 1993.

Table 6-44. Comparisons of Estimated Basal Metabolic Rates (BMR) with Average Food-Energy Intakes (EFDs) for Individuals Sampled in the 1977−1978 NFCS

Cohort/Age (years)	Body Weight (kg)	BMR[a]		EFD		Ratio
		MJ/day[b]	Kcal/day[c]	MJ/day	Kcal/day	EFD[d]/BMR
Males and Females						
<1	7.6	1.74	416	3.32	793	1.90
1 to 2	13	3.08	734	5.07	1,209	1.65
3 to 5	18	3.69	881	6.14	1,466	1.66
6 to 8	26	4.41	1,053	7.43	1,774	1.68
Males						
9 to 11	36	5.42	1,293	8.55	2,040	1.58
12 to 14	50	6.45	1,540	9.54	2,276	1.48
15 to 18	66	7.64	1,823	10.8	2,568	1.41
19 to 22	74	7.56	1,804	10.0	2,395	1.33
23 to 34	79	7.87	1,879	10.1	2,418	1.29
35 to 50	82	7.59	1,811	9.51	2,270	1.25
51 to 64	80	7.49	1,788	9.04	2,158	1.21
65 to 74	76	6.18	1,476	8.02	1,913	1.30
≥75	71	5.94	1,417	7.82	1,866	1.32
Females						
9 to 11	36	4.91	1,173	7.75	1,849	1.58
12 to 14	49	5.64	1,347	7.72	1,842	1.37
15 to 18	56	6.03	1,440	7.32	1,748	1.21
19 to 22	59	5.69	1,359	6.71	1,601	1.18
23 to 34	62	5.88	1,403	6.72	1,603	1.14
35 to 50	66	5.78	1,380	6.34	1,514	1.10
51 to 64	67	5.82	1,388	6.40	1,528	1.10
65 to 74	66	5.26	1,256	5.99	1,430	1.14
≥75	62	5.11	1,220	5.94	1,417	1.16

[a] Calculated from the appropriate age and sex-based BMR equations given in Table 6-46.
[b] MJ/day = megajoules/day.
[c] Kcal/day = kilocalories/day.
[d] Food-energy intake (Kcal/day) or (MJ/day).

Source: Layton, 1993.

Table 6-45. Daily Inhalation Rates (DIRs) Calculated from Food-Energy Intakes (EFDs)

Cohort/Age (years)	L[b]	Daily Inhalation Rate[c] (m^3/day)	Sleep (hours)	MET[a] Value A[d]	MET[a] Value F[e]	Inhalation Rates Inactive[f] (m^3/day)	Inhalation Rates Active[f] (m^3/day)
Males and Females							
<1	1	4.5	11	1.9	2.7	2.35	6.35
1 to 2	2	6.8	11	1.6	2.2	4.16	9.15
3 to 5	3	8.3	10	1.7	2.2	4.98	10.96
6 to 8	3	10	10	1.7	2.2	5.95	13.09
Males							
9 to 11	3	14	9	1.9	2.5	7.32	18.3
12 to 14	3	15	9	1.8	2.2	8.71	19.16
15 to 18	4	17	8	1.7	2.1	10.31	21.65
19 to 22	4	16	8	1.6	1.9	10.21	19.4
23 to 34	11	16	8	1.5	1.8	10.62	19.12
35 to 50	16	15	8	1.5	1.8	10.25	18.45
51 to 64	14	15	8	1.4	1.7	10.11	17.19
65 to 74	10	13	8	1.6	1.8	8.34	15.01
≥75	1	13	8	1.6	1.9	8.02	15.24
Lifetime average[g]		14					
Females							
9 to 11	3	13	9	1.9	2.5	6.63	16.58
12 to 14	3	12	9	1.6	2.0	7.61	15.22
15 to 18	4	12	8	1.5	1.7	8.14	13.84
19 to 22	4	11	8	1.4	1.6	7.68	12.29
23 to 34	11	11	8	1.4	1.6	7.94	12.7
35 to 50	16	10	8	1.3	1.5	7.80	11.7
51 to 64	14	10	8	1.3	1.5	7.86	11.8
65 to 74	10	9.7	8	1.4	1.5	7.10	10.65
≥75	1	9.6	8	1.4	1.6	6.90	11.04
Lifetime average[g]		10					

[a] MET = Metabolic equivalent.

[b] L is the number of years for each age cohort.

[c] Daily inhalation rate was calculated by multiplying the EFD values (see Table 6-44) by $H \times VQ \times (m^3\ 1{,}000\ L^{-1})$ for subjects under 9 years of age and by $1.2 \times H \times VQ \times (m^3\ 1{,}000\ L^{-1})$ (for subjects 9 years of age and older (see text for explanation).

where:
- *EFD* = (Kcal/day) or (MJ/day),
- *H* = Oxygen uptake = 0.05 L O_2/KJ or 0.21 L O_2/Kcal, and
- *VQ* = Ventilation equivalent = 27 = geometric mean of VQs (unitless).

[d] For individuals 9 years of age and older, A was calculated by multiplying the ratio for EFD/BMR (unitless) (see Table 6-44) by the factor 1.2 (see text for explanation).

[e] $F = (24A - S)/(24 - S)$ (unitless), ratio of the rate of energy expenditure during active hours to the estimated BMR (unitless).

where:
- *S* = Number of hours spent sleeping each day (hours).

[f] Inhalation rate for inactive periods was calculated as $BMR \times H \times VQ \times (d\ 1{,}440\ minute^{-1})$ and for active periods by multiplying inactive inactive inhalation rate by F (See footnote e); BMR values are from Table 6-44.

where:
- *BMR* = Basal metabolic rate (MJ/day) or (kg/hour).

[g] Lifetime average was calculated by multiplying individual inhalation rate by corresponding L values summing the products across cohorts and dividing the result by 75, the total of the cohort age spans.

Source: Layton, 1993.

Table 6-46. Statistics of the Age/Sex Cohorts Used to Develop Regression Equations for Predicting Basal Metabolic Rates (BMR)

Sex, Age (years)	BMR MJ d^{-1}	BMR SD	CV	Body Weight (kg)	*N*	BMR Equation[a]	*r*
Males							
Under 3	1.51	0.92	0.61	6.6	162	0.249 BW − 0.127	0.95
3 to <10	4.14	0.50	0.12	21	338	0.095 BW + 2.110	0.83
10 to <18	5.86	1.17	0.20	42	734	0.074 BW + 2.754	0.93
18 to <30	6.87	0.84	0.12	63	2,879	0.063 BW + 2.896	0.65
30 to <60	6.75	0.87	0.13	64	646	0.048 BW + 3.653	0.60
≥60	5.59	0.93	0.17	62	50	0.049 BW + 2.459	0.71
Females							
Under 3	1.54	0.92	0.59	6.9	137	0.244 BW − 0.130	0.96
3 to <10	3.85	0.49	0.13	21	413	0.085 BW + 2.033	0.81
10 to <18	5.04	0.78	0.15	38	575	0.056 BW + 2.898	0.80
18 to <30	5.33	0.72	0.14	53	829	0.062 BW + 2.036	0.73
30 to <60	5.62	0.63	0.11	61	372	0.034 BW + 3.538	0.68
≥60	4.85	0.61	0.12	56	38	0.038 BW + 2.755	0.68

[a] Body weight (BW) in kg.
SD = Standard deviation.
CV = Coefficient of variation (SD/mean).
N = Number of observations.
r = Coefficient of correlation.

Source: Layton, 1993.

Table 6-47. Daily Inhalation Rates (DIRs) Obtained from the Ratios of Total Energy Expenditure to Basal Metabolic Rate (BMR)

Sex/Age (years)	Body Weight[a] (kg)	BMR[b] (MJ/day)	*VQ*	*A*[c]	*H* (m^3O_2/MJ)	Inhalation Rate, V_E (m^3/day)[d]
Males						
0.5 to <3	14	3.4	27	1.6	0.05	7.3
3 to <10	23	4.3	27	1.6	0.05	9.3
10 to <18	53	6.7	27	1.7	0.05	15
18 to <30	76	7.7	27	1.59	0.05	17
30 to <60	80	7.5	27	1.59	0.05	16
≥60	75	6.1	27	1.59	0.05	13
Females						
0.5 to <3	11	2.6	27	1.6	0.05	5.6
3 to <10	23	4.0	27	1.6	0.05	8.6
10 to <18	50	5.7	27	1.5	0.05	12
18 to <30	62	5.9	27	1.38	0.05	11
30 to <60	68	5.8	27	1.38	0.05	11
≥60	67	5.3	27	1.38	0.05	9.9

[a] Body weight was based on the average weights for age/sex cohorts in the U.S. population.
[b] The BMRs are calculated using the respective body weights and BMR equations (see Table 6-46).
[c] The values of the BMR multiplier (EFD/BMR) for those 18 years and older were derived from the Basiotis et al. (1989) study: male = 1.59, female = 1.38. For males and females under 10 years old, the mean BMR multiplier used was 1.6. For males and females aged 10 to <18 years, the mean values for *A* given in Table 6-45 for 12−14 years and 15−18 years, age brackets for males and females were used: male = 1.7 and female = 1.5.
[d] Inhalation rate = $BMR \times A \times H \times VQ$; *VQ* = ventilation equivalent and *H* = oxygen uptake.

Source: Layton, 1993.

Table 6-48. Daily Inhalation Rates (DIRs) Based on Time-Activity Survey

Age (years) and Activity	MET	Males: Body Weight[a] (kg)	BMR[b] (KJ/hour)	Duration[c] (hour/day)	E^d (MJ/day)	V_E[e] (m^3/day)	V_E[f] (m^3/hour)	Females: Body Weight[a] (kg)	BMR[b] (KJ/hour)	Duration[c] (hour/day)	E^d (MJ/day)	V_E[e] (m^3/day)	V_E[f] (m^3/hour)
20−34													
Sleep	1	76	320	7.2	2.3	3.1	0.4	62	283	7.2	2.0	2.8	0.4
Light	1.5	76	320	14.5	7.0	9.4	0.7	62	283	14.5	6.2	8.3	0.6
Moderate	4	76	320	1.2	1.5	2.1	1.7	62	283	1.2	1.4	1.8	1.5
Hard	6	76	320	0.64	1.2	1.7	2.6	62	283	0.64	1.1	1.5	2.3
Very Hard	10	76	320	0.23	0.74	1.0	4.3	62	283	0.23	0.65	0.88	3.8
Totals				24	17	17				24	11	15	
35−49													
Sleep	1	81	314	7.1	2.2	3.0	0.4	67	242	7.1	1.7	2.3	0.3
Light	1.5	81	314	14.6	6.9	9.3	0.6	67	242	14.6	5.3	7.2	0.5
Moderate	4	81	314	1.4	1.8	2.4	1.7	67	242	1.4	1.4	1.8	1.3
Hard	6	81	314	0.59	1.1	1.5	2.5	67	242	0.59	0.9	1.2	2.0
Very Hard	10	81	314	0.29	0.91	1.2	4.2	67	242	0.29	0.70	0.95	3.2
Totals				24	13	17				24	9.9	13	
50−64													
Sleep	1	80	312	7.3	2.3	3.1	0.4	68	244	7.3	1.8	2.4	0.3
Light	1.5	80	312	14.9	7.0	9.4	0.6	68	244	14.9	5.4	7.4	0.5
Moderate	4	80	312	1.1	1.4	1.9	1.7	68	244	1.1	1.1	1.4	1.3
Hard	6	80	312	0.50	0.94	1.3	2.5	68	244	0.5	0.7	1.0	2.0
Very Hard	10	80	312	0.14	0.44	0.6	4.2	68	244	0.14	0.34	0.46	3.3
Totals				24	12	16				24	9.4	13	
65−74													
Sleep	1	75	256	7.3	1.9	2.5	0.3	67	221	7.3	1.6	2.2	0.3
Light	1.5	75	256	14.9	5.7	7.7	0.5	67	221	14.9	4.9	6.7	0.4
Moderate	4	75	256	1.1	1.1	1.5	1.4	67	221	1.1	1.0	1.3	1.2
Hard	6	75	256	0.5	0.8	1.0	2.1	67	221	0.5	0.7	0.9	1.8
Very Hard	10	75	256	0.14	0.36	0.48	3.5	67	221	0.14	0.31	0.42	3.0
Totals				24	9.8	13				24	8.5	11	

[a] Body weights were obtained from Najjar and Rowland (1987).
[b] The BMRs for the age/sex cohorts were calculated using the respective body weights and the BMR equations (see Table 6-46).
[c] Duration of activities were obtained from Sallis et al. (1985).
[d] Energy expenditure rate (*E*) was calculated by multiplying BMR (KJ/hour) × (MJ/1,000 KJ) × duration (hour/day) × MET.
[e] V_E (inhalation rate) was calculated by multiplying *E* (MJ/day) by *H* (0.05 m^3 oxygen/MJ) by VQ (27).
[f] V_E (m^3/hour) was calculated by multiplying BMR (KJ/hour) × (MJ/1,000 KJ) × MET × *H* (0.05 m^3 oxygen/MJ) × VQ (27).

Source: Layton, 1993.

Table 6-49. Inhalation Rates for Short-Term Exposures

Sex/Age (years)	Body Weight (kg)[a]	BMR[b] (MJ/day)	Activity Type				
			Rest	Sedentary	Light	Moderate	Heavy
			MET (BMR Multiplier)				
			1	1.2	2[c]	4[d]	10[e]
			Inhalation Rate (m^3/minute)[f,g]				
Males							
0.5 to <3	14	3.40	3.2E−03	3.8E−03	6.3E−03	1.3E−02	–[h]
3 to <10	23	4.30	4.0E−03	4.8E−03	8.2E−03	1.6E−02	–[h]
10 to <18	53	6.70	6.3E−03	7.5E−03	1.3E−02	2.5E−02	6.3E−02
18 to <30	76	7.70	7.2E−03	8.7E−03	1.4E−02	2.9E−02	7.2E−02
30 to <60	80	7.50	7.0E−03	8.3E−03	1.4E−02	2.8E−02	7.0E−02
≥60	75	6.10	5.7E−03	6.8E−03	1.1E−02	2.3E−02	5.7E−02
Females							
0.5 to <3	11	2.60	2.4E−03	2.8E−03	4.8E−03	1.0E−02	–[h]
3 to <10	23	4.00	3.8E−03	4.5E−03	7.5E−03	1.5E−02	–[h]
10 to <18	50	5.70	5.3E−03	6.3E−03	1.1E−02	2.1E−02	5.3E−02
18 to <30	62	5.90	5.5E−03	6.7E−03	1.1E−02	2.2E−02	5.5E−02
30 to <60	68	5.80	5.3E−03	6.5E−03	1.1E−02	2.2E−02	5.4E−02
≥60	67	5.30	5.0E−03	6.0E−03	9.8E−03	2.0E−02	5.0E−02

[a] Body weights were based on average weights for age/sex cohorts of the U.S. population.

[b] The BMRs for the age/sex cohorts were calculated using the respective body weights and the BMR equations (see Table 6-46).

[c] Range = 1.5−2.5.

[d] Range = 3−5.

[e] Range = >5−20.

[f] The inhalation rate was calculated as *IR* = *BMR* (MJ/day) × *H* (0.05 L/KJ) × *MET* × *VQ* (27) × (day/1,440 minutes).

[g] Original data were presented in L/minute. Conversion to m^3/minute was obtained as follows: $\frac{m^3}{1000L} \times \frac{L}{min}$

[h] The maximum possible MET sustainable for more than 5 minutes does not reach 10 for females and males until ages 13 and 12, respectively. Therefore, an MET of 10 is not possible for this age category.

Source: Layton, 1993.

Table 6-50. Distributions of Individual and Group Inhalation/Ventilation Rate (VR) for Outdoor Workers

Population Group and Subgroup[a]	Mean ± SD	VR (m^3/hour) Percentile 1st	50th	99th
All Subjects (*N*[b] = 19)	1.68 ± 0.72	0.66	1.62	3.90
Job				
GCW[c]/Laborers (*N* = 5)	1.44 ± 0.66	0.48	1.32	3.66
Iron Workers (*N* = 3)	1.62 ± 0.66	0.60	1.56	3.24
Carpenters (*N* = 11)	1.86 ± 0.78	0.78	1.74	4.14
Site				
Medical Office Site (*N* = 7)	1.38 ± 0.66	0.60	1.20	3.72
Hospital Site (*N* = 12)	1.86 ± 0.78	0.72	1.80	3.96

[a] Each group or subgroup mean was calculated from individual means, not from pooled data.
[b] *N* = number of individuals performing specific jobs or number of individuals at survey sites.
[c] GCW = general construction worker.

Source: Linn et al., 1993.

Table 6-51. Individual Mean Inhalation Rate (m^3/hour) by Self-Estimated Breathing Rate or Job Activity Category for Outdoor Workers

	Self-Estimated Breathing Rate (m^3/hour)			Job Activity Category (m^3/hour)			
Population Group and Subgroup	Slow	Medium	Fast	Sit/Stand	Walk	Carry	Trade[a]
All Subjects (*N* = 19)	1.44	1.86	2.04	1.56	1.80	2.10	1.92
Job							
GCW[b]/Laborers (*N* = 5)	1.20	1.56	1.68	1.26	1.44	1.74	1.56
Iron Workers (*N* = 3)	1.38	1.86	2.10	1.62	1.74	1.98	1.92
Carpenters (*N* = 11)	1.62	2.04	2.28	1.62	1.92	2.28	2.04
Site							
Office Site (*N* = 12)	1.14	1.44	1.62	1.14	1.38	1.68	1.44
Hospital Site (*N* = 12)	1.62	2.16	2.40	1.80	2.04	2.34	2.16

[a] Trade = "Working at Trade" (i.e., tasks specific to the individual's job classification).
[b] GCW = general construction worker.

Source: Linn et al., 1993.

Table 6-52. Mean, Median, and SD of Inhalation Rate According to Waking or Sleeping in 618 Infants and Children Grouped in Classes of Age

		Inhalation Rate (breaths/minute)			
		Waking		Sleeping	
Age (months)	*N*	Mean ± SD	Median	Mean ± SD	Median
<2	104	48.0 ± 9.1	47	39.8 ± 8.7	39
2 to <6	106	44.1 ± 9.9	42	33.4 ± 7.0	32
6 to <12	126	39.1 ± 8.5	38	29.6 ± 7.0	28
12 to <18	77	34.5 ± 5.8	34	27.2 ± 5.6	26
18 to <24	65	32.0 ± 4.8	32	25.3 ± 4.6	24
24 to <30	79	30.0 ± 6.2	30	23.1 ± 4.6	23
30 to 36	61	27.1 ± 4.1	28	21.5 ± 3.7	21

SD = Standard deviation.
N = Number of individuals.

Source: Rusconi et al., 1994.

Table 6-53. Distribution of Physiological Daily Inhalation Rate (PDIR) (m^3/day) Percentiles for Free-Living Underweight[a] Adolescents and Women Aged 11 to 55 Years During Pregnancy and Postpartum Weeks

Age Group (years)	Progression of the Reproductive Cycle		Number of Subjects[b] NExp or NSim	Physiological Daily Inhalation Rates[c] (m^3/day)								
					Percentile							
				Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		50	12.18 ± 2.08	8.76	9.52	10.78	12.18	13.58	14.84	15.60	17.02
	Pre-pregnancy	0 week	5,000	12.27 ± 1.95	9.35	9.74	10.79	12.18	13.72	14.63	15.48	16.90
	Pregnancy	9th week	5,000	17.83 ± 4.52	13.20	13.91	15.40	17.34	19.55	21.38	23.13	27.40
	Pregnancy	22nd week	5,000	17.98 ± 4.77	13.19	13.95	15.47	17.46	19.73	22.09	23.90	30.69
	Pregnancy	36th week	5,000	18.68 ± 4.73	13.44	14.25	15.96	17.88	20.24	23.01	25.59	34.45
	Postpartum	6th week	5,000	20.39 ± 2.69	16.31	17.02	18.47	20.31	22.22	23.79	24.82	26.62
	Postpartum	27th week	5,000	20.21 ± 2.66	16.17	16.88	18.31	20.14	22.02	23.58	24.61	26.39
23 to <30	Non-pregnant females		17	13.93 ± 2.27	10.20	11.02	12.40	13.93	13.93	16.83	17.65	19.20
	Pre-pregnancy	0 week	5,000	13.91 ± 2.17	11.41	11.50	12.08	13.92	15.32	16.01	17.81	19.97
	Pregnancy	9th week	5,000	20.03 ± 5.01	15.83	16.17	17.08	19.75	21.60	23.76	26.94	34.21
	Pregnancy	22nd week	5,000	20.15 ± 4.24	15.81	16.16	17.07	19.80	21.67	24.49	27.46	32.69
	Pregnancy	36th week	5,000	20.91 ± 5.37	15.97	16.37	17.56	20.29	22.31	26.42	28.95	38.26
	Postpartum	6th week	5,000	22.45 ± 2.91	18.70	19.15	20.14	22.23	24.15	25.65	27.68	30.57
	Postpartum	27th week	5,000	22.25 ± 2.89	18.53	18.98	19.96	22.04	23.94	25.42	27.44	30.30
30 to 55	Non-pregnant females		14	12.89 ± 1.40	10.58	11.09	11.94	12.89	12.89	14.69	15.20	16.16
	Pre-pregnancy	0 week	5,000	12.91 ± 1.36	10.85	11.28	11.99	12.49	13.98	14.99	15.13	15.18
	Pregnancy	9th week	5,000	18.68 ± 3.95	15.33	15.93	16.79	18.05	20.22	21.39	22.69	27.38
	Pregnancy	22nd week	5,000	18.84 ± 4.08	15.30	15.93	16.80	18.07	20.23	21.52	23.20	30.80
	Pregnancy	36th week	5,000	19.60 ± 4.66	15.54	16.14	17.03	18.73	20.74	23.04	25.58	34.26
	Postpartum	6th week	5,000	21.19 ± 1.96	18.30	18.86	19.79	20.92	22.58	23.98	24.53	25.28
	Postpartum	27th week	5,000	21.01 ± 1.94	18.14	18.69	19.62	20.74	22.39	23.77	24.31	25.07

[a] Underweight females are defined as those having a body mass index lower than 19.8 kg/m^2 in pre-pregnancy.
[b] NExp = number of experimental non-pregnant and non-lactating females; NSim = number of simulated females.
[c] Resulting total energy requirements (TDERs) from the integration of energetic measurements in underweight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER \times H \times (V_E/VO_2) \times 10^{-3}$. *TDER* = total energy requirement (*ECG* + *TDEE*). *ECG* = stored daily energy cost for growth; *TDEE* = total daily energy.

SD = Standard deviation.

Source: Brochu et al., 2006b.

Table 6-54. Distribution of Physiological Daily Inhalation Rate (PDIR) (m^3/day) Percentiles for Free-Living Normal-Weight[a] Adolescents and Women Aged 11 to 55 Years During Pregnancy and Postpartum Weeks

Age Group (years)	Progression of the Reproductive Cycle		Number of Subjects[b] NExp or NSim	Physiological Daily Inhalation Rates[c] (m^3/day)								
					Percentile							
				Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		57	14.55 ± 2.70	10.11	11.09	12.73	14.55	16.37	18.01	18.99	20.83
	Pre-pregnancy	0 week	5,000	14.55 ± 2.69	9.71	10.83	13.29	14.78	15.89	17.34	18.71	20.91
	Pregnancy	9th week	5,000	19.99 ± 3.89	13.32	14.84	18.32	20.26	21.86	23.86	25.89	28.75
	Pregnancy	22nd week	5,000	22.59 ± 4.83	15.35	17.09	20.06	22.27	24.69	28.25	30.75	35.88
	Pregnancy	36th week	5,000	23.27 ± 4.63	16.01	17.76	20.69	23.10	25.55	28.77	31.07	35.65
	Postpartum	6th week	5,000	23.28 ± 3.60	16.91	18.36	21.40	23.56	25.24	27.17	28.98	31.80
	Postpartum	27th week	5,000	23.08 ± 3.56	16.76	18.20	21.21	23.36	25.02	26.93	28.73	31.52
23 to <30	Non-pregnant females		54	13.59 ± 2.23	9.92	10.73	12.09	13.59	15.09	16.45	17.26	18.78
	Pre-pregnancy	0 week	5,000	13.66 ± 2.29	10.19	10.64	12.12	13.73	14.90	16.49	17.87	19.09
	Pregnancy	9th week	5,000	19.00 ± 9.98	13.92	14.55	16.55	18.76	20.49	22.80	24.49	27.04
	Pregnancy	22nd week	5,000	21.36 ± 4.36	15.54	16.70	18.63	20.89	23.58	26.59	28.43	33.98
	Pregnancy	36th week	5,000	22.14 ± 4.13	16.21	17.34	19.35	21.69	24.55	27.59	29.27	32.77
	Postpartum	6th week	5,000	22.15 ± 30.5	17.37	18.26	20.11	22.11	23.96	26.21	27.53	29.21
	Postpartum	27th week	5,000	21.96 ± 3.02	17.22	18.10	19.93	21.91	23.75	25.98	27.29	28.96
30 to 55	Non-pregnant females		61	13.82 ± 1.91	10.67	11.37	12.53	13.82	15.12	16.28	16.97	18.28
	Pre-pregnancy	0 week	5,000	13.79 ± 1.83	11.07	11.48	12.54	13.61	14.91	16.40	17.02	18.32
	Pregnancy	9th week	5,000	19.02 ± 3.81	15.18	15.74	17.14	18.63	20.46	22.45	23.38	27.39
	Pregnancy	22nd week	5,000	21.53 ± 4.06	16.71	17.56	19.01	20.85	23.45	26.03	28.30	33.44
	Pregnancy	36th week	5,000	22.20 ± 3.68	17.45	18.19	19.69	21.73	24.16	26.78	28.53	32.75
	Postpartum	6th week	5,000	22.31 ± 2.50	18.72	19.35	20.58	22.09	23.84	25.70	26.70	28.39
	Postpartum	27th week	5,000	22.12 ± 2.48	18.55	19.18	20.40	21.90	23.64	25.47	26.47	28.14

[a] Normal-weight females are defined as those having a body mass index varying between 19.8 and 26 kg/m^2 in pre-pregnancy.
[b] NExp = number of experimental non-pregnant and non-lactating females; NSim = number of simulated females.
[c] Resulting TDERs from the integration of energetic measurements in underweight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER \times H \times (V_E/VO_2) \times 10^{-3}$. *TDER* = total energy requirement (*ECG* + *TDEE*). *ECG* = stored daily energy cost for growth; *TDEE* = total daily energy.
SD = Standard deviation.
Source: Brochu et al., 2006b.

Table 6-55. Distribution of Physiological Daily Inhalation Rate (PDIR) (m^3/day) Percentiles for Free-Living Overweight/Obese[a] Adolescents and Women Aged 11 to 55 Years During Pregnancy and Postpartum Weeks

Age Group (years)	Progression of the Reproductive Cycle		Number of Subjects[b] NExp or NSim	Physiological Daily Inhalation Rates[c] (m^3/day)								
				Percentile								
				Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		15	16.62 ± 2.91	11.82	12.88	14.65	16.62	18.58	20.35	21.41	23.39
	Pre-pregnancy	0 week	5,000	16.64 ± 2.81	10.21	12.13	15.52	17.22	18.52	19.68	20.06	20.16
	Pregnancy	9th week	5,000	25.51 ± 6.48	16.11	19.09	23.04	25.38	27.85	30.62	33.32	41.61
	Pregnancy	22nd week	5,000	26.10 ± 6.96	16.38	19.29	23.12	25.65	28.17	31.56	34.93	45.94
	Pregnancy	36th week	5,000	25.71 ± 8.09	15.67	18.78	22.73	25.23	27.84	31.14	34.95	46.76
	Postpartum	6th week	5,000	25.93 ± 3.70	17.94	20.12	24.52	26.61	28.38	29.87	30.53	31.27
	Postpartum	27th week	5,000	25.71 ± 3.67	17.79	19.94	24.30	26.38	28.13	29.61	30.26	31.00
23 to <30	Non-pregnant females		25	15.45 ± 2.32	11.63	12.47	13.88	15.45	17.02	18.43	19.27	20.86
	Pre-pregnancy	0 week	5,000	15.47 ± 2.27	11.94	13.12	14.36	15.50	16.86	17.96	19.46	20.41
	Pregnancy	9th week	5,000	23.93 ± 5.94	17.75	19.13	21.08	23.22	25.62	29.09	31.77	40.74
	Pregnancy	22nd week	5,000	24.44 ± 6.24	18.06	19.45	21.32	23.51	26.44	29.92	33.49	44.56
	Pregnancy	36th week	5,000	24.15 ± 6.82	17.60	19.00	20.91	23.05	26.02	30.04	34.18	47.31
	Postpartum	6th week	5,000	24.47 ± 3.04	19.31	21.07	22.80	24.45	26.16	27.93	29.43	31.08
	Postpartum	27th week	5,000	24.25 ± 3.02	19.14	20.88	22.60	24.23	25.93	27.68	29.17	30.81
30 to 55	Non-pregnant females		64	15.87 ± 2.52	11.72	12.63	14.17	15.87	17.57	19.10	20.01	21.73
	Pre-pregnancy	0 week	5,000	15.83 ± 2.46	11.92	12.79	14.30	15.79	17.19	18.78	19.47	22.03
	Pregnancy	9th week	5,000	24.47 ± 5.68	17.87	19.17	21.38	23.77	26.37	29.77	33.08	41.49
	Pregnancy	22nd week	5,000	25.02 ± 6.65	18.13	19.41	21.44	23.92	26.93	30.98	35.01	46.88
	Pregnancy	36th week	5,000	24.46 ± 6.24	17.67	18.83	20.92	23.40	26.37	30.32	34.27	45.08
	Postpartum	6th week	5,000	24.91 ± 3.28	19.82	20.92	22.82	24.91	26.81	28.70	29.75	32.94
	Postpartum	27th week	5,000	24.70 ± 3.25	19.65	20.74	22.63	24.69	26.58	28.45	29.50	32.65

a Overweight/obese females are defined as those having a body mass index higher than 26 kg/m^2 in pre-pregnancy.
b NExp = number of experimental non-pregnant and non-lactating females; NSim = number of simulated females.
c Resulting TDERs from the integration of energetic measurements in underweight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER \times H \times (V_E/VO_2) \times 10^{-3}$. *TDER* = total energy requirement (*ECG* + *TDEE*). *ECG* = stored daily energy cost for growth; *TDEE* = total daily energy.
SD = Standard deviation.
Source: Brochu et al., 2006b.

Table 6-56. Distribution of Physiological Daily Inhalation Rate (PDIR) (m^3/kg-day) Percentiles for Free-Living Underweight[a] Adolescents and Women Aged 11 to 55 Years During Pregnancy and Postpartum Weeks

Age Group (years)	Progression of the Reproductive Cycle		Number of Subjects[b] NExp or NSim	Physiological Daily Inhalation Rates[c] (m^3/kg-day)								
					Percentile							
				Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		50	0.277 ± 0.046	0.201	0.218	0.246	0.277	0.277	0.335	0.352	0.383
	Pre-pregnancy	0 week	5,000	0.276 ± 0.045	0.209	0.218	0.238	0.277	0.313	0.337	0.345	0.368
	Pregnancy	9th week	5,000	0.385 ± 0.110	0.278	0.291	0.327	0.377	0.428	0.474	0.504	0.622
	Pregnancy	22nd week	5,000	0.343 ± 0.093	0.246	0.259	0.291	0.335	0.378	0.419	0.455	0.602
	Pregnancy	36th week	5,000	0.323 ± 0.083	0.230	0.243	0.274	0.314	0.357	0.404	0.452	0.575
	Postpartum	6th week	5,000	0.368 ± 0.058	0.321	0.337	0.370	0.414	0.467	0.517	0.548	0.596
	Postpartum	27th week	5,000	0.383 ± 0.064	0.329	0.348	0.383	0.433	0.491	0.549	0.584	0.647
23 to <30	Non-pregnant females		17	0.264 ± 0.047	0.186	0.203	0.232	0.264	0.264	0.325	0.342	0.374
	Pre-pregnancy	0 week	5,000	0.264 ± 0.046	0.206	0.212	0.228	0.257	0.284	0.342	0.361	0.362
	Pregnancy	9th week	5,000	0.366 ± 0.098	0.277	0.287	0.311	0.351	0.400	0.468	0.501	0.591
	Pregnancy	22nd week	5,000	0.332 ± 0.076	0.250	0.260	0.282	0.318	0.362	0.421	0.452	0.532
	Pregnancy	36th week	5,000	0.317 ± 0.086	0.233	0.242	0.266	0.301	0.346	0.402	0.439	0.582
	Postpartum	6th week	5,000	0.352 ± 0.056	0.307	0.320	0.348	0.385	0.431	0.486	0.518	0.573
	Postpartum	27th week	5,000	0.364 ± 0.061	0.316	0.330	0.357	0.397	0.449	0.508	0.545	0.606
30 to 55	Non-pregnant females		14	0.249 ± 0.027	0.204	0.214	0.231	0.249	0.249	0.283	0.293	0.312
	Pre-pregnancy	0 week	5,000	0.249 ± 0.026	0.208	0.220	0.232	0.242	0.268	0.286	0.294	0.299
	Pregnancy	9th week	5,000	0.347 ± 0.075	0.279	0.291	0.311	0.337	0.370	0.405	0.431	0.529
	Pregnancy	22nd week	5,000	0.315 ± 0.071	0.252	0.262	0.280	0.305	0.335	0.368	0.401	0.529
	Pregnancy	36th week	5,000	0.301 ± 0.074	0.233	0.243	0.260	0.287	0.321	0.360	0.404	0.529
	Postpartum	6th week	5,000	0.337 ± 0.038	0.312	0.326	0.347	0.376	0.408	0.439	0.457	0.489
	Postpartum	27th week	5,000	0.349 ± 0.042	0.320	0.333	0.357	0.389	0.425	0.462	0.483	0.518

[a] Underweight females are defined as those having a body mass index lower than 19.8 kg/m^2 in pre-pregnancy.
[b] NExp = number of experimental non-pregnant and non-lactating females; NSim = number of simulated females.
[c] Resulting TDERs from the integration of energetic and weight measurements in normal-weight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER \times H \times (V_E/VC > 2) \times 10^{-3}$. *TDER* = total energy requirement (*ECG* + *TDEE*). *ECG* = stored daily energy cost for growth; *TDEE* = total daily energy expenditure.
SD = Standard deviation.
Source: Brochu et al., 2006b.

Table 6-57. Distribution of Physiological Daily Inhalation Rate (PDIR) (m^3/kg-day) Percentiles for Free-Living Normal-Weight[a] and Women Aged 11 to 55 Years During Pregnancy and Postpartum Weeks

Age Group (years)	Progression of the Reproductive Cycle		Number of Subjects[b] NExp or NSim	Physiological Daily Inhalation Rates[c] (m^3/kg-day)								
					Percentile							
				Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		15	0.252 ± 0.051	0.168	0.186	0.217	0.252	0.286	0.317	0.336	0.370
	Pre-pregnancy	0 week	5,000	0.252 ± 0.051	0.169	0.189	0.218	0.246	0.282	0.324	0.339	0.361
	Pregnancy	9th week	5,000	0.344 ± 0.074	0.232	0.259	0.297	0.336	0.388	0.440	0.468	0.518
	Pregnancy	22nd week	5,000	0.360 ± 0.085	0.243	0.268	0.304	0.349	0.406	0.462	0.500	0.594
	Pregnancy	36th week	5,000	0.329 ± 0.072	0.225	0.247	0.281	0.323	0.372	0.422	0.453	0.517
	Postpartum	6th week	5,000	0.342 ± 0.062	0.272	0.292	0.327	0.369	0.418	0.469	0.499	0.544
	Postpartum	27th week	5,000	0.352 ± 0.067	0.279	0.298	0.334	0.380	0.433	0.490	0.527	0.580
23 to <30	Non-pregnant females		54	0.221 ± 0.035	0.164	0.176	0.197	0.221	0.244	0.265	0.278	0.301
	Pre-pregnancy	0 week	5,000	0.222 ± 0.035	0.174	0.181	0.199	0.218	0.242	0.269	0.285	0.317
	Pregnancy	9th week	5,000	0.308 ± 0.189	0.233	0.243	0.269	0.298	0.333	0.371	0.395	0.458
	Pregnancy	22nd week	5,000	0.321 ± 0.067	0.239	0.252	0.277	0.310	0.351	0.399	0.433	0.521
	Pregnancy	36th week	5,000	0.297 ± 0.056	0.220	0.233	0.258	0.289	0.328	0.369	0.399	0.448
	Postpartum	6th week	5,000	0.309 ± 0.045	0.265	0.278	0.302	0.333	0.368	0.402	0.425	0.464
	Postpartum	27th week	5,000	0.317 ± 0.049	0.269	0.283	0.309	0.342	0.380	0.416	0.441	0.490
30 to 55	Non-pregnant females		61	0.229 ± 0.035	0.171	0.184	0.206	0.229	0.253	0.274	0.287	0.311
	Pre-pregnancy	0 week	5,000	0.229 ± 0.035	0.174	0.187	0.202	0.229	0.253	0.275	0.287	0.302
	Pregnancy	9th week	5,000	0.314 ± 0.069	0.237	0.252	0.276	0.309	0.346	0.382	0.400	0.443
	Pregnancy	22nd week	5,000	0.330 ± 0.069	0.242	0.257	0.285	0.321	0.365	0.409	0.439	0.522
	Pregnancy	36th week	5,000	0.303 ± 0.057	0.225	0.238	0.264	0.297	0.336	0.373	0.401	0.461
	Postpartum	6th week	5,000	0.316 ± 0.046	0.267	0.280	0.307	0.343	0.382	0.416	0.434	0.467
	Postpartum	27th week	5,000	0.325 ± 0.050	0.272	0.285	0.314	0.352	0.394	0.432	0.453	0.491

a Normal-weight females are defined as those having a body mass index varying between 19.8 and 26 kg/m^2 in pre-pregnancy.
b NExp = number of experimental non-pregnant and non-lactating females; NSim = number of simulated females.
c Resulting TDERs from the integration of energetic and weight measurements in normal-weight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER \times H \times (V_E/VC > 2) \times 10^{-3}$. *TDER* = total energy requirement (*ECG* + *TDEE*). *ECG* = stored daily energy cost for growth; *TDEE* = total daily energy expenditure.
SD = Standard deviation.
Source: Brochu et al., 2006b.

Table 6-58. Distribution of Physiological Daily Inhalation Rate (PDIR) (m^3/kg-day) Percentiles for Free-Living Overweight/Obese[a] Adolescents and Women Aged 11 to 55 Years During Pregnancy and Postpartum Weeks

Age Group (years)	Progression of the Reproductive Cycle		Number of Subjects[b] NExp or NSim	Physiological Daily Inhalation Rates[c] (m^3/kg-day)								
					Percentile							
				Mean ± SD	5th	10th	25th	50th	75th	90th	95th	99th
11 to <23	Non-pregnant females		15	0.206 ± 0.033	0.151	0.163	0.184	0.206	0.229	0.249	0.261	0.284
	Pre-pregnancy	0 week	5,000	0.207 ± 0.032	0.146	0.153	0.188	0.214	0.227	0.240	0.253	0.259
	Pregnancy	9th week	5,000	0.302 ± 0.075	0.205	0.223	0.263	0.298	0.329	0.368	0.401	0.515
	Pregnancy	22nd week	5,000	0.287 ± 0.079	0.191	0.206	0.246	0.279	0.314	0.357	0.391	0.512
	Pregnancy	36th week	5,000	0.270 ± 0.090	0.179	0.193	0.225	0.259	0.296	0.337	0.377	0.521
	Postpartum	6th week	5,000	0.280 ± 0.050	0.213	0.230	0.266	0.301	0.337	0.372	0.395	0.444
	Postpartum	27th week	5,000	0.285 ± 0.053	0.214	0.233	0.269	0.307	0.344	0.381	0.409	0.464
23 to <30	Non-pregnant females		54	0.186 ± 0.025	0.144	0.153	0.169	0.186	0.203	0.218	0.227	0.244
	Pre-pregnancy	0 week	5,000	0.186 ± 0.025	0.143	0.155	0.172	0.183	0.201	0.222	0.233	0.236
	Pregnancy	9th week	5,000	0.274 ± 0.068	0.203	0.217	0.238	0.263	0.298	0.337	0.374	0.476
	Pregnancy	22nd week	5,000	0.261 ± 0.069	0.193	0.205	0.224	0.248	0.283	0.323	0.360	0.466
	Pregnancy	36th week	5,000	0.245 ± 0.074	0.175	0.185	0.205	0.231	0.268	0.314	0.360	0.498
	Postpartum	6th week	5,000	0.256 ± 0.042	0.205	0.217	0.241	0.271	0.304	0.338	0.360	0.406
	Postpartum	27th week	5,000	0.260 ± 0.046	0.209	0.222	0.246	0.277	0.311	0.349	0.372	0.426
30 to 55	Non-pregnant females		61	0.184 ± 0.031	0.132	0.144	0.163	0.184	0.205	0.224	0.235	0.257
	Pre-pregnancy	0 week	5,000	0.184 ± 0.031	0.127	0.141	0.166	0.185	0.205	0.221	0.226	0.246
	Pregnancy	9th week	5,000	0.272 ± 0.068	0.184	0.203	0.234	0.263	0.299	0.343	0.378	0.465
	Pregnancy	22nd week	5,000	0.259 ± 0.071	0.176	0.194	0.222	0.249	0.282	0.322	0.363	0.490
	Pregnancy	36th week	5,000	0.242 ± 0.068	0.162	0.177	0.201	0.230	0.265	0.313	0.351	0.455
	Postpartum	6th week	5,000	0.253 ± 0.048	0.188	0.205	0.237	0.270	0.305	0.340	0.364	0.404
	Postpartum	27th week	5,000	0.257 ± 0.051	0.191	0.208	0.239	0.273	0.310	0.348	0.374	0.430

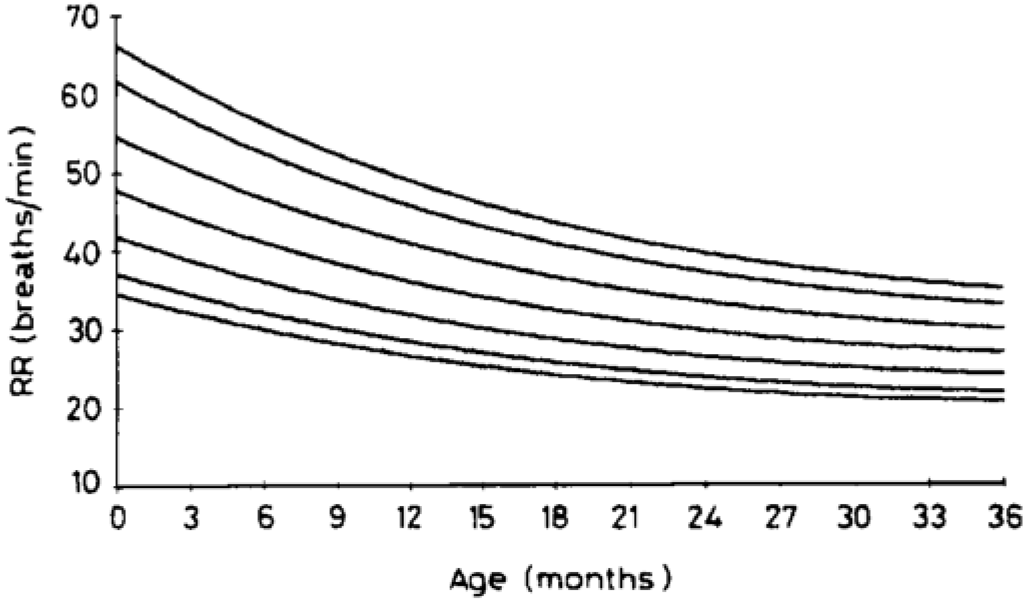
[a] Overweight/obese females are defined as those having a body mass index higher than 26 kg/m^2 in pre-pregnancy.

[b] NExp = number of experimental non-pregnant and non-lactating females; NSim = number of simulated females.

[c] Resulting TDERs from the integration of energetic and weight measurements in normal-weight non-pregnant and non-lactating females with those during pregnancy and lactation by Monte Carlo simulations were converted into physiological daily inhalation rates by the following equation: $TDER \times H \times (V_E/VC > 2) \times 10^{-3}$. *TDER* = total energy requirement (*ECG* + *TDEE*). *ECG* = stored daily energy cost for growth; *TDEE* = total daily energy expenditure.

SD = Standard deviation.

Source: Brochu et al., 2006b.



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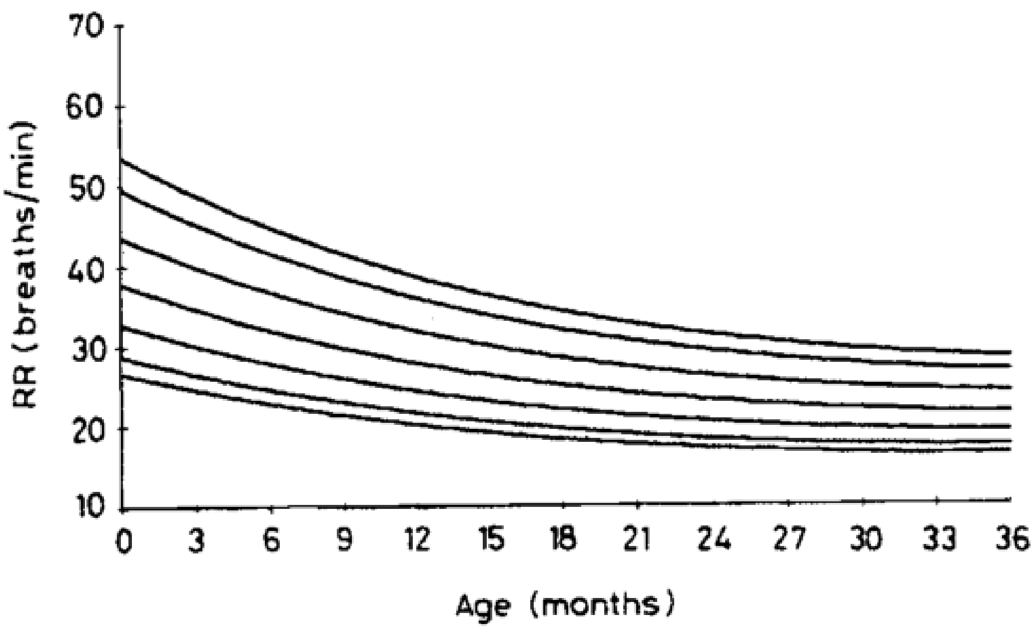
RR = respiratory rate.
Source: Rusconi et al., 1994.



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7. DERMAL EXPOSURE FACTORS

7.1. INTRODUCTION

Dermal exposure can occur during a variety of activities in different environmental media and microenvironments (U.S. Environmental Protection Agency [U.S. EPA], 1992a, b, 2004). These include:

- water (e.g., bathing, washing, swimming);
- soil (e.g., outdoor recreation, gardening, construction);
- sediment (e.g., wading, fishing);
- other liquids (e.g., use of commercial products);
- vapors/fumes/gases (e.g., use of commercial products); and
- other solids or residues (e.g., soil/dust or chemical residues on carpets, floors, counter tops, outdoor surfaces, or clothing).

Exposure via the dermal route may be estimated in various ways, depending on the exposure media and scenario of interest. For example, dermal exposure to contaminants in soil, sediment, or dust may be evaluated using information on the concentration of contaminant in these materials in conjunction with information on the amount of material that adheres to the skin per unit surface area and the total area of skin surface exposed. An approach for estimating dermal exposure to contaminants in liquids uses information on the concentration of contaminant in the liquid in conjunction with information on the film thickness of liquid remaining on the skin after contact. When assessing dermal exposure to water (e.g., bathing or swimming) or to vapors and fumes, the concentration of chemical in water or vapor with the total exposed skin surface area may be considered. An approach for estimating exposure to surface residues is to use information on the rate of transfer of chemical residues to the skin as a result of contact with the surfaces. Dermal exposure also may result from leaching of chemicals that are impregnated in materials that come into contact with skin. For example, Snodgrass (1992) evaluated transfer of pesticides from treated clothing onto the skin. For information on various methods used to estimate dermal exposure, refer to *Guidelines for Exposure Assessment* (U.S. EPA, 1992a), *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992b), and *Dermal Exposures Assessment: A Summary of EPA Approaches* (U.S. EPA, 2007). Additional scenario-specific information on dermal exposure assessment is available in *Risk Assessment Guidance for Superfund (RAGS) Part E* (U.S. EPA, 2004), *Standard Operating Procedures for Residential Pesticide Exposure Assessment, draft* (U.S. EPA, 2009), and *Methods for Assessing Exposure to Chemical Substances: Volume 7, Methods for Assessing Consumer Exposure to Chemical Substances* (U.S. EPA, 1987). In general, these methods for estimating dermal exposure require information on the surface area of the skin that is exposed. Some methods also require information on the adherence of solids to the skin or information on the film thickness of liquids on the skin. Others utilize information on the transfer of residues from contaminated surfaces to the skin surface and/or rate of contact with objects or surfaces. This chapter focuses on measurements of body surface area and non-chemical-specific factors related to dermal exposure (i.e., the deposition of contaminants onto the skin), such as adherence of solids to the skin, film thickness of liquids on the skin, and residue transfer from contaminated surfaces to the skin. However, this chapter only provides recommendations for surface area and solids adherence to skin. According to Riley et al. (2004), numerous factors may affect loading and retention of chemicals on the skin, including the form of the contaminant (particle, liquid, residue), surface characteristics (hard, plush, porous, surface loading, previous transfers), skin characteristics (moisture, age, loading), contact mechanics (pressure, duration, repetition), and environmental conditions (temperature, relative humidity, air exchange). These factors are discussed in this chapter, as reported by the various study authors. Information on other factors that may affect dermal exposure (e.g., contact frequency and duration, and skin thickness) also is provided in this chapter.

Factors that influence dermal uptake (i.e., absorption) and internal dose, including chemical-specific factors, are not provided in this handbook. These include factors such as the concentration of chemical in contact with the skin, weight fraction of chemicals in consumer products, and characteristics of the chemical (i.e., lipophilicity, polarity, volatility, solubility). Also, factors affecting the rate of absorption of the chemical through the skin at the site of application and the amount of chemical delivered to the target organ are not covered in this chapter. Absorption may be affected by the age and condition of the skin, including presence of perspiration (Williams et al., 2004, 2005). Also, the thickness of the stratum corneum (outer layer of the skin) varies over parts of the body and may affect absorption. While not the primary focus of this chapter, some limited information on skin thickness is presented in Section 7.7—Other Factors. For guidance on how to use information on factors needed to assess dermal dose, refer to *Dermal Exposure Assessment: Principles and Applications* (U.S. EPA, 1992b) and *Risk Assessment Guidelines for Superfund (RAGs) Part E* (U.S. EPA, 2004).

Frequency and duration of contact also may affect dermal exposure and dose. Data on dermal contact frequency and duration of hand contact with objects and surfaces are presented in Section 7.7.1 of this chapter. Additional information on consumer products use and activity factors that may affect dermal exposure is presented in Chapters 16 and 17.

Section 7.3 of this chapter provides data on surface area of the human skin. Section 7.4 provides data on adherence of solids to human skin. Information on the film thickness of liquids on the skin is limited. However, studies that estimated film thickness of liquids on the skin are presented in Section 7.5. Section 7.6 presents available information on the transfer of residues from contaminated surfaces to the skin. Section 7.7 provides information on other factors affecting dermal exposure (e.g., frequency and duration of dermal contact with objects and surfaces, and skin thickness).

Recommendations for skin surface area and dermal adherence of solids to skin are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. EPA for these factors. Relevant data on these and other factors also are presented in this chapter to provide added perspective on the state-of-knowledge pertaining to dermal exposure factors.

7.2. RECOMMENDATIONS

7.2.1. Body Surface Area

Table 7-1 summarizes the recommended mean and 95th percentile total body surface area values. For children under 21 years of age, the recommendations for total body surface area are based on the U.S. EPA analysis of 1999–2006 data from the National Health and Nutrition Examination Survey (NHANES). These data are presented for the standard age groupings recommended by U.S. EPA (2005) for male and female children combined. For adults 21 years and over, the recommendations for total body surface area are based on the U.S. EPA analysis of NHANES (2005–2006) data. The U.S. EPA analysis of NHANES data uses correlations with body weight and height for deriving skin surface area (see Section 7.3.1.3 and Appendix 7A). NHANES (1999–2006) used a statistically based survey design that should ensure that the data are reasonably representative of the general population for each 2-year interval (e.g., 1999 to 2000, 2001 to 2002). Multiple NHANES study years, supplying a larger sample size, were necessary for estimating surface area for children given the multiple stratifications by age. The advantage of using the NHANES data sets to derive the total surface area recommendations is that data are nationally representative and remain the principal source of body-weight and height data collected nationwide from a large number of subjects. Note that differences between the surface area recommendations presented here and those in the previous *Exposure Factors Handbook* (U.S. EPA, 1997) reflect changes in the body weights used in calculating these surface areas. If sex-specific data for children, sex-combined data for adults, or data for statistics other than the mean or 95th percentile are needed, refer to Tables 7-9 through 7-13 of this chapter.

Table 7-2 presents the recommendations for the percentage of total body surface area represented by individual body parts for children based on data from U.S. EPA (1985) and Boniol et al. (2007) (see Section 7.3.1). The data from Boniol et al. (2007) are used for the recommendations for children greater than 2 years of age because they are based on a larger sample size than those in U.S. EPA (1985) for the same age groups. Because the Boniol et al. (2007) study does not include data for children less than 2 years of age, recommendations for this age group are based on the data from U.S. EPA (1985). It should be noted, however, that the sample size for the percentages of the total body represented by various body parts in this age group is very small. Table 7-2 also provides age-specific body part surface areas (m^2) for children. These values were obtained by multiplying the age-specific mean body part percentages (for males and females combined) by the total body surface areas presented in Table 7-1. If sex-specific data are needed for children equal to or greater than_2 years of age, or if data for additional body parts not summarized in Table 7-2 are needed, refer to Table 7-8. The body part data in this table may be applied to data in Tables 7-9 through 7-11 to calculate surface area for the various body parts.

The recommendations for surface area of adult body parts are based on the U.S. EPA Analysis of NHANES 2005–2006 data and algorithms from U.S. EPA (1985). The U.S. EPA Analysis of the NHANES data was used to develop recommendations for body parts because the data are nationally representative and based on a large number of subjects. Table 7-2 presents the data for adult males and adult females (21+ years of age). If sex-combined data for adults or data for statistics other than the mean and 95th percentile are needed, refer to Tables 7-12 and 7-13. These tables present the surface area of body parts for males and females, respectively, 21 years of age and older. Table 7-3 presents the confidence ratings for the recommendations for body surface area.

For swimming and bathing scenarios, past exposure assessments have assumed that 75 to 100% of the skin surface is exposed (U.S. EPA, 1992b). More recent guidance recommends assuming 100% exposure for these scenarios (U.S. EPA, 2004). For other exposure scenarios, it is reasonable to assume that clothing reduces the contact area. However, while it is generally assumed that adherence of solids to skin only occurs to the areas of the body not covered by clothing, it is important to understand that soil and dust particles can get under clothing and be deposited on skin to varying degrees depending on the protective properties of the clothing. Likewise, liquids or chemical residues on surfaces may soak through clothing and contact covered areas of the skin. Assessors should consider these possibilities for the scenario of concern and select skin areas that are judged appropriate. Also, surface area of the body and body weight are highly correlated (Phillips et al., 1993). The relationship between these factors, therefore, should be considered when selecting body weights for use with the surface area data for estimating dermal exposure.

7.2.2. Adherence of Solids to Skin

The adherence factor (AF) describes the amount of solid material that adheres to the skin per unit of surface area. Although most research in this area has focused on soils, a variety of other solid residues can accumulate on skin, including household dust, sediments, and commercial powders. Studies on soil adherence have shown that (1) soil properties influence adherence, (2) soil adherence varies considerably across different parts of the body, and (3) soil adherence varies with activity (U.S. EPA, 2004). It is recommended that exposure assessors use adherence data derived from testing that matches the exposure scenario of concern in terms of solid type, exposed body parts, and activities as closely as possible. Refer to the activities described in Table 7-19 to select those that best represent the exposure scenarios of concern and use the corresponding adherence values from Table 7-20. Table 7-19 also lists the age ranges covered by each study. This may be used as a general guide to the ages covered by these data.

Table 7-4 summarizes recommended mean AF values according to common activities. The key studies used to develop the recommendations for adherence of solids to skin are those based on field studies in which specific activities relevant to dermal exposure were evaluated (compared to relevant studies that evaluated adherence in controlled laboratory trials using sieved or standardized soil). Insufficient data were available to develop activity-specific distributions or probability functions for these studies. Also, the small number of subjects in these studies prevented the development of recommendations for the childhood specific age groups recommended by U.S. EPA (2005).

U.S. EPA (2004) recommends that scenario-specific adherence values be weighted according to the body parts exposed. Weighted adherence factors may be estimated according to the following equation:

$$AF_{wtd} = \frac{(AF_1)(SA_1) + (AF_2)(SA_2) + \ldots . (AF_i)(SA_i)}{SA_1 + SA_2 + \ldots SA_i} \qquad \text{(Eqn. 7-1)}$$

where:

AF_{wtd} = weighted adherence factor,
AF = adherence factor, and
SA = surface area.

For the purposes of this calculation, the surface area of the face may be assumed to be 1/3 that of the head, forearms may be assumed to represent 45% of the arms, and lower legs may be assumed to represent 40% of the legs (U.S. EPA, 2004).

The recommended dermal AFs represent the amount of material on the skin at the time of measurement. U.S. EPA (1992b) recommends interpreting AFs as representative of contact events. Assuming that the amount of solids measured on the skin represents accumulation between washings, and that people wash at least once per day, these adherence values can be interpreted as daily contact rates (U.S. EPA, 1992b). The rate of solids accumulation on skin over time has not been well studied but probably occurs fairly quickly. Therefore, prorating the adherence values for exposure time periods of less than 1 day is not recommended.

Table 7-5 shows the confidence ratings for these AF recommendations. While the recommendations are based on the best available estimates of activity-specific adherence, they are based on limited data from studies that have focused primarily on soil.

Therefore, they have a high degree of uncertainty, and considerable judgment must be used when selecting them for an assessment. It also should be noted that the skin-adherence studies on which these recommendations are based have generally not considered the influence of skin moisture on adherence. Skin moisture varies depending on a number of factors, including activity level and ambient temperature/humidity. It is uncertain how well this variability has been captured in the dermal-adherence studies used for the recommendations.

7.2.3. Film Thickness of Liquids on Skin

The film thickness of liquids on skin represents the amount of material that remains on the skin after contact with a liquid (e.g., consumer product such as cleaning solution or soap). The data on film thickness of liquids on the hand are limited, and recommended values are not provided in this chapter. Refer to Section 7.5 for a description of the available data that may be used to assess dermal contact with liquid using the film thickness approach.

7.2.4. Residue Transfer

Several studies have developed methods for quantifying the rates of transfer of chemical residues to the skin of individuals performing activities on contaminated surfaces. These studies have been conducted primarily for the purpose of estimating exposure to pesticides. Section 7.6 describes studies that have estimated residue transfer to human skin. Because use of residue transfer depends on the specific conditions under which exposure occurs (e.g., activity, contact surfaces, age), general recommendations are not provided. Instead, refer to Section 7.6 for a description of the available data from which appropriate values may be selected.

Table 7-1. Recommended Values for Total Body Surface Area, For Children (Sexes Combined) and Adults by Sex

Age Group	Mean	95th Percentile	Multiple Percentiles	Source
	m²			
Male and Female Children Combined				
Birth to <1 month	0.29	0.34	See Tables 7-9, 7-10, and 7-11 (for sex-specific data)	U.S. EPA Analysis of NHANES 1999−2006 data
1 to <3 months	0.33	0.38		
3 to <6 months	0.38	0.44		
6 to <12 months	0.45	0.51		
1 to <2 years	0.53	0.61		
2 to <3 years	0.61	0.70		
3 to <6 years	0.76	0.95		
6 to <11 years	1.08	1.48		
11 to <16 years	1.59	2.06		
16 to <21 years	1.84	2.33		
Adult Male				
21 to 30 years	2.05	2.52	See Tables 7-9 (for sex-combined data) and 7-10	U.S. EPA Analysis of NHANES 2005−2006 data
30 to <40 years	2.10	2.50		
40 to <50 years	2.15	2.56		
50 to <60 years	2.11	2.55		
60 to <70 years	2.08	2.46		
70 to <80 years	2.05	2.45		
80 years and over	1.92	2.22		
Adult Female				
21 to 30 years	1.81	2.25	See Tables 7-9 (for sex-combined data) and 7-11	U.S. EPA Analysis of NHANES 2005−2006 data
30 to <40 years	1.85	2.31		
40 to <50 years	1.88	2.36		
50 to <60 years	1.89	2.38		
60 to <70 years	1.88	2.34		
70 to <80 years	1.77	2.13		
80 years and over	1.69	1.98		

Table 7-2. Recommended Values for Surface Area of Body Parts							
Age Group	Head	Trunk[a]	Arms[b]	Hands	Legs[c]	Feet	Source
	Mean Percent of Total Surface Area						
Male and Female Children Combined							
Birth to <1 month[d]	18.2	35.7	13.7	5.3	20.6	6.5	U.S. EPA, 1985
1 to <3 months[d]	18.2	35.7	13.7	5.3	20.6	6.5	
3 to <6 months[d]	18.2	35.7	13.7	5.3	20.6	6.5	
6 to <12 months[d]	18.2	35.7	13.7	5.3	20.6	6.5	
1 to <2 years[d]	16.5	35.5	13.0	5.7	23.1	6.3	
2 to <3 years[e]	8.4	41.0	14.4	4.7	25.3	6.3	Boniol et al., 2007 (average of data for males and females)
3 to <6 years[f]	8.0	41.2	14.0	4.9	25.7	6.4	
6 to <11 years[g]	6.1	39.6	14.0	4.7	28.8	6.8	
11 to <16 years[h]	4.6	39.6	14.3	4.5	30.4	6.6	
16 to <21 years[i]	4.1	41.2	14.6	4.5	29.5	6.1	
Adult Male							U.S. EPA Analysis of NHANES 2005−2006 data and U.S. EPA, 1985
21+ years	6.6	40.1	15.2	5.2	33.1	6.7	
Adult Female							
21+ years	6.2	35.4	12.8	4.8	32.3	6.6	
	Mean Surface Area by Body Part[j] m^2						
Male and Female Children Combined							
Birth to <1 month[d]	0.053	0.104	0.040	0.015	0.060	0.019	U.S. EPA Analysis of NHANES 1999−2006 data and U.S. EPA, 1985
1 to <3 months[d]	0.060	0.118	0.045	0.017	0.068	0.021	
3 to <6 months[d]	0.069	0.136	0.052	0.020	0.078	0.025	
6 to <12 months[d]	0.082	0.161	0.062	0.024	0.093	0.029	
1 to <2 years[d]	0.087	0.188	0.069	0.030	0.122	0.033	
2 to <3 years[e]	0.051	0.250	0.088	0.028	0.154	0.038	U.S. EPA Analysis of NHANES 1999−2006 data and Boniol et al., 2007
3 to <6 years[f]	0.061	0.313	0.106	0.037	0.195	0.049	
6 to <11 years[g]	0.066	0.428	0.151	0.051	0.311	0.073	
11 to <16 years[h]	0.073	0.630	0.227	0.072	0.483	0.105	
16 to <21 years[i]	0.075	0.759	0.269	0.083	0.543	0.112	
Adult Male							U.S. EPA Analysis of NHANES 2005−2006 data and U.S. EPA, 1985
21+ years	0.136	0.827	0.314	0.107	0.682	0.137	
Adult Female							
21+ years	0.114	0.654	0.237	0.089	0.598	0.122	

Table 7-2. Recommended Values for Surface Area of Body Parts (continued)

Age Group	Head	Trunk[a]	Arms[b]	Hands	Legs[c]	Feet	Source
	95th Percentile Surface Area by Body Part[k] m²						
Male and Female Children Combined							
Birth to <1 month[d]	0.062	0.121	0.047	0.018	0.070	0.022	U.S. EPA Analysis of NHANES 1999−2006 data and U.S. EPA, 1985
1 to <3 months[d]	0.069	0.136	0.052	0.020	0.078	0.025	
3 to <6 months[d]	0.080	0.157	0.060	0.023	0.091	0.029	
6 to <12 months[d]	0.093	0.182	0.070	0.027	0.105	0.033	
1 to <2 years[d]	0.101	0.217	0.079	0.035	0.141	0.038	
2 to <3 years[e]	0.059	0.287	0.101	0.033	0.177	0.044	U.S. EPA Analysis of NHANES 1999−2006 data and Boniol et al., 2007
3 to <6 years[f]	0.076	0.391	0.133	0.046	0.244	0.061	
6 to <11 years[g]	0.090	0.586	0.207	0.070	0.426	0.100	
11 to <16 years[h]	0.095	0.816	0.295	0.093	0.626	0.136	
16 to <21 years[i]	0.096	0.960	0.340	0.105	0.687	0.142	
Adult Male							U.S. EPA Analysis of NHANES 2005−2006 data and U.S. EPA, 1985
21+ years	0.154	1.10	0.399	0.131	0.847	0.161	
Adult Female							
21+ years	0.121	0.850	0.266	0.106	0.764	0.146	

[a] For children, ages 2 to <21 years, data from Boniol et al. (2007) for the neck, bosom, shoulders, abdomen, back, genitals, and buttocks were combined to represent the trunk.
[b] For children, ages 2 to <21 years, data from Boniol et al. (2007) for the upper and lower arms were combined to represent the arms.
[c] For children, ages 2 to <21 years, data from Boniol et al. (2007) for the thigh and legs were combined to represent the legs.
[d] Percentages based on a small number of observations for this age group.
[e] Based on data for 2 year olds from Boniol et al. (2007).
[f] Based on data for 4 year olds from Boniol et al. (2007).
[g] Based on average of data for 6, 8, and 10 year olds from Boniol et al. (2007).
[h] Based on average of data for 12 and 14 year olds from Boniol et al. (2007).
[i] Based on average of data for 16 and 18 year olds from Boniol et al. (2007).
[j] Children's values calculated as mean percentage of body part times mean total body surface area.
[k] Children's values calculated as mean percentage of body part times 95th percentile total body surface area.

Note: Surface area values reported in m^2 can be converted to cm^2 by multiplying by 10,000 cm^2/m^2.

Table 7-3. Confidence in Recommendations for Body Surface Area		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Total surface area estimates were based on algorithms developed using direct measurements and data from NHANES surveys. The methods used for developing these algorithms were adequate. The NHANES data and the secondary data analyses to estimate total surface areas were appropriate. NHANES included large sample sizes; sample size varied with age. Body-part percentages for children <2 years of age were based on direct measurements from a very small number of subjects ($N = 4$). Percentages for children ≥2 years were based on 2,050 children; adult values were based on 89 adults.	
Minimal (or Defined) Bias	The data used to develop the algorithms for estimating surface area from height and weight data were limited. NHANES collected physical measurements of weight and height for a large sample of the population.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key studies were directly relevant to surface area estimates.	
Representativeness	The direct measurement data used to develop the algorithms for estimating total body surface area from weight and height may not be representative of the U.S. population. However, NHANES height and weight data were collected using a complex, stratified, multi-stage probability cluster sampling design intended to be representative of the U.S. population. Body part percentages for children <2 years of age were based on direct measurements from a very small number of subjects ($N = 4$). Percentages for children ≥2 years were based on 2,050 children from various states in the United States and are assumed to be representative of U.S. children; adult values were based on 89 adults.	
Currency	The U.S. EPA analysis used the most current NHANES data to generate surface area data using algorithms based on older direct measurements. The data on body part percentages were dated. However, the age of the percentage data is not expected to affect its utility if the percentages are applied to total surface area data that has been updated based on the most recent NHANES body-weight and height data.	
Data Collection Period	The U.S. EPA analysis was based on four NHANES data sets covering 1999−2006 for children and one NHANES data set, 2005−2006, for adults.	

Table 7-3. Confidence in Recommendations for Body Surface Area (continued)		
General Assessment Factors	Rationale	Rating
Clarity and Completeness		Medium
Accessibility	The U.S. EPA analysis of the NHANES data is unpublished, but used the same methodology as that described in the 1997 *Exposure Factors Handbook* (U.S. EPA, 1997). U.S. EPA (1985) is a U.S. EPA-published report. Boniol et al. (2007) is a published paper.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance of NHANES data was good; quality control of secondary data analysis was not well described.	
Variability and Uncertainty		Medium
Variability in Population	The full distributions were given for total surface area.	
Uncertainty	A source of uncertainty in total surface areas resulted from the limitations in data used to develop the algorithms for estimating total surface from height and weight. Because of the small sample size for some ages, there is uncertainty in the body part percentage estimates for these age groups.	
Evaluation and Review		Medium
Peer Review	The NHANES surveys received a high level of peer review. The U.S. EPA analysis was not published in a peer-reviewed journal, but used the same methodology as that described in the 1997 *Exposure Factors Handbook* (U.S. EPA, 1997).	
Number and Agreement of Studies	There is one key study for total surface area and two key studies for the surface area of body parts.	
Overall Rating		**Medium** for Total Surface Area and **Low** for Surface Area of Individual Body Parts

Table 7-4. Recommended Values for Mean Solids Adherence to Skin						
	Face	Arms	Hands	Legs	Feet	Source
	mg/cm^2					
Children						
Residential (indoors)[a]	-	0.0041	0.011	0.0035	0.010	Holmes et al., 1999
Daycare (indoors and outdoors)[b]	-	0.024	0.099	0.020	0.071	Holmes et al., 1999
Outdoor sports[c]	0.012	0.011	0.11	0.031	-	Kissel et al., 1996a
Indoor sports[d]	-	0.0019	0.0063	0.0020	0.0022	Kissel et al., 1996a
Activities with soil[e]	0.054	0.046	0.17	0.051	0.20	Holmes et al., 1999
Playing in mud[f]	-	11	47	23	15	Kissel et al., 1996a
Playing in sediment[g]	0.040	0.17	0.49	0.70	21	Shoaf et al., 2005
Adults						
Outdoor sports[h]	0.0314	0.0872	0.1336	0.1223	-	Holmes et al., 1999; Kissel et al., 1996a
Activities with soil[i]	0.0240	0.0379	0.1595	0.0189	0.1393	Holmes et al., 1999; Kissel et al., 1996a
Construction activities[j]	0.0982	0.1859	0.2763	0.0660	-	Holmes et al., 1999

a Based on weighted average of geometric mean soil loadings for 2 groups of children (ages 3 to13 years; N = 10) playing indoors.

b Based on weighted average of geometric mean soil loadings for 4 groups of daycare children (ages 1 to 6.5 years; N = 21) playing both indoors and outdoors.

c Based on geometric mean soil loadings of 8 children (ages 13 to 15 years) playing soccer.

d Based on geometric mean soil loadings of 6 children (ages $\geq$8 years) and one adult engaging in Tae Kwon Do.

e Based on weighted average of geometric mean soil loadings for gardeners and archeologists (ages 16 to 35 years).

f Based on weighted average of geometric mean soil loadings of 2 groups of children (age 9 to 14 years; N = 12) playing in mud.

g Based on geometric mean soil loadings of 9 children (ages 7 to 12 years) playing in tidal flats.

h Based on weighted average of geometric mean soil loadings of 3 groups of adults (ages 23 to 33 years) playing rugby and 2 groups of adults (ages 24 to 34) playing soccer.

i Based on weighted average of geometric mean soil loadings for 69 gardeners, farmers, groundskeepers, landscapers and archeologists (ages 16 to 64 years) for faces, arms and hands; 65 gardeners, farmers, groundskeepers, and archeologists (ages 16 to 64 years) for legs; and 36 gardeners, groundskeepers and archeologists (ages 16 to 62) for feet.

j Based on weighted average of geometric mean soil loadings for 27 construction workers, utility workers and equipment operators (ages 21 to 54) for faces, arms and hands; and based on geometric mean soil loadings for 8 construction workers (ages 21 to 30 years) for legs.

\- = No data.

Table 7-5. Confidence in Recommendations for Solids Adherence to Skin		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The approach was adequate; the skin-rinsing technique is widely employed for purposes similar to this. Small sample sizes were used in the studies; the key studies directly measured soil adherence to skin.	
Minimal (or Defined) Bias	The studies attempted to measure soil adherence for selected activities and conditions. The number of activities and study participants was limited.	
Applicability and Utility		Low
Exposure Factor of Interest	The studies were relevant to the factor of interest; the goal was to determine soil adherence to skin.	
Representativeness	The soil/dust studies were limited to the State of Washington, and the sediment study was limited to Rhode Island. The data may not be representative of other locales. All three studies were conducted by researchers from a laboratory where a similar methodology was used. This may limit the representativeness of the data in terms of a wider population.	
Currency	The studies were published between 1996 and 2005.	
Data Collection Period	Short-term data were collected. Seasonal factors may be important, but have not been studied adequately.	
Clarity and Completeness		Medium
Accessibility	Articles were published in widely circulated journals/reports.	
Reproducibility	The reports clearly describe the experimental methods, and enough information was provided to allow for the study to be reproduced.	
Quality Assurance	Quality control was not well described.	
Variability and Uncertainty		Low
Variability in Population	Variability in soil adherence is affected by many factors including soil properties, activity and individual behavior patterns. Not all age groups were represented in the sample.	
Uncertainty	The estimates are highly uncertain; the soil adherence values were derived from a small number of observations for a limited set of activities.	

Table 7-5. Confidence in Recommendations for Solids Adherence to Skin (continued)

General Assessment Factors	Rationale	Rating
Evaluation and Review		Medium
Peer Review	The studies were reported in peer-reviewed journal articles.	
Number and Agreement of Studies	There are three key studies that evaluated different activities in children and adults.	
Overall Rating		**Low**

7.3. SURFACE AREA

Surface area of the skin can be determined by using measurement or estimation techniques. Coating, triangulation, and surface integration are direct measurement techniques that have been used to measure total body surface area and the surface area of specific body parts. The coating method consists of coating either the whole body or specific body regions with a substance of known density and thickness. Triangulation consists of marking the area of the body into geometric figures, then calculating the figure areas from their linear dimensions. Surface integration is performed by using a planimeter and adding the areas. The results of studies conducted using these various techniques have been summarized in *Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments* (U.S. EPA, 1985). Because of the difficulties associated with direct measurements of body surface area, the existing direct measurement data are limited and dated. However, several researchers have developed methods for estimating body surface area from measurements of other body dimensions (DuBois and DuBois, 1916; Boyd, 1935; Gehan and George, 1970). Generally, these formulas are based on the observation that body weight and height are correlated with surface area and are derived using multiple regression techniques. U.S. EPA (1985) evaluated the various formulas for estimating total body surface area. Appendix 7A presents a discussion and comparison of formulas. The key studies on body surface area that are presented in Section 7.3.1 are based on these formulas, as well as weight and height data from NHANES.

7.3.1. Key Body Surface Area Studies

7.3.1.1. *U.S. EPA (1985)—Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments*

U.S. EPA (1985) summarized the direct measurements of the surface area of adults' and children's body parts provided by Boyd (1935) and Van Graan (1969) as a percentage of total surface area. Table 7-6 presents these percentages. A total of 21 children less than 18 years of age were included. Because of the small sample size, it is unclear how accurately these estimates represent averages for the age groups. A total of 89 adults, 18 years and older, were included in the analysis of body parts, providing greater accuracy for the adult estimates. Note that the proportion of total body surface area contributed by the head decreases from childhood to adulthood, whereas the proportion contributed by the leg increases.

U.S. EPA (1985) analyzed the direct surface area measurement data of Gehan and George (1970) using the Statistical Processing System (SPS) software package of Buhyoff et al. (1982). Gehan and George (1970) selected 401 measurements made by Boyd (1935) that were complete for surface area, height, weight, and age for their analysis. Boyd (1935) had reported surface area estimates for 1,114 individuals using coating, triangulation, or surface integration methods (U.S. EPA, 1985).

U.S. EPA (1985) used SPS to generate equations to calculate surface area as a function of height and weight. These equations were subsequently used by U.S. EPA to calculate body surface area distributions of the U.S. population using the height and weight data obtained from the National Health and Nutrition Examination Survey, 1999–2006 (CDC, 2006; see Section 7.3.1.3).

The equation proposed by Gehan and George (1970) was determined by U.S. EPA (1985) to be the best choice for estimating total body surface area. However, the paper by Gehan and George (1970) gave insufficient information to estimate the standard error about the regression. Therefore, U.S. EPA (1985) used the 401 direct measurements of children and adults and reanalyzed the data using the formula of Dubois and Dubois (1916) and SPS to obtain the standard error (U.S. EPA, 1985).

Regression equations were developed for specific body parts using the Dubois and Dubois (1916) formula and using the surface area of various body parts provided by Boyd (1935) and Van Graan (1969) in conjunction with SPS. Regression equations for adults were developed for the head, trunk (including the neck), upper extremities (arms and hands, upper arms, and forearms) and lower extremities (legs and feet, thighs, and lower legs) (U.S. EPA, 1985). Table 7-7 presents a summary of the equation parameters developed by U.S. EPA (1985) for calculating surface area of adult body parts. Equations to estimate the body part surface area of children were not developed because of insufficient data.

7.3.1.2. *Boniol et al. (2007)—Proportion of Skin Surface Area of Children and Young Adults from 2 to 18 Years Old*

Boniol et al. (2007) applied measurement data for 87 body parts to a computer model to estimate the surface area of body parts of children. The measurement data were collected in the late 1970s by Snyder et al. (1978) for the purpose of product safety design (e.g., toys and ergonomics) and represent 1,075 boys and 975 girls from various states in the United States. A surface area module of the computer model MAN3D was used to construct models of the human body for children (ages 2, 4, 6, 8, 10, 12, 14, 16, and 18 years) to estimate surface area of 13 body parts for use in treating skin lesions. The body parts included head, neck, bosom, shoulders, abdomen, back, genitals and buttocks, thighs, legs, feet, upper arms, lower arms, and feet. The proportion of the skin surface area of these body parts relative to total surface area was computed. Table 7-8 presents these data for the various ages of male and female children. Except for the head, for which the percentages are much lower in this study than in U.S. EPA (1985), the body part proportions in this study appear to be similar to those presented in U.S. EPA (1985). For example, the proportions for hands range from 4.2 to 4.9% in this study and from 5.0 to 5.9% in U.S. EPA (1985). Because this study provides additional body parts that were not included in the U.S. EPA (1985) study, it is necessary to combine some body parts for the purpose of comparing their results. For example, upper arms and lower arms can be combined to represent total arms, and thighs plus legs can be combined to represent total legs. Upper arms plus lower arms for 4-year-olds from this study represent 14% of the total body surface, compared to 14.2% for arms for 3- to 6-year-olds from U.S. EPA (1985). Thighs plus legs for 2-year-olds from this study represent 25.3% of the total surface, compared to 23.2% for 2- to 3-year-olds from U.S. EPA (1985). Likewise, neck, bosom, shoulders, abdomen, back, and genitals/buttocks can be combined to represent the trunk.

The advantages of this study are that the data represent a larger sample size of children and are more recent than those used in U.S. EPA (1985). This study also provides data for more body parts than U.S. EPA (1985). However, the age groups presented in this study differ from those recommended in U.S. EPA (2005) and used elsewhere in this handbook, and no data are available for children 1 year of age and younger.

7.3.1.3. *U.S. EPA Analysis of NHANES 2005−2006 and 1999–2006 Data*

The U.S. EPA estimated total body surface areas by using the empirical relationship shown in Appendix 7A and U.S. EPA (1985), and body-weight and height data from the 1999–2006 NHANES for children and the 2005–2006 NHANES for adults. NHANES is conducted annually by the Centers for Disease Control (CDC) National Center of Health Statistics. The survey's target population is the civilian, non-institutionalized U.S. population. The NHANES 1999–2006 survey was conducted on a nationwide probability sample of approximately 40,000 people for all ages, of which approximately 20,000 were children. The survey is designed to obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations. A number of anthropometrical measurements were taken for each participant in the study, including body weight and height. Unit non-response to the household interview was 19%, and an additional 4% did not participate in the physical examinations (including body-weight measurements).

The NHANES 1999–2006 survey includes oversampling of low-income persons, adolescents 12 to 19 years of age, persons 60+ years of age, African Americans, and Mexican Americans. Sample data were assigned weights to account both for the disparity in sample sizes for these groups and for other inadequacies in sampling, such as the presence of non-respondents. For children's estimates, the U.S. EPA utilized four NHANES data sets in its analysis (NHANES 1999–2000, 2001–2002, 2003−2004, and 2005–2006) to ensure adequate sample size for the age groupings of interest. Sample weights were developed for the combined data set in accordance with CDC guidance from the NHANES' Web site (http://www.cdc.gov/nchs/about/major/nhanes/nhanes20052006/faqs05_06.htm#question%2012). For adult estimates, the U.S. EPA utilized NHANES 2005–2006 in its estimates for currency and the same analytical methodology as in the earlier version of the *Exposure Factors Handbook* (U.S. EPA, 1997).

Table 7-9 presents the mean and percentile estimates of total body surface area by age category for males and females combined. Tables 7-10 and 7-11 present the mean and percentiles of total body surface area by age category for males and females, respectively. Tables 7-12 and 7-13 present the mean and percentile estimates of body surface area of specific body parts for males and females 21 years and older, respectively.

An advantage of using the NHANES data sets to derive total surface area estimates is that data are available for infants from birth and older. In addition, the NHANES data are nationally representative and remain the principal source of body-weight and height data collected nationwide from a large number of subjects. It should be noted that in the NHANES surveys, height measurements for children less than 2 years of age were based on recumbent length whereas standing height information was collected for children aged 2 years and older. Some studies have reported differences between recumbent length and standing height measurements for the same individual, ranging from 0.5 to 2 cm, with recumbent length being the larger of the two measurements (Buyken et al., 2005). The use of height data obtained from two different types of height measurements to estimate surface area of children may potentially introduce errors into the estimates.

7.3.2. Relevant Body Surface Area Studies

7.3.2.1. *Murray and Burmaster (1992)—Estimated Distributions for Total Body Surface Area of Men and Women in the United States*

Murray and Burmaster (1992) generated distributions of total body surface area for men and women ages 18 to 74 years using Monte Carlo simulations based on height and weight distribution data. Four different formulae for estimating body surface area as a function of height and weight were employed: Dubois and Dubois (1916), Boyd (1935), U.S. EPA (1985), and Costeff (1966). The formulae of Dubois and Dubois (1916), Boyd (1935), and U.S. EPA (1985) are based on height and weight. The formula developed by Costeff (1966) is based on 220 observations that estimate body surface area based on weight only. Formulae were compared, and the effect of the correlation between height and weight on the body surface area distribution was analyzed.

Monte Carlo simulations were conducted to estimate body surface area distributions. They were based on the bivariate distributions estimated by Brainard and Burmaster (1992) for height and natural logarithm of weight and the formulae described previously. A total of 5,000 random samples each for men and women were selected from the two correlated bivariate distributions. Body surface area calculations were made for each sample, and for each formula, resulting in body surface area distributions. Murray and Burmaster (1992) found that the body surface area frequency distributions were similar for the four models (see Table 7-14). Using the U.S. EPA (1985) formula, the median surface area values were calculated to be 1.96 m^2 for men and 1.69 m^2 for women. The median value for women is identical to that generated by U.S. EPA (1985) but differs for men by approximately 1%. Body surface area was found to have lognormal distributions for both men and women (see Figure 7-1). It also was found that assuming correlation between height and weight influences the final distribution by less than 1%.

The advantages of this study are that it compared the various formulae for computing surface area and confirmed that the formula used by the U.S. EPA in its analysis—as described in Section 7.3.1.3—is appropriate. This study is considered relevant because the height and weight data used in this analysis predates the height and weight data used in the more recent U.S. EPA analysis (see Section 7.3.1.3).

7.3.2.2. *Phillips et al. (1993)—Distributions of Total Skin Surface Area to Body-Weight Ratios*

Phillips et al. (1993) observed a strong correlation (0.986) between body surface area and body weight and studied the effect of using these factors as independent variables in the lifetime average daily dose (LADD) equation (see Chapter 1). The authors suggested that, because of the correlation between these two variables, the use of body surface area-to-body-weight (SA/BW) ratios in human exposure assessments may be more appropriate than treating these factors as independent variables. Direct measurement data from the scientific literature were used to calculate SA/BW ratios for three age groups of the population (infants age 0 to 2 years, children age 2.1 to 17.9 years, and adults age 18 years and older). These ratios were calculated by dividing body surface areas by corresponding body weights for the 401 individuals analyzed by Gehan and George (1970) and summarized by U.S. EPA (1985). Distributions of SA/BW ratios were developed, and summary statistics were calculated for the three age groups and the combined data set.

Table 7-15 presents summary statistics for both adults and children. The shapes of these SA/BW distributions were determined using D'Agostino's test, as described in D'Agostino et al. (1990). The results indicate that the SA/BW ratios for infants were lognormally distributed. The SA/BW ratios for adults and all ages combined were normally distributed. SA/BW ratios for children were neither normally nor lognormally distributed. According to Phillips et al. (1993), SA/BW ratios may be used to calculate LADDs by replacing the body surface area factor in the numerator of the LADD equation with the SA/BW ratio and eliminating the body-weight factor in the denominator of the LADD equation.

The effect of sex and age on SA/BW distribution also was analyzed by classifying the 401 observations by sex and age. Statistical analyses indicated no significant differences between SA/BW ratios for males and females. SA/BW ratios were found to decrease with increasing age.

The advantage of this study is that it studied correlations between surface area and body weight. However, data could not be broken out by finer age categories.

7.3.2.3. *Garlock et al. (1999)—Adult Responses to a Survey of Soil Contact Scenarios*

Garlock et al. (1999) reported on a survey conducted during the summer of 1996. The objective of the study was to evaluate behaviors relevant to dermal contact with soil and dust. Garlock et al. (1999) conducted computer-aided telephone interviews designed to be nationally representative of the U.S. population. The survey response rate was 61.4%, with a sample size of 450. Adult respondents were asked to provide information on what they usually wore while engaging in the following activities during warm or cold weather: gardening, outdoor team sports (e.g., soccer, softball, football), and home construction projects that include digging, as well as whether they washed or bathed following these activities. Information also was collected on frequency and duration of these activities (see Chapter 16). Similar information was collected for children's outdoor activities and is reported in Wong et al. (2000). Using the activity-specific clothing choices reported for each survey participant and body surface area data from U.S. EPA (1985), Garlock et al. (1999) estimated the percentages of adult total body surface areas that would be uncovered for each of the warm weather and cold weather activities (see Table 7-16). The median ranged from 28 to 33% for warm weather activities and 3 to 8% for cold weather activities.

The advantages of this study are that it provides information on the percentage of adult total surface area that may be exposed to soil during a variety of outdoor activities. These data represent outdoor activities only (no data are provided for exposure to indoor surface dusts).

7.3.2.4. *Wong et al. (2000)—Adult Proxy Responses to a Survey of Children's Dermal Soil Contact Activities*

Wong et al. (2000) reported on two national phone surveys that gathered information on activity patterns related to dermal contact with soil. The first (also reported on by Garlock et al., 1999) was conducted in 1996 using random digit dialing. Information about 211 children was gathered from adults more than 18 years of age. For older children (those between the ages of 5 and 17 years), information was gathered on their participation in "gardening and yardwork," "outdoor sports," and "outdoor play activities." For children less than 5 years of age, information was gathered on "outdoor play activities," including whether the activity occurred on a playground or yard with "bare dirt or mixed grass and dirt" surfaces. Information on the types of clothing worn while participating in these play activities during warm weather months (April through October) was obtained. The results of this survey indicated that most children wore short pants, a dress or skirt, short sleeve shirts, no socks, and leather or canvas shoes during the outdoor play activities of interest. Using the survey data on clothing and total body surface area data from U.S. EPA (1985), estimates were made of the skin area exposed (expressed as percentages of total body surface area) associated with various age ranges and activities. Table 7-17 provides these estimates.

The advantage of this study is that it provides information on the percentage of children's bodies exposed to soil. These data reflect exposed skin areas during warm weather for outdoor activities only.

7.3.2.5. *AuYeung et al. (2008)—The Fraction of Total Hand Surface Area Involved in Young Children's Outdoor Hand-to-Mouth Contacts*

AuYeung et al. (2008) videotaped a total of 38 children (20 girls and 18 boys) between the ages of 1 and 6 years while they engaged in unstructured play activities in outdoor residential locations. The data were reviewed, and contact information was recorded according to the objects contacted and the associated contact configurations (e.g., full palm press, closed hand grip, open hand grip, side hand contact, partial palm, fingers only). The fraction of the hand associated with each of the various configuration categories then was estimated for a convenience sample of children and adults using hand traces and handprints consistent with the various contact configurations. Statistical distributions of the fraction of children's total hand surface associated with outdoor contacts were estimated by combining the information on occurrence and configuration of contacts from the videotaped activity study with the data on the fraction of the hand associated with the various contact configurations. Table 7-18 provides the per-contact fractional surface areas for the various types of objects contacted and for all objects combined. For all objects contacted, fractional surface areas ranged from 0.13 to 0.27. AuYeung et al. (2008) suggested that "the majority of children's outdoor contacts with objects involve a relatively small fraction of the hand's total surface area."

The advantage of this study is that it provides information on the fraction of the hand that contacts various surfaces and objects. However, the data are for a relatively small sample size of children (ages 1 to 6 years). Similar data for adults and older children were not provided.

7.4. ADHERENCE OF SOLIDS TO SKIN

Several field studies have been conducted to estimate the adherence of solids to skin. These field studies consider factors such as activity, sex, age, field conditions, and clothing worn. Section 7.4.1 provides information on key studies that measured adherence of solids to skin according to specific activities. Section 7.4.2 provides relevant information. Relevant studies provide additional perspective on adherence, including information on loading per contact event and the effects of soil/dust type, particle size, soil organic and moisture content, skin condition, and contact pressure and duration. This information may be useful for models based on individual contact events.

7.4.1. Key Adherence of Solids to Skin Studies

7.4.1.1. *Kissel et al. (1996a)—Field Measurements of Dermal Soil Loading Attributable to Various Activities: Implications for Exposure Assessment*

Kissel et al. (1996a) collected direct measurements of soil loading on the surface of the skin of volunteers before and after activities expected to result in soil contact. Soil adherence associated with the following indoor and outdoor activities were estimated: greenhouse gardening, Tae Kwon Do, soccer, rugby, reed gathering, irrigation installation, truck farming, outdoor gardening and landscaping (groundskeepers), and playing in mud. Skin-surface areas monitored included hands, forearms, lower legs, faces, and feet (Kissel et al., 1996a).

Table 7-19 provides the activities, information on their duration, sample size, and clothing worn by participants. The subjects' body surfaces (forearms, hands, lower legs for all sample groups; faces and/or feet in some sample groups) were washed before and after the monitored activities. Paired samples were pooled into single ones. The mass recovered was converted to soil loading by using allometric models of surface area.

Table 7-20 presents geometric means for post-activity soil adherence by activity and body region for the four groups of volunteers evaluated. Children playing in the mud had the highest soil loadings among the groups evaluated. The results also indicate that, in general, the amount of soil adherence to the hands is higher than for other parts of the body during the same activity.

An advantage of this study is that it provides information on soil adherence to various body parts resulting from unscripted activities. However, the study authors noted that because the activities were unstaged, "control of variables such as specific behaviors within each activity, clothing worn by participants, and duration of activity was limited." In addition, soil adherence values were estimated based on a small number of observations, and very young children and indoor activities were under represented.

7.4.1.2. *Holmes et al. (1999)—Field Measurements of Dermal Loadings in Occupational and Recreational Activities*

Holmes et al. (1999) collected pre- and post-activity soil loadings on various body parts of individuals within groups engaged in various occupational and recreational activities. These groups included children at a daycare center ("Daycare Kids"), children playing indoors in a residential setting ("Indoor Kids"), individuals removing historical artifacts from a site ("Archeologists"), individuals erecting a corrugated metal wall ("Construction Workers"), heavy equipment operators ("Equipment Operators"), individuals playing rugby ("Rugby Players"), utility workers jack-hammering and excavating trenches ("Utility Workers"), individuals conducting landscaping and rockery ("Landscape/Rockery"), and individuals performing gardening work ("Gardeners"). The study was conducted as a follow-up to previous field sampling of soil adherence on individuals participating in various activities (Kissel et al., 1996a). For this round of sampling, soil loading data were collected utilizing the same methods used and described in Kissel et al. (1996a). Table 7-19 presents information regarding the groups studied and their observed activities.

The daycare children studied were all at one location, and measurements were taken on three different days. The children freely played both indoors in the house and outdoors in the backyard. Table 7-19 describes the number of children within each day's group and the clothing worn. For the second observation day ("Daycare Kids No. 2"), post-activity data were collected for five children. All the activities on this day occurred indoors. For the third daycare group ("Daycare Kids No. 3"), four children were studied.

On two separate days, children playing indoors in a home environment were monitored. The first group ("Indoor Kids No. 1") had four children while the second group ("Indoor Kids No. 2") had six. The play area was described by the authors as being primarily carpeted. Table 7-19 describes the clothing worn by the children within each day's group.

Seven individuals ("Archeologists") were monitored while excavating, screening, sorting, and cataloging historical artifacts from an ancient Native American site during a single event. Eight rugby players were monitored on two occasions after playing or practicing rugby. Eight volunteers from a construction company were monitored for 1 day while erecting corrugated metal walls. Four volunteers ("Landscape/Rockery") were monitored while relocating a rock wall in a park. Four excavation workers ("Equipment Operators") were monitored twice after operation of heavy equipment. Utility workers were monitored while cleaning and fixing water mains, jack-hammering, and excavating trenches ("Utility Workers") on 2 days; five participated on the 1st day and four on the 2nd. Eight volunteers ("Gardeners") ages 16 to 35 years were monitored while performing gardening activities (i.e., weeding, pruning, digging small irrigation trenches, picking and cleaning fruit). Table 7-19 describes the clothing worn by these groups.

Table 7-20 summarizes the geometric means and standard deviations (SDs) of the post-activity soil adherence for each group of individuals and for each body part. According to the authors, variations in the soil loading data from the daycare participants reflect differences in the weather and access to the outdoors.

An advantage of this study is that it provides a supplement to soil-loading data collected in a previous round of studies (Kissel et al., 1996a). Also, the data support the assumption that hand loading can be used as a conservative estimate of soil loading on other body surfaces for the same activity. The activities studied represent normal child play both indoors and outdoors, as well as different combinations of clothing. The small number of participants is a disadvantage of this study. Also, the children studied and the activity setting may not be representative of the U.S. population.

7.4.1.3. *Shoaf et al. (2005)—Child Dermal Sediment Loads Following Play in a Tide Flat*

The purpose of the Shoaf et al. (2005) study was to obtain sediment adherence data for children playing in a tidal flat ("Shoreline Play"). The study was conducted 1 day in late September 2003 at a tidal flat in Jamestown, RI. A total of nine subjects (three females and six males) ages 7 to 12 years participated in the study. Table 7-19 presents information on activity duration, sample size, and clothing worn by participants. Participants' parents completed questionnaires on their child's typical activity patterns during tidal flat play, exposure frequency and duration, clothing choices, bathing practices, and clothes laundering.

This study reported direct measurements of sediment loadings on five body parts (face, forearms, hands, lower legs, and feet) after play in a tide flat. Each of nine subjects participated in two timed sessions, and pre- and post-activity sediment loading data were collected. Geometric mean (geometric standard deviations) dermal loadings (mg/cm^2) on the face, forearm, hands, lower legs, and feet for the combined sessions, as shown in Table 7-20, were 0.04 (2.9), 0.17 (3.1), 0.49 (8.2), 0.70 (3.6), and 21 (1.9), respectively. Event duration did not appear to be associated with sediment loading on the skin.

The primary advantage of this study is that it provides adherence data specific to children and sediments, which previously had been largely unavailable. Results will be useful to risk assessors considering exposure scenarios involving child activities at a coastal shoreline or tidal flat. The limited number of participants (nine) and sampling during just 1 day and at one location, make extrapolation to other situations uncertain.

7.4.2. Relevant Adherence of Solids to Skin Studies

7.4.2.1. *Harger (1979) A Model for the Determination of an Action Level for Removal of Curene Contaminated Soil*

U.S. EPA (1987, 1988, 1992b) reported on experimental values for (soil-related) dust adherence as estimated by Harger (1979). According to U.S. EPA (1992b), "these estimates are based on unpublished experiments by Dr. Rolf Hartung (University of Michigan) as reported in a 1979 memorandum from J. Harger to P. Cole (both from Michigan Toxic Substance Control Commission in Lansing, MI). According to this memo, Dr. Hartung measured adherence using his own hands and found: 2.77 mg/cm^2 for kaolin with a SD of 0.66 and $N = 6$; 1.45 mg/cm^2 for potting soil with SD = 0.36 and $N = 6$; and 3.44 mg/cm^2 for sieved vacuum cleaner dust (mesh 80) with SD = 0.80 and $N = 6$. The details of the experimental procedures were not reported. Considering the informality of the study and lack of procedural details, the reliability of these estimates cannot be evaluated." Accordingly, these data are not considered to be key for the purpose of developing recommendations for soil adherence to the skin.

7.4.2.2. *Que Hee et al. (1985)—Evolution of Efficient Methods to Sample Lead Sources, Such as House Dust and Hand Dust, in the Homes of Children*

Que Hee et al. (1985) used house dust having particle sizes ranging from 44 to 833 µm in diameter, fractionated into six size ranges, to estimate the amount that adhered to the palm of the hand of a small adult. The amount of dust that adhered to skin was determined by applying approximately 5 grams of dust for each size fraction, removing excess dust by shaking the hands, and then measuring the difference in weight before and after application. Que Hee et al. (1985) found no relationship between particle size and adherence for house dusts with particle sizes <246 µm. For all six particle sizes, an average of 63 ± 42 percent of applied dust adhered to the palm of the hand. This represents 31.2 ± 16.6 mg of soil. Excluding the two largest size fractions, 58 ± 29% of the applied dust adhered to the hand, representing 28.9 ± 1.9 mg.

The limitation of these data is that they were based on one adult hand and a single house dust sample. Also, the data are for hands only and are not linked to specific activities.

7.4.2.3. *Driver et al. (1989)—Soil Adherence to Human Skin*

Driver et al. (1989) conducted experiments to evaluate the conditions that may affect soil adherence to the skin of adult hands. Both top soils and subsoils of five soil types (Hyde, Chapanoke, Panorama, Jackland, and Montalto) were collected from sites in Virginia. The organic content, clay mineralogy, and particle size distribution of the soils were characterized, and the soils were dry sieved to obtain particle sizes of ≤250 µm and ≤150 µm. For each soil type, the amount of soil adhering to adult male hands when using both sieved and unsieved soils was determined gravimetrically (i.e., measuring the difference in soil sample weight before and after soil application to the hands). An attempt was made to measure only the minimal or "monolayer" of soil adhering to the hands. This was done by mixing a preweighed amount of soil over the entire surface area of the hands for a period of approximately 30 seconds, followed by removing excess soil by gently rubbing the hands together after contact with the soil. Excess soil that was removed from the hands was collected, weighed, and compared to the original soil sample weight. Driver et al. (1989) measured average adherence of 1.40 mg/cm^2 for particle sizes less than 150 µm, 0.95 mg/cm^2 for particle sizes less than 250 µm, and 0.58 mg/cm^2 for unsieved soils. Analysis of variance statistics showed that the most important factor affecting adherence variability was particle size ($p < 0.001$). The next most important factor was soil type and subtype ($p < 0.001$), but the interaction of soil type and particle size also was significant ($p < 0.01$).

Driver et al. (1989) found statistically significant increases in soil adherence with decreasing particle size, whereas Que Hee et al. (1985) found that different size particles of house dust <246 µm adhered equally well to hands.

The advantages of this study are that it provides additional perspective on the effects of particle size on adherence and that it evaluated several different soil types. However, it is based on data for hands only for a limited number of experimental observations (i.e., one subject). Also, the data are not activity based.

7.4.2.4. *Sedman (1989)—The Development of Applied Action Levels for Soil Contact: A Scenario for the Exposure of Humans to Soil in a Residential Setting*

Sedman (1989) used estimates from Lepow et al. (1975), Roels et al. (1980), and Que Hee et al. (1985) to develop a maximum soil load that could occur on the skin. Lepow et al. (1975) estimated that approximately 0.5 mg of soil adhered to 1 cm^2 of skin. Roels et al. (1980) estimated that 159 mg of soil adhered to the hand of an 11-year-old child. Assuming that approximately 60% (185 cm^2) of the surface area of the hand was sampled, the amount of soil adhering per unit area of skin was estimated to be 0.9 mg/cm^2. Que Hee et al. (1985) estimated that approximately 31.2 mg of housedust adhered to the palm of a small adult. Assuming a hand surface area of 160 cm^2, Sedman (1989) estimated a soil loading of 0.2 mg/cm^2. A rounded arithmetic mean of 0.5 mg/cm^2 was calculated from these three studies. According to Sedman (1989), this was near the maximum load of soil that could occur on the skin, but it is unlikely that most skin surfaces would be covered with this amount of soil (Sedman, 1989).

This study is considered relevant and not key because it does not provide any new data, but uses data from other studies and various assumptions to estimate soil adherence.

7.4.2.5. *Finley et al. (1994)—Development of a Standard Soil-to-Skin Adherence Probability Density Function for Use in Monte Carlo Analyses of Dermal Exposure*

Using data from several existing studies, Finley et al. (1994) developed probability density functions of soil-to-skin adherence. Finley et al. (1994) reviewed studies that estimated adherence among adults and children based on various gravimetric and hand wiping/rinsing methods. Several of these studies were originally conducted for the purpose of estimating lead exposure from soil contact. By combining data from four studies (Charney et al., 1980; Roels et al., 1980; Gallacher et al., 1984; and Duggan et al.; 1985), Finley et al. (1994) estimated a mean ± standard deviation soil adherence value for children of 0.65 ± 1.2 mg soil/cm^2-skin. (50th percentile = 0.36 and 95th percentile = 2.4 mg soil/cm^2-skin). Using data from three studies (Gallacher et al., 1984; Que Hee et al., 1985; and Driver et al., 1989), Finley et al. (1994) estimated a mean ± standard deviation soil adherence value for adults of 0.49 ± 0.54 mg soil/cm^2-skin. (50th percentile = 0.06 and 95th percentile = 1.6 mg soil/cm^2-skin). Because the distributions of soil-to-skin adherence were similar for children and adults, Finley et al. (1994) developed a probability density function based on the combined data for children and adults. The probability density function is lognormally distributed with a mean ± standard deviation of 0.52 ± 0.9 mg soil/cm^2-skin (50th percentile = 0.25 and 95th percentile = 1.7 mg soil/cm^2-skin).

The advantage of this study is that it provides distributions of soil adherence for children, adults, and children and adults combined. However, it is based on some older, relevant studies that are not activity- or body-part specific.

7.4.2.6. *Kissel et al. (1996b)—Factors Affecting Soil Adherence to Skin in Hand-Press Trials: Investigation of Soil Contact and Skin Coverage*

Kissel et al. (1996b) conducted soil adherence experiments to evaluate the effect of particle size and soil moisture content on adherence to the skin. Five soil types were obtained in the Seattle, WA, area (sand, two types of loamy sand, sandy loam, and silt loam) and were analyzed to determine composition. Clay content ranged from 0.5 to 7.0%, and organic carbon content ranged from 0.7 to 4.6%. Soils were dry-sieved to obtain particle size ranges of <150, 150−250, and >250 µm. For each soil type, the amount of soil adhering to an adult female hand when using both sieved and unsieved soils was determined by measuring the soil sample weight before and after the hand was pressed into a pan containing the test soil. Loadings were estimated by dividing the recovered soil mass by the total surface area of one hand, although loading occurred primarily on only one side of the hand. Results showed that generally, soil adherence to hands was directly correlated with moisture content, inversely correlated with particle size, and independent of clay content or organic carbon content. For dry soil, mean adherence was the lowest for the largest particle sizes (i.e., >250 µm) of dry soil (0.06 to 0.34 mg/cm^2) and highest for the smallest particle sizes (0.42 to 0.76 mg/cm^2). Adherence values based on moisture content ranged from 0.22 to 0.54 mg/cm^2 for soils with moisture contents of 9% or less, 0.39 to 3.09 mg/cm^2 for soils with moisture contents of 10 to 19%, and 1.64 to 14.8 mg/cm^2 for soils with moisture contents of 21 to 27%.

The advantage of this study is that it provides information on how soil type can affect adherence to the skin. However, the soil adherence data are for a single subject, and the data are limited to five soil samples.

7.4.2.7. *Holmes et al. (1996)—Investigation of the Influence of Oil on Soil Adherence to Skin*

Holmes et al. (1996) conducted experiments to evaluate differences in adherence of soil to skin based on soil type, moisture content, and the presence of oil (i.e., petroleum contaminants) in the soil. Three soil types (loamy sand, silt loam, and sand) treated with three concentrations (0, 1, and 10%) of motor oil were used, and the experiments were conducted under wet and dry soil conditions. A single subject pressed the right hand, palm down, into a pan containing soil. The soil adhering to the hand was collected by washing and then weighed. For dry soil containing no oil, adherence values ranged from 0.29 mg/cm^2 for sandy soil to 0.59 mg/cm^2 for silt loam. For wet soil containing no oil (13 to 15% moisture), adherence values were 0.25 mg/cm^2 for silt loam, 1.6 mg/cm^2 for sand, and 3.7 mg/cm^2 for loamy sand. According to Holmes et al. (1996), "high concentrations of petroleum contaminants can increase the dermal adherence of soil, but the magnitude of the effect is likely to be modest."

The advantage of this study is that it provides additional perspective on the factors that affect soil adherence to skin. However, it is based on limited observations (i.e., one subject) for only the hand under experimental conditions (i.e., not activity-based).

7.4.2.8. *Kissel et al. (1998)—Investigation of Dermal Contact with Soil in Controlled Trials*

Kissel et al. (1998) measured dermal exposure to soil from staged activities conducted in a greenhouse. A fluorescent marker was mixed in soil so that soil contact for a particular skin surface area could be identified. The subjects were video-imaged under a long-wave ultraviolet (UV) light before and after soil contact. In this manner, soil contact on hands, forearms, lower legs, and faces was assessed by presence of fluorescence. In addition to fluorometric data, gravimetric measurements for pre-activity and post-activity were obtained from the different body parts examined. The studied groups included adults transplanting 14 plants for 9 to 18 minutes, children playing for 20 minutes in a soil bed of varying moisture content representing wet and dry soils, and adults laying plastic pipes for 15, 30, or 45 minutes. Table 7-21 summarizes the parameters describing each of these activities. Before each trial, each participant was washed to obtain a preactivity or background gravimetric measurement.

For wet soil, post-activity fluorescence results indicated that the hand had a much higher fractional coverage than other body surfaces (see Figure 7-2). As shown in Figure 7-3, post-activity gravimetric measurements for children playing and adults transplanting showed higher soil loading on hands and much lower soil loading on other body surfaces. This also was observed in adults laying pipe. The arithmetic mean percent of hand surface area fluorescing was 65% after 15 minutes laying pipe in wet soil and 85% after 30 and 45 minutes laying pipe in wet soil. The arithmetic mean percent of lower leg surface area fluorescing was ~20% after 15 minutes of laying pipe in wet soil, 25% after 30 minutes, and 40% after 45 minutes. According to Kissel et al. (1998), the relatively low loadings observed on non-hand body parts may be a result of a more limited area of contact for the body part rather than lower localized loadings. Kissel et al. (1998) observed geometric means of up to about 3 mg/cm^2 on adults' hands after the 30-minute pipelaying activity with wet soil. After children played and adults transplanted in wet soil, geometric mean soil loadings were 0.7 and 1.1 mg/cm^2, respectively. Mean loadings were lower on hands in the dry soil trial and on lower legs, forearms, and faces in both the wet and dry soil trials. Higher loadings were observed for all body surfaces with the higher moisture content soils.

This report is valuable in showing soil loadings from soils of different moisture content and providing evidence that dermal exposure to soil is not uniform for various body surfaces. This study also provides some evidence of the protective effect of clothing. Disadvantages of the study include the small number of study participants and the short activity duration.

7.4.2.9. *Rodes et al. (2001)—Experimental Methodologies and Preliminary Transfer Factor Data for Estimation of Dermal Exposure to Particles*

Rodes et al. (2001) conducted a study using the fluorescein-tagged Arizona Test Dust (ATD) as a surrogate for house dust and evaluated particle mass transfer from surfaces to the human skin of three test subjects (one female and two males). Transfers to wet and dry skin from stainless steel, vinyl, and carpeted surfaces that had been preloaded with tagged ATD were quantified. For carpets, experiments were conducted in which particles were either embedded in the carpet fibers or not embedded. Particles were embedded into carpet by dragging a steel cylinder across the carpet after loading. Controlled hand (palm) press experiments were conducted, and the amount of tagged ATD that had transferred to the skin of the palm was measured using fluorometry. Surface loadings that represented typical indoor conditions were used in the study. Rodes et al. (2001) used defined dust fractions (<80 μm) to evaluate the influence of particles size on transfer. For the experiments with wet hands, a surrogate saliva solution was used. The portion of the hand that contacted the material also was estimated.

Dermal transfer factors were calculated as the mass of particles on the hand (μg on hand/cm^2 of dermal contact area) divided by the mass of particles on the surface contacts (μg on surface/cm^2 of surface contact). Table 7-22 shows the dermal transfer factors (based on the mean of left and right hand presses) for the various surface types and hand moisture contents. The results indicate that for dry hands, transfer from smooth surfaces (i.e., stainless steel) was higher than for other materials (58.2 to 76.0%; mean = 69 $\pm$ 9%). Skin moisture content was shown to be a critical factor in the proportion of particles to transfer (wet hands resulted in 100% transfer from stainless steel). As surface roughness increased, transfer tended to decrease, with carpet surfaces having the lowest transfer factors (3.4 to 16.9%). Embedding particles into the carpet significantly reduced particle transfer. Rodes et al. (2001) also observed that "only about

1/3rd of the projected hand surface typically came in contact with the smooth test surfaces during a press….[and] consecutive presses decreased the particle transfer by a factor of three as the skin became loaded, requiring ~100 presses to reach an equilibrium transfer rate."

The advantage of this study is that it evaluated particle transfer for a variety of surface types and skin conditions. However, a small number of subjects were involved in the study, and Rodes et al. (2001) suggested that when using these data, the similarities and differences in characteristics between ATD and real house dust should be considered.

7.4.2.10. *Edwards and Lioy (2001)—Influence of Sebum and Stratum Corneum Hydration on Pesticide/Herbicide Collection Efficiencies of the Human Hand*

Edwards and Lioy (2001) studied the effects of sebum/sweat and skin hydration on the transfer of pesticide residues in dust to the hands. Under normal conditions, the skin on the hand is covered by a layer of sebum, a mixture of lipids secreted from the sebaceous glands, and sweat that is secreted from sweat ducts. Edwards and Lioy (2001) measured the levels of sebum and moisture on the palm of the hand of one subject prior to conducting hand press experiments using house dust treated with a mixture of four pesticides (atrazine, diazinon, malathion, and chlorpyrifos). The house dust sample was obtained from vacuum cleaner bags and was sieved to <250 µm. The dust was settled onto the sample surfaces and sprayed with the pesticide mixture, and the subject pressed one hand to the surface in a series of trials conducted approximately 1 week apart. The hand was rinsed with solvent to extract any transferred pesticide/dust, and the solution was analyzed for pesticide residues. Transfer efficiencies (percentage) were calculated as the concentration of residues measured in the hand rinse solution divided by the concentration of pesticide on the sampling surface times 100. The results of this study indicated that the transfer efficiencies of two pesticides in dust were negatively correlated with sebum levels (i.e., increased sebum levels resulted in a 13% reduction in atrazine transfer and an 8% reduction in malathion transfer) and transfer efficiencies of two pesticides in dust were negatively correlated with skin hydration (i.e., increased skin moisture resulted in a 7% reduction in diazinon transfer and 5% reduction in chlorpyrifos transfer; Edwards and Lioy, 2001).

The advantage of this study is that it provides additional perspective on factors that can affect adherence of solids to the skin. However, it is considered relevant and not key because the transfer of dust was studied for the hands only and used experimental conditions not based on exposure-related activities.

7.4.2.11. *Choate et al. (2006)—Dermally Adhered Soil: Amount and Particle Size Distribution*

Choate et al. (2006) investigated the soil characteristics that affect particle adherence to human skin. The factors considered included particle size, organic carbon content, and soil moisture. Day-to-day variability and differences based on whether or not hands were washed before contacting the soil also were examined. A total of 108 subjects (1/3 female) between 18 and 30 years of age participated in one or more of a series of soil adherence experiments. Some of the experiments were conducted using clay loam soil collected in Colorado, while others were conducted using silty-clay loam soil collected in Iowa. Soil moisture contents ranged from 1 to 10%. Choate et al. (2006) used either preweighed adhesive tape or hand washing with distilled water to remove and collect soil that had adhered to the palm of subjects' hands after contact with bulk soil under controlled experimental conditions. Removed soil was weighed, and the mass of soil per area of skin surface was calculated for each sample.

Based on the adhesive tape tests, an average of 0.7 mg/cm^2 of the Colorado soil adhered to the hand ($N = 6$ subjects each sampled using the right or left hand on 10–12 study days). There were no significant differences between the left and right hands, but there were "large average variabilities . . . both between subjects on a given day (±52%) and for an individual subject on different days (±50%)." Differences between soil adherence to hands that had or had not been washed prior to soil contact were observed, with hand washing resulting in a lower mean adherence value (0.51 mg/cm^2; $N = 76$) than non-washing (1.1 mg/cm^2; $N = 72$), when soil with a moisture content of 4.7% was used. The authors suggested that this is "probably due to the removal [during washing] of oils from the skin that aid in the adherence of soil particles." Soil adherence for the two types of soils (i.e., from Colorado and Iowa) with low moisture content (i.e., <2%) averaged 0.64 and 0.69 mg/cm^2, compared to 1.47 and 1.36 mg/cm^2 for those with high moisture content (9% to 10%). Large particle fractions of the soils with higher moisture content adhered more readily than those in soils with low or medium moisture content. The "adhered fractions of dry or moderately moist soils with wide distribution of particle sizes generally consist[ed] of particles of diameters <63 µm." The organic carbon content of the soils did not appear to be an important contributor to soil adherence.

The advantage of this study is that it provides additional perspective on factors that affect soil adherence to skin by using a larger number of subjects compared to some of the earlier studies. However, the data are based only on controlled experimental conditions and may not be representative of the specific types of activities in which dermal exposure may occur.

7.4.2.12. *Yamamoto et al. (2006)—Size Distribution of Soil Particles Adhered to Children's Hands*

Yamamoto et al. (2006) conducted both laboratory and field experiments that showed finer soil particles adhered more readily to children's hands than coarse particles. In the laboratory, one female subject pressed her hand into a tray containing reference soil. Her hand then was washed in ultrapure water that was analyzed to determine the size distributions and the amount of soil that had adhered to the hand. Yamamoto et al. (2006) observed that the mode diameter of soil adhering to the hand (22.8 ± 0.0 µm) was less than that of the reference soil (36.9 ± 4.9 µm), indicating that finer particles adhered more efficiently to the hand. The effect of hand moisture was tested by moistening the hand prior to pressing it onto the tray of soil. Yamamoto et al. (2006) observed that while the amount of soil that adhered to the hand increased with hand moisture, the size distributions were not greatly changed.

A separate field experiment was conducted in which ten 4-year-old children (five males and five females) attending a nursery school in Japan participated. After playing in the playground and sandbox for a morning or afternoon, the children's hands were washed in bottles containing 500 mL ultrapure water, and aliquots of the water were analyzed to determine the size distributions and amounts of particles that had adhered to the hands. The particles sizes of soil samples collected from the children's playing area (i.e., playground, field, and sandbox) also were analyzed. The mean, median, and maximum amounts of soil adhering to the children's hands were 26.2, 15.2, and 162.5 mg/hand, respectively. Assuming a surface area of the hand of 210 cm^2, the amounts are equivalent to 0.125, 0.73, and 0.774 mg/cm^2, respectively. Compared to the soil in the children's play area, the soil adhering to the children's hands was composed primarily of the finer particles.

The advantage of this study is that both laboratory and field measurements were used to evaluate particle sizes of soil that adheres to the hands. However, only one subject participated in the laboratory study, and the children's activities in the field portion were not indexed to the amount of time spent performing soil contact activities.

7.4.2.13. *Ferguson et al. (2008, 2009a, b, c)—Soil-Skin Adherence: Computer-Controlled Chamber Measurements*

Ferguson et al. (2008, 2009a, b, c) conducted a series of soil adherence experiments by using a mechanical chamber designed to control and measure pressure and time of contact with surfaces loaded with soil. Adherence of play sand and lawn soil to human cadaver skin and cotton sheet samples was measured after contact with either loaded carpet or aluminum surfaces. Multiple pressure levels (20 to 50 kPa), durations of contact (10 to 50 seconds), and particle sizes (<139.7 µm and ≥139.7 to <381.0 µm) were evaluated (Ferguson et al., 2008, 2009a, b). Also, both single- and multiple-contact experiments were conducted (Ferguson et al., 2009c). Soil adherence was estimated by weighing the carpet or aluminum samples loaded with play sand or lawn soil both before and after controlled contacts occurred and calculating the weight differences. Each experiment, using different combinations of pressure, contact duration, particle size, soil type, surface, and contact material, was repeated multiple times. Table 7-23 presents a comparison of the adherence values for contact with carpet and aluminum surfaces. Mean soil to skin adherence from contact with aluminum surfaces (1.18 mg/cm^2) was higher than from carpet (0.71 mg/cm^2). In general, soil transfer increased as pressure increased, and contact durations of 30 seconds or more did not appear to result in higher adherence. For carpets, larger particle size was associated with higher adherence, while smaller particle size was associated with higher adherence from aluminum (Ferguson et al., 2009b), Based on a comparison of data from experiments with multiple contacts, Ferguson et al. (2009c) found that, "on average, 8% of the original transfer amount will transfer during a second contact. Therefore, attaching a soil/adherence transfer of the original magnitude for every contact may result in overestimates for exposure."

The advantages of these studies are that they provide data from controlled experiments in which a variety of conditions were tested. However, a single carpet type was used, and transfer may differ based on carpet type. Also, adherence may be different for different types of soil or house dust, as well as for different skin types and conditions. Differences in the nature of contact and the initial surface soil loadings also may affect adherence.

7.5. FILM THICKNESS OF LIQUIDS ON SKIN

Information on the thickness of liquids on human skin is sometimes used to estimate dermal exposure to contaminants in liquids that come into contact with the skin. For example, these data are used to estimate exposure to consumer products in U.S. EPA's Exposure and Fate Assessment Screening Tool (EFAST; Versar, 2007). Section 7.5.1 provides the available data on film thickness of liquids on the skin. However, these data are limited; therefore, studies related to this factor have not been categorized as key or relevant in this chapter, and specific recommendations are not provided for this factor.

7.5.1. U.S. EPA (1987)—Methods for Assessing Consumer Exposure to Chemical Substances; and U.S. EPA (1992c)—A Laboratory Method to Determine the Retention of Liquids on the Surface of Hands

U.S. EPA (1987, 1992c) reported on experiments that were conducted to measure the retention of liquids on hands after contact with six different types of liquids (mineral oil, cooking oil, water soluble bath oil, 50:50 oil/water emulsion, water, and 50:50 water ethanol). These liquids were selected because they were non-toxic and represented a range of viscosities and likely retention on the hands. Five exposure conditions were tested to simulate activities in which consumers' hands may be exposed to liquids, including (1) contact with dry skin (initial contact), (2) contact with skin previously exposed to the liquid and still wet (secondary contact), (3) immersion of a hand into a liquid, (4) contact from handling a wet rag, and (5) contact during spill cleanup. For the initial contact scenario, a cloth saturated with liquid was rubbed over the front and back of both clean, dry hands for the first time during an exposure event. For the secondary contact scenario, a cloth saturated with liquid was rubbed over the front and back of both hands for a second time, after as much as possible of the liquid that adhered to skin during the first contact event was removed using a clean cloth. For the immersion scenario, one hand was immersed in a container of liquid and then removed; the liquid was allowed to drip back into the container for 30 seconds (60 seconds for cooking oil). For the scenario involving the handling of a rag, a cloth saturated with liquid was rubbed over the palms of both hands in a manner simulating handling of a wet cloth. For the spill cleanup scenario, a subject used a clean cloth to wipe up 50 mL of liquid poured onto a plastic laminate countertop. For each of the five scenarios, retention was measured immediately after applying the liquid to the hands and after partial and full removal by wiping. Partial wiping was defined as "lightly [wiping with a removal cloth] for 5 seconds (superficially)." Full wiping was defined as "thoroughly and completely as possible within 10 seconds removing as much liquid as possible." Four human subjects were used in the experiments, and multiple replicates (four to six) were conducted for each subject and type of liquid and exposure condition. Retention of liquids on the skin was estimated by taking the difference between the weight of the cloth(s) before and after wiping and dividing by skin surface area. For the immersion scenario, retention was estimated as the weight difference in the immersion container before and after immersion. Film thickness (cm) was estimated as the amount of liquid retained on the skin (g/cm^2) divided by the density of the liquid (g/cm^3) used in the experiment.

Table 7-24 presents the estimated film thickness data from these experiments. Film thickness data may be used with information on the density of a liquid and the weight fraction of the chemical in the liquid to estimate the amount of contaminant retained on the skin (i.e., amount retained on skin [g/cm^2] = film thickness of liquid on skin [cm] × density of liquid [g/cm^3] × weight fraction [unitless]). Dermal exposure (g/event) may be estimated as the amount retained on the skin (g/cm^2) times the skin surface area exposed (cm^2/event).

The advantage of this study is that it provides data for a factor for which information is very limited. Data are provided for various types of liquids under various conditions. However, the data are based on a limited number of observations and may not be representative of all types of exposure scenarios.

7.6. RESIDUE TRANSFER

Several methods have been developed to quantify rates of residue transfer to the human skin of individuals performing activities on treated surfaces. These methods have been used to either develop transfer efficiencies or estimate residue transfer coefficients. Transfer efficiencies are the fraction (or percentage) of surface residues transferred to the skin. Transfer coefficients (cm^2/hour) represent the ratio of the dermal exposure during a specified time period (mg/hour) based on a specific exposure activity (e.g., harvesting a crop or performing indoor or outdoor activities) to the environmental concentration of the pesticide (mg/cm^2). Transfer coefficients are estimated in studies in which environmental residue levels are measured concurrently with exposure levels for particular job functions or activities. These studies have been conducted primarily for the purpose of estimating exposure to pesticides. Exposure levels are typically measured using dosimeter clothing that is worn by study subjects during the conduct of specific activities and then removed and analyzed for pesticide residues. Sometimes biomonitoring studies (i.e., urine analyses) or other methods (e.g., hand wash) are used to estimate exposure levels. Environmental residues are estimated using various techniques, including use of deposition coupons, wipe samples, or a residue collection tool such as a "drag sled" or roller on indoor or outdoor surfaces, as described in U.S. EPA (1996).

Although chemical-specific transfer coefficients are typically preferred for estimating exposure, U.S. EPA (2009) has used data from published and unpublished residue transfer studies to develop some generic activity-specific transfer coefficient assumptions to use in exposure assessments when chemical-specific data are unavailable. Use of these generic transfer coefficients for pesticides is based on the assumption that the transfer of residues to human skin is based primarily on the types of activities being performed rather than on the specific characteristics of the pesticide. This section presents data for published residue transfer studies only (i.e., unpublished data are not included here).

A transfer coefficient, expressed in units of cm^2/hour, is used to estimate exposure to chemical residues by combining it with the environmental concentration (in units of mg/cm^2) and an exposure time in hours/days (e.g., exposure [mg/day] = transfer coefficient [cm^2/hour] × environmental concentration [mg/cm^2] × exposure time [hours/day]). When using transfer co-efficients, it is important to ensure that the residue levels used are consistent with the method for developing the transfer coefficient (e.g., residue levels based on deposition coupons should be used with transfer co-efficients based on deposition coupons; residue levels based on a residue collection tool such as the California Roller should be used with transfer coefficients based on the same type of tool). Information on methods that may be used to estimate transferrable residues from indoor surfaces and dislodgeable residues from turf may be found in Hsu et al. (1990), Geno et al. (1996), Camann et al. (1996), Fortune (1998a, b), and Fortune et al. (2000). U.S. EPA (2009) describes the use of generic transfer coefficients for a variety of activities involving pesticides. Section 7.6.1 discusses the published data on transfer efficiencies and transfer coefficients gathered from the scientific literature. Because residue transfer depends on the specific conditions under which exposure occurs (e.g., activity, contact surfaces, age), the studies described in Section 7.6.1 have not been categorized as key or relevant, and specific recommendations are not provided for this factor.

7.6.1. Residue Transfer Studies

7.6.1.1. *Ross et al. (1990)—Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated from Indoor Fogger Use: An Interim Report*

Ross et al. (1990) utilized choreographed exercise routines to measure the amount of pesticide residues that may be transferred from carpets to adult skin. Five adult volunteers wore dosimeter clothing (i.e., cotton tight, shirt, gloves, and socks) over the skin areas that normally would be exposed and conducted exercise routines for 18.2 minutes in hotel rooms where pesticides (i.e., chlorpyrifos and d-trans-allethrin) were applied (20 minutes total exposure to account for entry and exit from the treated rooms). The exercise routines were performed at times ranging from 0 to 13 hours after pesticide application. The routines included "substantial body contact between the subject and treated carpet" and were "intended to represent a person's day-long (16 hours]) contact with pesticide-treated surfaces in a home in which a total discharge fogger had been used" (Kreiger et al., 2000). The dosimeter clothing was assumed to retain the same amount of pesticide as the skin (Kreiger et al., 2000). It was collected and analyzed for pesticide residues to estimate the amount of residues that had been transferred from the carpet the skin. Environmental concentrations of the pesticides were measured in the rooms where the exercise routines took place by using gauze coupons placed in the rooms prior to pesticide application.

Ross et al. (1990) found that the transfer of pesticides (i.e., potential dermal exposure) differed according to the body part exposed and declined with time after pesticide application with a rapid decline in pesticide transfer between 6 and 12 hours. Some of the possible factors attributed to this decline were loss of formulation inerts, absorption by or adsorption to the carpet, breakdown to non-detected materials, downward migration into non-contact areas of the carpet or adsorption to dust particles, and volatilization. Table 7-25 provides the mean transfer efficiencies (i.e., percent of pesticide residues transferred to the various body parts from carpet), based on the time after application. These percentages represent the clothing residues divided by the environmental concentrations—based on deposition coupons—times 100 (Ross et al., 1990).

The study demonstrated the efficacy of using choreographed activities to estimate pesticide residue transfer. A limitation of this study is that the exercise routines used may not be representative of other types of indoor activities.

7.6.1.2. *Ross et al. (1991)—Measuring Potential Dermal Transfer of Surface Pesticide Residue Generated from Indoor Fogger Use: Using the CDFA Roller Method: Interim Report II*

Ross et al. (1991) reported on the use of the California Food and Drug Administration (CDFA) roller to estimate pesticide transfer from carpet. This study was conducted in parallel with the Ross et al. (1990) study. The roller device was tested as a surrogate for human subjects for measuring residue transfer from indoor surfaces. The roller was a 12-kg, foam-covered rolling cylinder equipped with stationary handles. A cotton cloth covered with plastic was placed over a pesticide-treated carpet, and the device was rolled over it 10 times. The cloth then was collected and analyzed for pesticide residues. Environmental residue levels were measured using gauze coupons placed on the carpet prior to pesticide application. Mean gauze dosimeter residues were compared to the amount of material transferred to the roller sheet. The results showed that the carpet roller method transferred 1 to 3% of carpet residue to the roller sheet. As in the 1990 study, pesticide transferability decreased with time and with contact with the treated surface. Using the data from Ross et al. (1990), which involved the collection of pesticide residues on dosimeter clothing worn by human subjects who engaged in choreographed exercise routines, and the roller data from this study, Ross et al. (1991) calculated residue transfer coefficients as the total µg of residues transferred to dosimetry clothing times hours of exposure/µg/cm^2 residue transferred to the roller sheet. Mean transfer coefficients were 200,000 ± 50,000 cm^2/hr for chlorpyrifos and 140,000 ± 30,000 cm^2/hr for d-trans allethrin. Ross et al. (1991) concluded that the use of a carpet roller was a good surrogate for measuring residue transfer.

A limitation of this study is that transfer of surface residues from the carpet to CDFA roller may not be representative of transfer of residues based on various human activities.

7.6.1.3. *Formoli (1996)—Estimation of Exposure of Persons in California to Pesticide Products that Contain Propetamphos*

Formoli (1996) conducted a study to estimate exposure to propetamphos that was applied to carpets. Five adult subjects (two men and three women) wore whole body dosimeters and performed structured exercise routines for 20 minutes on the treated carpet. The subjects' clothing was cut up and analyzed for pesticide residues. Transferable residues also were collected from the carpet by moving a roller device over cotton cloth that was subsequently analyzed for pesticide residues. Using the dermal exposure data from the dosimeters and the transferable residue data from the roller device, Formoli (1996) calculated a transfer coefficient of 43,800 cm^2/hr.

These data are useful because they provide perspective on residue transfer data based on controlled experimental conditions. However, the limitations of this study are that the exercise routines used may not be representative of all types of activities in which transfer of surface residues occurs, and the data are based on a single pesticide and a limited number of observations.

7.6.1.4. *Krieger et al. (2000)—Biomonitoring and Whole Body Dosimetry to Estimate Potential Human Dermal Exposure to Semi-Volatile Chemicals*

Krieger et al. (2000) conducted a study similar to the Ross et al. (1990, 1991) studies. The purpose of the Kreiger et al. (2000) study was to compare dermal exposure estimated by four different methods. The methods included (1) measurement of residues deposited onto foil coupons that had been placed on the carpet prior to pesticide application; (2) measurement of residues transferred to cotton cloth using the CDFA roller method, as described by Ross et al. (1991); (3) measurement of residues transferred to whole body cotton dosimeters during structured exercise routines; and (4) analysis of biomonitoring (urine) from subjects who participated in structured activities wearing either cotton whole body dosimeters or swimsuits. A total of 13 subjects wore whole body dosimeters while 21 subjects wore bathing suits. Foggers containing the pesticide chlorpyrifos were discharged from the centers of two identical rectangular meeting rooms at the University of California, Riverside. The rooms were kept unventilated for 2 hours and then were opened with a room divider removed during 30 minutes of ventilation. Surface deposition and dislodgeable residues were measured with three aluminum foil coupons and cotton sheets placed at two, four, and six feet from each fogger. The exercise routines were the same as those used in Ross et al. (1990). Biomonitoring was conducted by collecting four successive 24-hour urine samples from each subject 1 day prior to exposure and 3 days after exposure to chlorpyrifos.

The average amounts of pesticide transferred to the dosimeters were 0.27 µg/cm^2 based on the CDFA roller method and 0.73 µg/cm^2 based on the whole body dosimetry method. These transfer amounts represent 7.5% and 20.2%, respectively, of the average concentration of pesticide on the surface of the carpet (3.6 µg/cm^2) based on the deposition coupons. Calculating the transfer coefficient in the same way as Ross et al. (1991), the mean transfer coefficient would be approximately 154,000 cm^2/hr (13,758 µg of residues transferred to dosimetry clothing per 0.33 hour of exposure/0.27 µg/cm^2 residue transferred to the roller sheet). Using the concentration of residues on the deposition coupons instead of those transferred to the roller cloth as the environmental concentration would give a transfer coefficient of approximately 12,000 cm^2/hr (13,758 µg of residues transferred to dosimetry clothing per 0.33 hour of exposure/3.6 µg/cm^2 residue deposited on the carpet). Absorbed doses and biomonitoring data reported by Kreiger et al. (2000) are not summarized because the data are specific to the pesticide (chlorpyrifos) studied. However, the biomonitoring data indicate that "both types of dosimeters [roller cloth and whole body] removed substantially more [pesticide] than was transferred and absorbed by human skin" (Kreiger et al., 2000).

The advantage of this study is that it compared estimates of pesticide residue transfer using a variety of methods. However, the results are based on a single pesticide and may not be representative of other chemicals or activities that may result in exposure.

7.6.1.5. *Clothier (2000)—Dermal Transfer Efficiency of Pesticides from New, Vinyl Sheet Flooring to Dry and Wetted Palms*

Clothier (2000) compared the transfer of pesticide residues from vinyl flooring to dry, water-wetted, and saliva-wetted hands. Three different pesticides were used in the study (chlorpyrifos, piperonyl butoxide, and pyrethrin). Three male subjects participated in the study by pressing their hand palm down on the vinyl surface. Prior to performing the hand presses, the hands were either treated with a sample of their own saliva or water or received no pretreatment (dry hands). Transferable residues also were collected using the polyurethane foam (PUF) roller method described by Camann et al. (1996). Deposition coupons also were used to measure the amount of pesticide applied to the flooring. Transfer efficiencies were estimated as the rate of transfer to hands or PUF roller (µg/cm^2) /mean surface loading (µg/cm^2) times 100. Table 7-26 presents the transfer efficiencies from this study. Transfer efficiencies were higher for wetted palms than for dry palms and for the PUF roller than for dry hands.

The advantage of this study is that it provides perspective on the effects of hand moisture on residue transfer. The data are based on three pesticides applied to vinyl surfaces and a limited number of subjects under controlled experimental conditions. However, the data may not reflect transfer associated with other chemicals or activities.

7.6.1.6. *Bernard et al. (2001)—Environmental Residues and Biomonitoring Estimates of Human Insecticide Exposure from Treated Residential Turf*

Bernard et al. (2001) conducted a study similar to those conducted by Ross et al. (1990) and Kreiger et al. (2000), except that the exercise routines were conducted on pesticide-treated turf instead of on pesticide-treated carpets. Exposure was measured by analyzing whole body dosimeters worn by female participants during 20 minutes of exercise that occurred approximately 3.5 hours after pesticide had been applied to the turf. Pesticide deposition was estimated by collecting and analyzing cotton coupons present at the time of application. Dislodgeable residues were measured by collecting and rinsing foliage samples in an aqueous solution, and transferable turf residues were estimated using the CDFA roller 0, 1, and 3 days after application. Turf residues based on spray deposition (i.e., coupons), dislodgeable (aqueous wash) residues, and transferable (roller) residues were 12, 3.4, and 0.085 µg/cm^2, respectively. This suggests that dislodgeable residues were approximately 28% of the deposition residues, and transferable residues were less than 1% of the deposition residues. Bernard et al. (2001) estimated that exposures based on transferable residues and those based on whole body dosimetry would be similar because transferable residues based on whole body dosimetry and those based on the roller technique were similar.

This study provides perspective on residue transfer from treated turf. However, the data are for a single pesticide and may not be representative of other chemical substances or exposure conditions.

7.6.1.7. *Cohen-Hubal et al. (2005)—Characterizing Residue Transfer Efficiencies Using a Fluorescent Imaging Technique*

Cohen-Hubal et al. (2005) used a fluorescent tracer method to evaluate the factors that affect the transfer of residues from indoor surfaces to the hands. The non-toxic fluorescent tracer vitamin B_2 riboflavin was applied to carpet and laminate flooring. Two levels of analyte loading were evaluated in the study (2 μg/cm^2 and 10 μg/cm^2). Three adult subjects participated in a series of controlled experiments in which the hands contacted the treated surfaces using one of two different levels of pressure for one of two different durations. Transfer as a result of multiple sequential contacts also was evaluated. The hands were characterized as dry, moist, or sticky prior to conducting the hand presses on the treated flooring materials. To simulate moist hands, the hands were placed under a cool mist vaporizer for 20 seconds; to simulate sticky conditions, 1.2 grams of Karo Syrup was applied to the hands. Dermal loading on the hands was measured by using a fluorescence imaging system. Transfer efficiencies were estimated by dividing the mass of tracer on the hand per unit surface area (μg/cm^2) divided by the loading of tracer on the carpet or laminate surface (μg/cm^2) times 100. Incremental transfer efficiency was calculated separately for each individual contact, whereas overall transfer efficiency was calculated cumulatively for the series of contacts. Table 7-27 provides the incremental and overall transfer efficiencies based on the hand conditions, the surface type, the surface loading, and the number of contacts. Based on the data in Table 7-27, the mean transfer efficiency after a single contact ranged from 3 to 14% for dry and sticky hands, respectively. According to Cohen-Hubal et al. (2005), surface loading and skin condition were important parameters in characterizing transfer efficiency, but duration of contact and pressure did not have a significant effect on transfer.

An advantage of this study is that it uses a tracer method to estimate transfer efficiency from surfaces to human skin. It also provides perspective on various conditions that may affect transfer efficiency. A limitation is that the data may not reflect transfer associated with specific chemicals or activities.

7.6.1.8. *Cohen-Hubal et al. (2008)—Comparing Surface Residue Transfer Efficiencies to Hands Using Polar and Non-Polar Fluorescent Transfer*

As a follow up to the Cohen-Hubal et al. (2005) study, Cohen-Hubal et al. (2008) conducted a study using a second fluorescent tracer, Uvitex OB, which has different physical-chemical properties than riboflavin. The fluorescent tracer, which was used as a surrogate for pesticide residues, was applied to carpet or laminate surfaces at two different loading levels, and controlled hand transfer experiments were conducted by using various pressures and motions (i.e., press and smudge), numbers of contacts, and different hand conditions (i.e., dry or moist). The mass of tracer transferred to the hands was measured using a fluorescent tracer imaging system. The results indicated that "overall percent transfer ranged from 0.8 to 45.5% for the first contact and 0.6 to 19.4% for the seventh contact," and dermal loadings increased in a near linear fashion through the seventh contact. "Transfer was greater for laminate (over carpet), smudge (over press), and moist (over dry)" (Cohen-Hubal et al., 2008). For lower surface loadings, dermal transfer increased through the seventh contact, suggesting that multiple contacts may be required to reach an effective equilibrium with the surface.

Similar to the previous study, the advantage of these data is that they are based on tracers and provide information on factors affecting residue transfer. However, the data may or may not accurately reflect transfer for specific chemicals or activities.

7.6.1.9. *Beamer et al. (2009)—Developing Probability Distributions for Transfer Efficiencies for Dermal Exposure*

Beamer et al. (2009) combined data from nine residue transfer studies and developed distributions for three pesticides (chlorpyrifos, pyrethrin I, and piperonyl butoxide) and three surface types (foil, vinyl, and carpet). The studies used for developing these distributions included Hsu et al. (1990), Ross et al. (1991), Camann et al. (1995, 1996), Geno et al. (1996), Fortune (1998a, b), Clothier (2000), and Kreiger et al. (2000). Beamer et al. (2009) stratified the data by chemical and surface type. Statistical methods were used to develop the distributions, based on combined data from studies that used different sampling methods, surface concentrations, formulations, sampling time, and skin conditions (i.e., dry or wet). Transfer efficiencies were defined as the amount transferred to skin or a transfer media used as a surrogate for skin divided by the amount of pesticide applied to the surface.

Table 7-28 presents the lognormal parameter values for the three chemicals and three surface types evaluated. The results of statistical analyses indicated that the distributions of transfer efficiencies were statistically different for the surface types and chemicals shown in Table 7-28. Transfer efficiency was highest for foil for all chemicals, followed by vinyl and carpet. For example, the geometric mean transfer efficiencies ranged from 0.01 to 0.02 (i.e., 1 to 2%) for carpet, 0.03 to 0.04 (3 to 4%) for vinyl, and 0.83 to 0.86 (83 to 86%) for foil. According to Beamer et al. (2009), these distributions can be used for modeling transfer efficiencies.

An advantage of this data set is that it uses data from several of the studies described in this chapter to develop distributions for three pesticides and three surface types. However, there is some uncertainty with regard to the representativeness of these data for other chemicals or exposure conditions.

7.7. OTHER FACTORS

7.7.1. Frequency and Duration of Dermal (Hand) Contact

This section provides information from studies that evaluated activities that may affect dermal exposure. This includes information on the frequency and duration of dermal contact with objects and surfaces. Additional information on activities patterns and consumer product use that affect the frequency and duration of dermal contact is provided in Chapters 16 and 17. Information on hand-to-mouth contact frequency in presented in Chapter 4.

7.7.1.1. *Zartarian et al. (1997)—Quantified Dermal Activity Data from a Four-Child Pilot Field Study*

Zartarian et al. (1997) conducted a pilot field study in California in 1993 to estimate children's dermal contact with objects in their environment. Four Mexican American farm worker children ages 2 to 4 years were videotaped to record their activities over a 1-day period. Five to 30% of the children's time was spent outdoors, while the remainder was spent indoors. Videotape data were obtained over 6 to 11 waking hours for the four children (i.e., a total of 33 hours of videotape). The videotapes were translated to provide information about the objects that the children contacted, as well as the frequency and duration of contact. The data indicated that most objects were contacted for approximately 2 to 3 seconds in duration, and hard surfaces and hard toys were touched by children's hands for the longest percent of the time (Zartarian et al., 1997). Table 7-29 provides the average contact frequency for the left and right hands of the four children who participated in the study. Frequency of contact was highest for hard surfaces and hard toys (see Table 7-29).

The advantage of this study is that it was the first in a series of papers that used video-transcription methods to evaluate children's micro-activities relative to potential dermal exposure. However, the number of participants in this study (four children) was small, and the results may not be representative of all U.S. children.

7.7.1.2. *Reed et al. (1999)—Quantification of Children's Hand and Mouthing Activities Through a Videotaping Methodology*

Reed et al. (1999) used a videotaping methodology similar to that used by Zartarian et al. (1997) to quantify the hand contact activities of 30 children in New Jersey. A total of 20 children ages 3 to 6 years were observed in daycare facilities, while an additional 10 children, ages 2 to 5 years were observed in residential settings. Total videotaping time ranged from 3 to 7 hours for the daycare children and 5 to 6 hours for the residential children. Frequency of hand contact with objects and surfaces was quantified by recording touches with clothing, dirt, objects, and smooth or textured surfaces, as observed on video. According to Reed et al. (1999), "comparison of activities of children in home settings and daycare showed that rates of many of the activities did not differ significantly between venues and therefore, data from homes and daycare were combined." Table 7-30 presents the hand contact frequency data for the 30 children observed in this study. High contact frequencies were observed for clothing, objects, other, and smooth surfaces.

The advantages of this study are that more children were observed than in the previous study, and both daycare and residential children were included. However, the children were from a single location and may not be representative of all U.S. children.

7.7.1.3. *Freeman et al. (2001)—Quantitative Analysis of Children's Micro-Activity Patterns: The Minnesota Children's Pesticide Exposure Study*

Freeman et al. (2001) conducted a survey response and video-transcription study of some of the respondents in a phased study of children's pesticide exposures in the summer and early fall of 1997. A probability-based sample of 168 families with children ages 3 to <14 years old in urban (Minneapolis/St. Paul) and non-urban (Rice and Goodhue Counties) areas of Minnesota answered questions about children's behaviors that might contribute to exposure via dermal contact or non-dietary ingestion. Of these 168 families, 19 agreed to videotaping of the study children's activities for a period of 4 consecutive hours. The videotaped children ranged in age from 3 to 12 years of age but were divided into four age groups (3 to 4 years, 5 to 6 years, 7 to 8 years, and 10 to 12 years) for the purposes of quantifying microactivities. The frequency of touching clothing, textured surfaces (e.g., carpets and upholstered furniture), smooth surfaces (e.g., wood or plastic furniture, hardwood floor), or objects (e.g., toys, pencils, or other things that could be manipulated) was quantified by observing the behaviors on the videotapes during a 4-hour observation period. Table 7-31 shows the frequency of hand contacts per hour for the 19 children.

An advantage to this study is that it included results for various ages of children. However, the children in this study may not be representative of all U.S. children. Also, the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

7.7.1.4. *Freeman et al. (2005)—Contributions of Children's Activities to Pesticide Hand Loadings Following Residential Pesticide Application*

Freeman et al. (2005) gathered data on hand contacts with surfaces and objects as part of a study to evaluate pesticide exposure in residential settings. A convenience sample of 10 children between the ages of 24 and 55 months was selected for videotape observation on the 2nd day after their homes were treated with pesticides. The children were videotaped during a 4-hour period (only three children spent time outside the house, with outdoor times ranging from 21 to 57 minutes). The videotapes were transcribed to quantify contact rates in terms of frequency and duration. According to Freeman et al. (2005), "the duration of contact of most contact events was very short (2−3 seconds)," but contact with bottles, food, and objects tended to be somewhat longer (median durations ranged from 4.5 to 7.5 seconds for these items). Table 7-32 presents the right-hand contact rates (contacts per hour) for the various objects and surfaces. High contact items include objects and smooth surfaces.

The advantage of this study is that it provides additional information on hand contact frequency. However, the data are based on a limited number of children and were collected over a relatively short time period. Also, the presence of a video camera may have affected the children's behavior.

7.7.1.5. *AuYeung et al. (2006)—Young Children's Hand Contact Activities; an Observational Study via Videotaping in Primarily Outdoor Residential Settings*

AuYeung et al. (2006) gathered data on children's hand contact activities by videotaping them in outdoor residential settings in 1998–1999. A total of 38 children ages 1 to 6 years from middle class suburban families were recruited from the San Francisco Bay peninsula area to participate in the study. Each child was videotaped during 2 hours of natural (i.e., unstructured) play in an outdoor location (i.e., park, playground, outdoor residential area). Videotapes then were translated using a software package specially designed for this use. Contacts were tabulated for 15 object surface categories and for all non-dietary objects and all objects and surfaces combined. Hourly contact frequency, median duration per contact, and hourly contact duration were calculated for each child for the left hand, right hand, and both hands combined, and summary statistics were developed for all children combined. Table 7-33 provides the data for outdoor locations. According to AuYeung et al. (2006), these data suggest that children have a large number of short-duration contacts with outdoor objects and surfaces. AuYeung et al. (2006) also collected some limited data for indoor locations. These data are based on nine children who were videotaped for 15 minutes or more indoors. Table 7-34 provides summary data for these children.

The advantage of this study is that it provides dermal (hand) contact data for a wide variety of outdoor objects and surfaces. The data for indoor environments were limited, however, and the presence of unfamiliar persons following the children with a video camera may have influenced the video-transcription methodology results.

7.7.1.6. *Ko et al. (2007)—Relationships of Video Assessments of Touching and Mouthing Behaviors During Outdoor Play in Urban Residential Yards to Parental Perceptions of Child Behaviors and Blood Lead Levels*

Ko et al. (2007) used video observation and transcription methods to assess children's hand contacts with outdoor surfaces as part of a study to assess the relationship between blood level levels and children's activities in urban environments. During the summers of 2000 and 2001, a total of 37 children ages 1 to 5 years were videotaped during 2-hour periods while playing in outdoor urban residential settings. The children were primarily from low-income, Hispanic families. Ko et al. (2007) tabulated surface contacts by reviewing the videotapes and counting the number of times a child's hands touched one of the following surfaces: (1) cement, stone, or steel on the ground (cement); (2) porch floor or porch steps (porch); (3) grass; and (4) bare soil. Distributions of contact frequency (contacts per hour) were developed using the data for the 37 children for the four surface types and for all surfaces combined. According to Ko et al. (2007), the median contact frequency for all surfaces was 81 contacts per hour (geometric mean = 70 contacts per hour), with several children touching surfaces approximately 400 contacts per hour (see Table 7-35).

Similar to the AuYeung et al. (2006) study described in the previous section, the advantage of this study is that it provides data for outdoor dermal (hand) contacts with a variety of objects and surfaces. These surface types are somewhat different from those in AuYeung et al. (2006) but provide additional perspective on contact with outdoor surfaces. As with all studies that use videotape methods, however, the presence of unfamiliar persons following the children with a video camera may have influenced the results.

7.7.1.7. *Beamer et al. (2008)—Quantified Activity Pattern Data from 6 to 27-Month-Old Farmworker Children for Use in Exposure Assessment*

Beamer et al. (2008) conducted a study in which children were videotaped to estimate contacts with objects and surfaces in their environment. A convenience sample of 23 children residing in the farm worker community of Salinas Valley, CA, participated in the study. Participants were 6- to 13-month-old infants and 20- to 26-month-old toddlers. Two researchers videotaped each child's activities for a minimum of 4 hours and kept a detailed written log of locations visited and objects and surfaces contacted by the child. A questionnaire was administered to an adult in the household to acquire demographic data, housing and cleaning characteristics, eating patterns, and other information pertinent to the child's potential pesticide exposure.

Table 7-36 presents the mean and median object and surface contact frequency in events per hour. The most frequently contacted objects included toys (121 contacts per hour) and clothing/towels (114 contacts per hour). The mean frequency of hand contact of all objects and surfaces for both hands combined was 686.3 contacts per hour. Table 7-36 also provides information on the duration of contact with these objects and surfaces in minutes per hour and in seconds per contact.

The advantage of this study is that it included both infants and toddlers. Also, it provided data for a wide variety of objects and surfaces. Differences between the two age groups, as well as sex differences, were observed. As with other video-transcription studies, however, the presence of non-family-member videographers and a video camera may have influenced the children's behavior.

7.7.2. Thickness of the Skin

Although factors that influence dermal uptake (i.e., absorption) and internal dose are not the focus of this chapter, limited information on the physiological characteristics of the skin (i.e., thickness of the skin on various body parts) is presented here to provide some perspective on this topic. It should be noted that this is only one factor that may influence dermal uptake. Others include the condition of the skin (e.g., Williams et al., 2004, 2005, suggested that the presence of perspiration on the skin may affect uptake of contaminants) and chemical-specific factors (e.g., concentration of chemical in contact with the skin and characteristics of the chemical that affect its rate of absorption).

The skin consists of two distinct layers: the epidermis (outermost layer) and dermis. The outermost layer of the epidermis is the stratum corneum or horny layer. Because the stratum corneum serves as the body's outermost boundary, it is the layer where chemical exposures may occur. According to the International Commission on Radiological Protection (ICRP, 1994), the thickness of the stratum corneum of adults is "approximately one-tenth that of the epidermis except for palms [of hands] and soles [of feet] where it may be much thicker." Over most parts of the body, the stratum corneum is estimated to range in thickness from about 13 to 15 µm, but it may vary by region of the body, with the certain parts (e.g., the "horny pads") of the palms and soles being as high as 600 µm (ICRP, 1994). Holbrook and Odland (1974) used electron microscopy to measure the thickness of the stratum corneum from fixed tissues collected from the abdomen, back, forearm, and thigh of six subjects (three men and three women) ages 25 to 31 years old. The mean thicknesses for these four body regions were 8.2, 9.4, 12.9, and 10.9 µm, respectively.

Schwindt et al. (1998) estimated thickness using skin at the same four sites in six women with a mean age of 33.2 years. Based on calculations from measurements of transepidermal water loss during tape stripping, mean thicknesses were estimated to be 7.7 ± 1.7, 11.2 ± 2.6, 12.3 ± 3.6, and 13.1 ± 4.7 µm for the abdomen, back, forearm, and thigh, respectively (Schwindt et al., 1998). Using two methods of calculating thickness, Pirot et al. (1998) estimated the thickness of the stratum corneum on the forearms of 13 subjects (2 men and 11 women) between the ages of 23 and 60 years. The mean ± standard deviation values were 11.3 ± 5.1 and 12.6 ± 5.3 µm. Russell et al. (2008) estimated the thickness of the stratum corneum on the forearm to be approximately 10 µm, based on 18 adults (3 men and 15 women) between the ages of 22 and 43 years. Egawa et al. (2007) estimated the stratum corneum thickness on five body parts of 15 Japanese adults (6 men and 9 women) ages 23 to 49 years old. Mean ± standard deviation thicknesses were 16.8 ± 2.8, 21.8 ± 3.6, 22.6 ± 4.3, 29.3 ± 6.8, and 173 ± 37.0 for the cheek, upper arm, forearm, back of hand, and palm of hand, respectively (Egawa et al., 2007).

For newborn infants, the stratum corneum "is extremely thin, but grows rapidly during the first month" (ICRP, 1994). Based on measurements of newborn skin that was fixed in formalin, thickness of the stratum corneum was about 10 µm on the back and about 80 to 140 µm on the sole of the foot of newborns. Based on measurement using non-fixed, fresh, frozen newborn skin, the thickness of the stratum corneum ranged from 10 to 50 µm for portions of the buttocks and abdomen and most other regions of the body except the hands and feet (ICRP, 1994).

7.8. REFERENCES FOR CHAPTER 7

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Table 7-6. Percentage of Total Body Surface Area by Body Part for Children (sexes combined) and Adults by Sex

Age (years)	*N* M:F	Percent of Total											
		Head		Trunk		Arms		Hands		Legs		Feet	
		Mean	Min–Max	Mean	Min–Max	Mean	Min–Max	Mean	Min–Max	Mean	Min–Max	Mean	Min–Max
Male and Female Children Combined													
<1	2:0	18.2	18.2−18.3	35.7	34.8−36.6	13.7	12.4−15.1	5.3	5.2−5.4	20.6	18.2−22.9	6.5	6.5−6.6
1 <2	1:1	16.5	16.5−16.5	35.5	34.5−36.6	13.0	12.8−13.1	5.7	5.6−5.8	23.1	22.1−24.0	6.3	5.8−6.7
2 <3	1:0	14.2		38.5		11.8		5.3		23.2		7.1	
3 <4	0:5	13.6	13.3−14.0	31.9	29.9−32.8	14.4	14.2−14.7	6.1	5.8−6.3	26.8	26.0−28.6	7.2	6.8−7.9
4 <5	1:3	13.8	12.1−15.3	31.5	30.5−32.4	14.0	13.0−15.5	5.7	5.2−6.6	27.8	26.0−29.3	7.3	6.9−8.1
5 <6													
6 <7	1:0	13.1		35.1		13.1		4.7		27.1		6.9	
7 <8													
8 <9													
9 <10	0:2	12.0	11.6−12.5	34.2	33.4−34.9	12.3	11.7−12.8	5.3	5.2−5.4	28.7	28.5−28.8	7.6	7.4−7.8
10 <11													
11 <12													
12 <13	1:0	8.7		34.7		13.7		5.4		30.5		7.0	
13 <14	1:0	10.0		32.7		12.1		5.1		32.0		8.0	
14 <15													
15 <16													
16 <17	1:0	8.0		32.7		13.1		5.7		33.6		6.9	
17 <18	1:0	7.6		31.7		17.5		5.1		30.8		7.3	
Male, 18+ years	32	7.8	6.1−10.6	35.9	30.5−41.4	14.1	12.5−15.5	5.2	4.6−7.0	31.2	26.1−33.4	7.0	6.0−7.9
Female, 18+ years	57	7.1	5.6−8.1	34.8	32.8−41.7	14.0[a]	12.4−14.8	5.1[b]	4.4−5.4	32.4[a]	29.8−35.3	6.5[a]	6.0−7.0

[a] Sample size = 13.
[b] Sample size = 12.
N = Number of subjects, (M:F = male:female).
Min = Minimum percent.
Max = Maximum percent.

Source: U.S. EPA, 1985.

Table 7-7. Summary of Equation Parameters for Calculating Adult Body Surface Area[a]

		Equation for surface areas (m^2)					
Body Part	*N*	a_o	W^{a1}	H^{a2}	P	R^2	SE
Head							
Female	57	0.0256	0.124	0.189	0.01	0.302	0.00678
Male	32	0.0492	0.339	−0.0950	0.01	0.222	0.0202
Trunk							
Female	57	0.188	0.647	−0.304	0.001	0.877	0.00567
Male	32	0.0240	0.808	−0.0131	0.001	0.894	0.0118
Upper Extremities							
Female	57	0.0288	0.341	0.175	0.001	0.526	0.00833
Male	48	0.00329	0.466	0.524	0.001	0.821	0.0101
Arms							
Female	13	0.00223	0.201	0.748	0.01	0.731	0.00996
Male	32	0.00111	0.616	0.561	0.001	0.892	0.0177
Upper Arms							
Male	6	8.70	0.741	−1.40	0.25	0.576	0.0387
Forearms							
Male	6	0.326	0.858	−0.895	0.05	0.897	0.0207
Hands							
Female	12[b]	0.0131	0.412	0.0274	0.1	0.447	0.0172
Male	32	0.0257	0.573	−0.218	0.001	0.575	0.0187
Lower Extremities[c]	105	0.00286	0.458	0.696	0.001	0.802	0.00633
Legs	45	0.00240	0.542	0.626	0.001	0.780	0.0130
Thighs	45	0.00352	0.629	0.379	0.001	0.739	0.0149
Lower legs	45	0.000276	0.416	0.973	0.001	0.727	0.0149
Feet	45	0.000618	0.372	0.725	0.001	0.651	0.0147

[a] $SA = a_o W^{a1} H^{a2}$ where: W = Weight in kilograms; H = Height in centimeters; P = Level of significance; R^2 = Coefficient of determination; SA = Surface Area; SE = Standard error; *N* = Number of observations.

[b] One observation for a female whose body weight exceeded the 95 percentile was not used.

[c] Although two separate regressions were marginally indicated by the F test, pooling was done for consistency with individual components of lower extremities.

Source: U.S. EPA, 1985.

Table 7-8. Mean Proportion (%) of Children's Total Skin Surface Area, by Body Part

	Age (years)								
	2	4	6	8	10	12	14	16	18
	Male								
N	115	118	117	104	124	154	155	100	88
Head	8.4	8.1	7.0	6.0	5.4	4.9	4.3	4.0	3.9
Neck	3.9	3.8	3.2	2.7	2.6	2.3	2.2	2.0	2.0
Bosom	12.3	12.3	12.2	12.2	12.2	12.4	12.3	12.3	12.8
Shoulders	1.9	2.1	1.9	1.9	1.8	1.8	1.8	1.8	1.9
Abdomen	2.7	2.9	2.7	2.8	2.7	2.8	2.8	2.8	2.9
Back	12.9	13.2	13.1	13.1	13.1	13.4	13.4	13.3	13.9
Genitals and Buttocks	7.1	6.9	6.9	6.8	7.1	7.0	7.2	7.2	6.8
Thighs	14.9	15.0	16.2	16.6	17.6	17.4	18.2	18.1	18.3
Legs	10.3	10.3	10.9	11.7	11.8	11.9	11.9	11.9	11.2
Feet	6.5	6.5	6.7	7.2	6.8	7.0	6.6	6.7	6.1
Upper Arms	8.7	8.5	8.6	8.6	8.8	8.7	8.9	9.6	9.6
Lower Arms	5.8	5.6	5.7	5.7	5.5	5.5	5.7	5.8	5.9
Hands	4.5	4.8	4.9	4.7	4.6	4.7	4.7	4.7	4.7
	Female								
N	97	110	126	93	134	133	116	98	68
Head	8.4	7.8	6.9	6.1	5.3	4.8	4.5	4.3	4.3
Neck	3.8	3.6	3.2	2.8	2.5	2.3	2.1	2.1	2.0
Bosom	12.4	12.6	12.4	12.2	12.1	12.0	12.3	13.3	14.3
Shoulders	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.8	1.8
Abdomen	3.0	2.9	2.8	2.8	2.7	2.7	2.8	2.9	3.0
Back	13.2	13.4	13.2	13.1	13.0	12.9	13.2	13.9	14.1
Genitals and Buttocks	6.8	6.6	6.6	6.6	7.0	7.3	8.0	7.9	8.1
Thighs	14.2	15.6	16.5	18.4	18.4	18.5	18.9	17.8	17.4
Legs	11.2	10.4	11.4	11.3	12.2	12.5	12.1	11.9	11.5
Feet	6.0	6.3	6.6	6.5	6.7	6.5	6.1	6.1	5.6
Upper Arms	8.6	8.4	8.3	8.1	8.4	8.8	8.8	8.6	8.5
Lower Arms	5.6	5.5	5.3	5.5	5.3	5.5	5.3	5.3	5.1
Hands	4.8	4.9	4.9	4.7	4.5	4.5	4.2	4.2	4.4

N = Number of observations.
Note: Sums of columns may equal slightly more or less than 100% due to rounding.

Source: Boniol et al., 2007.

Table 7-9. Mean and Percentile Skin Surface Area (m^2) Derived from U.S. EPA Analysis of NHANES 1999−2006 Male and Female Combined for Children <21 Years and NHANES 2005–2006 for Adults >21 Years

Age Group	*N*	Mean	Percentiles 5th	10th	15th	25th	50th	75th	85th	90th	95th
Male and Female Combined											
Birth to <1 month	154	0.29	0.24	0.25	0.26	0.27	0.29	0.31	0.31	0.33	0.34
1 to <3 months	281	0.33	0.27	0.29	0.29	0.31	0.33	0.35	0.37	0.37	0.38
3 to <6 months	488	0.38	0.33	0.34	0.35	0.36	0.38	0.40	0.42	0.43	0.44
6 to <12 months	923	0.45	0.38	0.39	0.40	0.42	0.45	0.48	0.49	0.50	0.51
1 to <2 years	1,159	0.53	0.45	0.46	0.47	0.49	0.53	0.56	0.58	0.59	0.61
2 to <3 years	1,122	0.61	0.52	0.54	0.55	0.57	0.61	0.64	0.67	0.68	0.70
3 to <6 years	2,303	0.76	0.61	0.64	0.66	0.68	0.74	0.81	0.85	0.89	0.95
6 to <11 years	3,590	1.08	0.81	0.85	0.88	0.93	1.05	1.21	1.31	1.36	1.48
11 to <16 years	5,294	1.59	1.19	1.25	1.31	1.4	1.57	1.75	1.86	1.94	2.06
16 to <21 years	4,843	1.84	1.47	1.53	1.58	1.65	1.80	1.99	2.10	2.21	2.33
21 to <30 years	914	1.93	1.51	1.56	1.62	1.73	1.91	2.09	2.21	2.29	2.43
30 to <40 years	813	1.97	1.55	1.63	1.67	1.77	1.95	2.16	2.26	2.31	2.43
40 to <50 years	806	2.01	1.59	1.66	1.71	1.80	1.99	2.21	2.31	2.40	2.48
50 to <60 years	624	2.00	1.57	1.63	1.69	1.80	1.97	2.19	2.29	2.37	2.51
60 to <70 years	645	1.98	1.58	1.63	1.70	1.78	1.98	2.15	2.26	2.33	2.43
70 to <80 years	454	1.89	1.48	1.56	1.64	1.72	1.90	2.05	2.15	2.22	2.30
80 years and over	330	1.77	1.45	1.53	1.56	1.62	1.76	1.92	2.00	2.05	2.12

N = Number of observations.

Source: U.S. EPA Analysis of NHANES 1999–2006 data (children) NHANES 2005–2006 data (adults).

Table 7-10. Mean and Percentile Skin Surface Area (m^2) Derived from U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Male

Age Group	*N*	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Male											
Birth to <1 month	85	0.29	0.24	0.25	0.26	0.27	0.29	0.31	0.33	0.34	0.36
1 to <3 months	151	0.33	0.28	0.29	0.30	0.31	0.34	0.36	0.37	0.37	0.38
3 to <6 months	255	0.39	0.34	0.35	0.36	0.37	0.39	0.41	0.42	0.43	0.44
6 to <12 months	471	0.45	0.39	0.41	0.42	0.43	0.46	0.48	0.49	0.50	0.51
1 to <2 years	620	0.53	0.46	0.47	0.48	0.50	0.53	0.57	0.58	0.59	0.62
2 to <3 years	548	0.62	0.54	0.56	0.56	0.58	0.62	0.65	0.67	0.68	0.70
3 to <6 years	1,150	0.76	0.61	0.64	0.66	0.69	0.75	0.82	0.86	0.89	0.95
6 to <11 years	1,794	1.09	0.82	0.86	0.89	0.94	1.06	1.21	1.29	1.34	1.46
11 to <16 years	2,593	1.61	1.17	1.23	1.28	1.39	1.60	1.79	1.90	1.99	2.12
16 to <21 years	2,457	1.94	1.61	1.66	1.7	1.76	1.91	2.08	2.22	2.30	2.42
21 to 30 years	361	2.05	1.70	1.76	1.81	1.87	2.01	2.18	2.30	2.39	2.52
30 to <40 years	390	2.10	1.74	1.81	1.85	1.93	2.08	2.24	2.31	2.39	2.50
40 to <50 years	399	2.15	1.78	1.86	1.90	1.97	2.12	2.29	2.41	2.47	2.56
50 to <60 years	310	2.11	1.68	1.81	1.86	1.94	2.12	2.26	2.34	2.46	2.55
60 to <70 years	323	2.08	1.72	1.78	1.84	1.94	2.08	2.25	2.33	2.37	2.46
70 to <80 years	249	2.05	1.71	1.80	1.84	1.92	2.05	2.18	2.23	2.31	2.45
80 years and older	163	1.92	1.67	1.71	1.74	1.80	1.92	2.02	2.08	2.13	2.22

N = Number of observations.

Source: U.S. EPA Analysis of NHANES 1999–2006 data (children) NHANES 2005–2006 data (adults).

Table 7-11. Mean and Percentile Skin Surface Area (m^2) Derived from U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Female

Age Group	*N*	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Female											
Birth to <1 month	69	0.28	0.24	0.25	0.26	0.27	0.28	0.30	0.30	0.31	0.33
1 to <3 months	130	0.32	0.27	0.28	0.29	0.30	0.31	0.35	0.36	0.37	0.37
3 to <6 months	233	0.38	0.32	0.33	0.34	0.35	0.38	0.40	0.40	0.41	0.43
6 to <12 months	452	0.44	0.38	0.39	0.40	0.41	0.44	0.47	0.48	0.49	0.51
1 to <2 years	539	0.52	0.44	0.46	0.47	0.48	0.52	0.56	0.57	0.58	0.59
2 to <3 years	574	0.60	0.51	0.53	0.54	0.56	0.59	0.63	0.66	0.67	0.70
3 to <6 years	1,153	0.75	0.61	0.64	0.66	0.68	0.74	0.80	0.84	0.88	0.94
6 to <11 years	1,796	1.08	0.80	0.85	0.87	0.92	1.04	1.21	1.33	1.39	1.51
11 to <16 years	2,701	1.57	1.20	1.28	1.34	1.42	1.55	1.69	1.8	1.88	2.00
16 to <21 years	2,386	1.73	1.42	1.47	1.51	1.57	1.69	1.85	1.98	2.06	2.17
21 to 30 years	553	1.81	1.45	1.51	1.54	1.60	1.79	1.94	2.08	2.17	2.25
30 to <40 years	423	1.85	1.50	1.55	1.61	1.67	1.82	2.00	2.13	2.23	2.31
40 to <50 years	407	1.88	1.54	1.59	1.63	1.70	1.83	2.04	2.19	2.27	2.36
50 to <60 years	314	1.89	1.54	1.58	1.62	1.70	1.85	2.005	2.19	2.26	2.38
60 to <70 years	322	1.88	1.49	1.59	1.62	1.70	1.85	2.04	2.14	2.20	2.34
70 to <80 years	205	1.77	1.44	1.48	1.55	1.62	1.77	1.91	1.99	2.03	2.13
80 years and older	167	1.69	1.41	1.46	1.51	1.56	1.68	1.80	1.86	1.92	1.98

N = Number of observations.

Source: U.S. EPA Analysis of NHANES 1999–2006 data (children) NHANES 2005–2006 data (adults).

Table 7-12. Surface Area of Adult Male (21 years and older) in Square Meters

Body part	Percentile									
	Mean	5th	10th	15th	25th	50th	75th	85th	90th	95th
					Adult Male					
Total	2.06	1.73	1.80	1.84	1.93	2.07	2.23	2.34	2.41	2.52
Head	0.136	0.123	0.126	0.128	0.131	0.136	0.143	0.147	0.149	0.154
Trunk[a]	0.827	0.636	0.672	0.701	0.74	0.820	0.918	0.984	1.02	1.10
Upper Extremities	0.393	0.332	0.346	0.354	0.369	0.395	0.425	0.442	0.456	0.474
Arms	0.314	0.253	0.265	0.274	0.289	0.316	0.346	0.364	0.379	0.399
Upper arms	0.172	0.139	0.145	0.149	0.156	0.169	0.185	0.196	0.205	0.220
Forearms	0.148	0.115	0.121	0.125	0.132	0.146	0.163	0.173	0.181	0.197
Hands	0.107	0.090	0.093	0.096	0.100	0.107	0.115	0.121	0.124	0.131
Lower Extremities	0.802	0.673	0.703	0.721	0.752	0.808	0.868	0.903	0.936	0.972
Legs	0.682	0.560	0.587	0.603	0.634	0.686	0.746	0.780	0.811	0.847
Thighs	0.412	0.334	0.349	0.360	0.379	0.4113	0.452	0.478	0.495	0.523
Lower Legs	0.268	0.225	0.234	0.241	0.252	0.271	0.292	0.302	0.312	0.324
Feet	0.137	0.118	0.123	0.125	0.130	0.138	0.147	0.152	0.156	0.161

[a] Trunk includes neck.

Source: Based on U.S. EPA (1985) and NHANES 2005–2006.

Table 7-13. Surface Area of Adult Females (21 years and older) in Square Meters										
Body Part	Percentile									
	Mean	5th	10th	15th	25th	50th	75th	85th	90th	95th
Adult Female										
Total	1.85	1.49	1.55	1.59	1.66	1.82	1.99	2.12	2.21	2.33
Head	0.114	0.108	0.109	0.110	0.111	0.114	0.116	0.118	0.119	0.121
Trunk[a]	0.654	0.511	0.530	0.544	0.571	0.633	0.708	0.765	0.795	0.850
Upper Extremities	0.304	0.266	0.272	0.277	0.284	0.301	0.320	0.333	0.342	0.354
Arms	0.237	0.213	0.218	0.221	0.227	0.237	0.248	0.254	0.259	0.266
Hands	0.089	0.076	0.078	0.079	0.082	0.087	0.094	0.099	0.102	0.106
Lower Extremities	0.707	0.579	0.599	0.616	0.643	0.698	0.761	0.805	0.835	0.875
Legs	0.598	0.474	0.494	0.509	0.533	0.588	0.649	0.693	0.724	0.764
Thighs	0.364	0.281	0.294	0.303	0.319	0.356	0.397	0.428	0.450	0.479
Lower Legs	0.233	0.191	0.198	0.204	0.213	0.230	0.250	0.263	0.273	0.286
Feet	0.122	0.103	0.106	0.109	0.113	0.121	0.130	0.136	0.140	0.146

[a] Trunk includes neck.

Source: Based on U.S. EPA (1985) and NHANES 2005–2006.

Table 7-14. Statistical Results for Total Body Surface Area Distributions (m^2), for Adults

	Male			
	U.S. EPA	Boyd	DuBois and DuBois	Costeff
Mean	1.97	1.95	1.94	1.89
Median	1.96	1.94	1.94	1.89
Mode	1.96	1.91	1.90	1.90
Standard Deviation	0.19	0.18	0.17	0.16
Skewness	0.27	0.26	0.23	0.04
Kurtosis	3.08	3.06	3.02	2.92
	Female			
	U.S. EPA	Boyd	DuBois and DuBois	Costeff
Mean	1.73	1.71	1.69	1.71
Median	1.69	1.68	1.67	1.68
Mode	1.68	1.62	1.60	1.66
Standard Deviation	0.21	0.20	0.18	0.21
Skewness	0.92	0.88	0.77	0.69
Kurtosis	4.30	4.21	4.01	3.52

Source: Murray and Burmaster, 1992.

Table 7-15. Descriptive Statistics for Surface Area/Body-Weight (SA/BW) Ratios (m²/kg)											
Age (year)	Mean	Range Min–Max	SD	SE	Percentiles						
					5th	10th	25th	50th	75th	90th	95th
Male and Female Combined											
0 to 2	0.064	0.042–0.114	0.011	0.001	0.047	0.051	0.056	0.062	0.072	0.078	0.085
2.1 to 17.9	0.042	0.027–0.067	0.008	0.001	0.029	0.033	0.038	0.042	0.045	0.050	0.059
≥18	0.028	0.020–0.031	0.003	7.68e-6	0.024	0.024	0.027	0.029	0.030	0.032	0.033
All Ages	0.049	0.020–0.114	0.019	9.33e-4	0.025	0.027	0.030	0.050	0.063	0.074	0.079

SD = Standard deviation.
SE = Standard error of the mean.

Source: Phillips et al., 1993.

Table 7-16. Estimated Percent of Adult Skin Surface Exposed During Outdoor Activities

	Skin Area Exposed (% of total body surface area)			
	N	5th percentile	50th percentile	95th percentile
Gardening				
Cold months	31	3	8	33
Warm months	212	3	33	69
Other Yard Work				
Cold months	73	3	3	31
Warm months	245	8	33	68
Team Sports				
Cold months	26	3	8	33
Warm months	71	14	33	43
Repair/Digging				
Cold months	15	3	3	14
Warm months	65	9	28	67

N = Number of observations.

Source: Garlock et al., 1999.

Table 7-17. Estimated Skin Surface Exposed During Warm Weather Outdoor Activities

	Skin Area Exposed (% of total body surface area)		
	Play	Gardening/Yardwork	Organized Team Sport
Age (year)	<5	5 to 17	5 to 17
N	41	47	65
Mean	38.0	33.8	29.0
Median	36.5	33.0	30.0
SD	6.0	8.3	10.5

N = Number of observations.
SD = Standard deviation.

Source: Wong et al., 2000.

Table 7-18. Median Per Contact Outdoor Fractional Surface Areas of the Hands, by Object, Both Hands Combined

	Animal	Body	Clothes	Fabric	Floor	Food	Footwear	Metal	Non-Dietary Water	Paper	Plastic	Rock /Brick	Toy	Vegetation /Grass	Wood	All Objects
N	12	38	38	19	37	26	30	38	9	27	36	16	37	37	38	38
Minimum	0.02	0.06	0.11	0.05	0.13	0.02	0.02	0.00	0.08	0.02	0.08	0.06	0.08	0.02	0.07	0.13
Maximum	0.27	0.27	0.30	0.30	1.00	1.00	0.25	0.27	1.00	0.30	0.30	0.30	0.27	0.30	0.30	0.27
Mean	0.18	0.15	0.22	0.16	0.24	0.16	0.11	0.14	0.52	0.13	0.17	0.20	0.15	0.17	0.20	0.16
5th percentile	0.04	0.07	0.14	0.11	0.13	0.03	0.03	0.11	0.10	0.03	0.13	0.07	0.13	0.03	0.11	0.13
25th percentile	0.12	0.13	0.19	0.14	0.19	0.05	0.06	0.14	0.19	0.08	0.14	0.18	0.14	0.12	0.15	0.14
50th percentile	0.20	0.16	0.22	0.15	0.24	0.11	0.10	0.14	0.31	0.13	0.15	0.23	0.14	0.16	0.18	0.15
75th percentile	0.24	0.19	0.26	0.15	0.27	0.14	0.14	0.15	1.00	0.17	0.19	0.24	0.15	0.24	0.25	0.17
95th percentile	0.26	0.24	0.30	0.24	0.30	0.80	0.21	0.19	1.00	0.25	0.28	0.28	0.24	0.30	0.30	0.26
95th percentile	0.26	0.26	0.30	0.29	0.75	1.00	0.25	0.26	1.00	0.29	0.30	0.30	0.26	0.30	0.30	0.27

N = Number of subjects.

Source: AuYeung et al., 2008.

Activity	Month	Event[a] (hours)	*N*	M	F	Age (years)	Conditions	Clothing	Study
Table 7-19. Summary of Field Studies That Estimated Activity-Specific Adherence Rates									
Indoor									
Tae Kwon Do	Feb.	1.5	7	6	1	8 to 42	Carpeted floor	All in long sleeve-long pants martial arts uniform, sleeves rolled back, barefoot	Kissel et al., 1996a
Greenhouse Worker	Mar.	5.25	2	1	1	37 to 39	Plant watering, spraying, soil blending, sterilization	Long pants, elbow length short sleeve shirt, no gloves	
Indoor Kid No. 1	Jan.	2	4	3	1	6 to 13	Playing on carpeted floor	3 or 4 short pants, 2 of 4 short sleeves, socks, no shoes	Holmes et al., 1999
Indoor Kid No. 2	Feb.	2	6	4	2	3 to 13	Playing on carpeted floor	5 of 6 long pants, 5 of 6 long sleeves, socks, no shoes	
Daycare Kid No. 1a	Aug.	3.5	6	5	1	1 to 6.5	Indoors: linoleum surface; Outdoors: grass, bare earth, barked area	4 of 6 long pants, 5 of 6 short sleeves, socks, shoes	
Daycare Kid No. 1b	Aug.	4	6	5	1	1 to 6.5	Indoors: linoleum surface; Outdoors: grass, bare earth, barked area	4 of 6 long pants, 5 of 6 short sleeves, 3 of 6 barefoot all afternoon, others barefoot half the afternoon	
Daycare Kid No. 2[b]	Sept.	8	5	4	1	1 to 4	Indoors: low napped carpeting, linoleum surfaces	4 of 5 long pants, 3 of 5 long sleeves, all barefoot for part of the day	
Daycare Kid No. 3	Nov.	8	4	3	1	1 to 4.5	Indoors: linoleum surface, Outside: grass, bare earth, barked area	All long pants, 3 of 4 long sleeves, socks and shoes	
Outdoor									
Soccer No. 1	Nov.	0.67	8	8	0	13 to 15	Half grass/half bare earth	6 of 8 long sleeves, 4 of 8 long pants, 3 of 4 short pants and shin guards	Kissel et al., 1996a
Soccer No. 2	Mar.	1.5	8	0	8	24 to 34	All weather field (sand-ground tires)	All in short sleeve shirts, shorts, knee socks, shin guards	
Soccer No. 3	Nov.	1.5	7	0	7	24 to 34	All weather field (sand-ground tires)	All in short sleeve shirts, shorts, knee socks, shin guards	
Groundskeeper No. 1	Mar.	1.5	2	1	1	29 to 52	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	
Groundskeeper No. 2	Mar.	4.25	5	3	2	22 to 37	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	
Groundskeeper No. 3	Mar.	8	7	5	2	30 to 62	Campus grounds, urban horticulture center, arboretum	All in long pants, intermittent use of gloves	

Table 7-19. Summary of Field Studies that Estimated Activity-Specific Adherence Rates (continued)

Activity	Month	Event[a] (hours)	*N*	M	F	Age (years)	Conditions	Clothing	Study
Outdoor (continued)									
Groundskeeper No. 4	Aug.	4.25	7	4	3	22 to 38	Campus grounds, urban horticulture center, arboretum	5 of 7 in short sleeve shirts, intermittent use of gloves	Kissel et al., 1996a
Groundskeeper No. 5	Aug.	8	8	6	2	19 to 64	Campus grounds, urban horticulture center, arboretum	5 of 8 in short sleeve shirts, intermittent use of gloves	
Irrigation Installer	Oct.	3	6	6	0	23 to 41	Landscaping, surface restoration	All in long pants, 3 of 6 short sleeve or sleeveless shirts	
Rugby No. 1	Mar.	1.75	8	8	0	20 to 22	Mixed grass-bare wet field	All in short sleeve shirts, shorts, variable sock lengths	
Farmer No. 1	May	2	4	2	2	39 to 44	Manual weeding, mechanical cultivation	All in long pants, heavy shoes, short sleeve shirts, no gloves	
Farmer No. 2	July	2	6	4	2	18 to 43	Manual weeding, mechanical cultivation	2 of 6 short, 4 of 6 long pants, 1 of 6 long sleeve shirt, no gloves	
Reed Gatherer	Aug.	2	4	0	4	42 to 67	Tidal flats	2 of 4 short sleeve shirts/knee length pants, all wore shoes	
Kid-in-Mud No. 1	Sept.	0.17	6	5	1	9 to 14	Lake shoreline	All in short sleeve T-shirts, shorts, barefoot	
Kid-in-Mud No. 2	Sept.	0.33	6	5	1	9 to 14	Lake shoreline	All in short sleeve T-shirts, shorts, barefoot	
Gardener No. 1	Aug.	4	8	1	7	16 to 35	Weeding, pruning, digging a trench	6 of 8 long pants, 7 of 8 short sleeves, 1 sleeveless, socks, shoes, intermittent use of gloves	Holmes et al., 1999
Gardener No. 2	Aug.	4	7	2	5	26 to 52	Weeding, pruning, digging a trench, picking fruit, cleaning	3 of 7 long pants, 5 of 7 short sleeves, 1 sleeveless, socks, shoes, no gloves	
Rugby No. 2	July	2	8	8	0	23 to 33	Grass field (80% of time) and all-weather field (mix of gravel, sand, and clay) (20% of time)	All in shorts, 7 of 8 in short sleeve shirts, 6 of 8 in low socks	
Rugby No. 3	Sept.	2.75	8	7	0	24 to 30	Compacted mixed grass and bare earth field	All short pants, 7 of 8 short or rolled up sleeves, socks, shoes	
Archeologist	July	11.5	7	3	4	16 to 35	Digging with trowel, screening dirt, sorting	6 of 7 short pants, all short sleeves, 3 no shoes or socks, 2 sandals	
Construction Worker	Sept.	8	8	8	0	21 to 30	Mixed bare earth and concrete surfaces, dust and debris	5 of 8 pants,7 of 8 short sleeves, all socks and shoes	
Landscape/Rockery	June	9	4	3	1	27 to 43	Digging (manual and mechanical), rock moving	All long pants, 2 long sleeves, all socks and boots	

Table 7-19. Summary of Field Studies that Estimated Activity-Specific Adherence Rates (continued)									
Activity	Month	Event[a] (hours)	*N*	M	F	Age (years)	Conditions	Clothing	Study
Outdoor (continued)									
Utility Worker No. 1	July	9.5	5	5	0	24 to 45	Cleaning, fixing mains, excavation (backhoe and shovel)	All long pants, short sleeves, socks, boots, gloves sometimes	Holmes et al., 1999
Utility Worker No. 2	Aug.	9.5	6	6	0	23 to 44	Cleaning, fixing mains, excavation (backhoe and shovel)	All long pants, 5 of 6 short sleeves, socks, boots, gloves sometimes	
Equip. Operator No. 1	Aug.	8	4	4	0	21 to 54	Earth scraping with heavy machinery, dusty conditions	All long pants, 3 of 4 short sleeves, socks, boots, 2 of 4 gloves	
Equip. Operator No. 2	Aug.	8	4	4	0	21 to 54	Earth scraping with heavy machinery, dusty conditions	All long pants, 3 of 4 short sleeves, socks, boots, 1 gloves	
Shoreline Play	Sept.	0.33−1.0	9	6	3	7 to 12	Tidal flat	No shirt or short sleeve T-shirts, shorts, barefoot	Shoaf et al., 2005

[a] Event duration.
[b] Activities were confined to the house.
N = Number of subjects.
M = Male.
F = Female.

Table 7-20. Geometric Mean and Geometric Standard Deviations of Solids Adherence by Activity and Body Region[a]						
Activity	*N*	Post-Activity Dermal Solids Loadings (mg/cm²)				
		Hands	Arms	Legs	Faces	Feet
Indoor						
Tae Kwon Do	7	0.0063 1.9	0.0019 4.1	0.0020 2.0		0.0022 2.1
Greenhouse Worker	2	0.043 --	0.0064 --	0.0015 --	0.0050 --	
Indoor Kid No. 1	4	0.0073 1.9	0.0042 1.9	0.0041 2.3		0.012 1.4
Indoor Kid No. 2	6	0.014 1.5	0.0041 2.0	0.0031 1.5		0.0091 1.7
Daycare Kid No. 1a	6	0.11 1.9	0.026 1.9	0.030 1.7		0.079 2.4
Daycare Kid No. 1b	6	0.15 2.1	0.031 1.8	0.023 1.2		0.13 1.4
Daycare Kid No. 2	5	0.073 1.6	0.023 1.4	0.011 1.4		0.044 1.3
Daycare Kid No. 3	4	0.036 1.3	0.012 1.2	0.014 3.0		0.0053 5.1
Outdoor						
Soccer No. 1	8	0.11 1.8	0.011 2.0	0.031 3.8	0.012 1.5	
Soccer No. 2	8	0.035 3.9	0.0043 2.2	0.014 5.3	0.016 1.5	
Soccer No. 3	7	0.019 1.5	0.0029 2.2	0.0081 1.6	0.012 1.6	
Groundskeeper No. 1	2	0.15 --	0.005 --		0.0021 --	0.018 --
Groundskeeper No. 2	5	0.098 2.1	0.0021 2.6	0.0010 1.5	0.010 2.0	
Groundskeeper No. 3	7	0.030 2.3	0.0022 1.9	0.0009 1.8	0.0044 2.6	0.0040
Groundskeeper No. 4	7	0.045 1.9	0.014 1.8	0.0008 1.9	0.0026 1.6	0.018 --
Groundskeeper No. 5	8	0.032 1.7	0.022 2.8	0.0010 1.4	0.0039 2.1	
Irrigation Installer	6	0.19 1.6	0.018 3.2	0.0054 1.8	0.0063 1.3	

Table 7-20. Geometric Mean and Geometric Standard Deviations of Solids Adherence by Activity and Body Region[a] (continued)						
Activity	*N*	Post-Activity Dermal Solids Loadings (mg/cm^2)				
		Hands	Arms	Legs	Faces	Feet
Rugby No. 1	8	0.40 1.7	0.27 1.6	0.36 1.7	0.059 2.7	
Farmers No. 1	4	0.41 1.6	0.059 3.2	0.0058 2.7	0.018 1.4	
Farmers No. 2	6	0.47 1.4	0.13 2.2	0.037 3.9	0.041 3.0	
Reed Gatherer	4	0.66 1.8	0.036 2.1	0.16 9.2		0.63 7.1
Kid-in-Mud No. 1	6	35 2.3	11 6.1	36 2.0		24 3.6
Kid-in-Mud No. 2	6	58 2.3	11 3.8	9.5 2.3		6.7 12.4
Gardener No. 1	8	0.20 1.9	0.050 2.1	0.072 --	0.058 1.6	0.17 --
Gardener No. 2	7	0.18 3.4	0.054 2.9	0.022 2.0	0.047 1.6	0.26 --
Rugby No. 2	8	0.14 1.4	0.11 1.6	0.15 1.6	0.046 1.4	
Rugby No. 3	7	0.049 1.7	0.031 1.3	0.057 1.2	0.020 1.5	
Archeologist	7	0.14 1.3	0.041 1.9	0.028 4.1	0.050 1.8	0.24 1.4
Construction Worker	8	0.24 1.5	0.098 1.5	0.066 1.4	0.029 1.6	
Landscape/Rockery	4	0.072 2.1	0.030 2.1		0.0057 1.9	
Utility Worker No.1	5	0.32 1.7	0.20 2.7		0.10 1.5	
Utility Worker No. 2	6	0.27 2.1	0.30 1.8		0.10 1.5	
Equip. Operator No. 1	4	0.26 2.5	0.089 1.6		0.10 1.4	
Equip. Operator No. 2	4	0.32 1.6	0.27 1.4		0.23 1.7	
Shoreline Play	9	0.49 8.2	0.17 3.1	0.70 3.6	0.04 2.9	21 1.9

[a] Means are presented above the standard deviations. The standard deviations generally exceed the means by large amounts indicating high variability in the data.

N = Number of subjects.

Sources: Kissel et al., 1996a; Holmes et al., 1999; Shoaf et al., 2005.

Table 7-21. Summary of Controlled Greenhouse Trials

Activity	Ages (years)	Duration (min)	Soil Moisture (%)	Clothing[a]	*N*	Male	Female
Transplanting	Adult	~12[b]	17−19	L	4	2	2
			15−18	S	13	6	7
Playing	8 to 12	20	17−18	L	4	3	1
			16−18	S	9	5	4
			3−4	S	5	3	2
Pipe Laying	Adult	15, 30, 45	9−12	S	7	4	3
			5−7	S	6	3	3

[a] L = long sleeves and long pants; S = short sleeves and short pants.
[b] Arithmetic mean (range was 9 to 18 minutes). Activity was terminated after completion of the task rather than at a fixed time.
N = Number of subjects.

Source: Kissel et al., 1998.

Table 7-22. Dermal Transfer Factors for Selected Contact Surface Types and Skin Wetness, Using <80 µm Tagged ATD

Mean surface Loading µg/cm^2	Test Subject[a]	Contact Surface Type[b]	Skin Moisture Level[c]	Dermal Transfer Factor[d]
36.3	F1	SS	Dry	0.760 (0.000)
39.1	M1	SS	Dry	0.716 (NA)
32.0	M1	SS	Damp	1.222 (NA)
45.0	M1	SS	Wet	1.447 (NA)
42.6	M2	SS	Dry	0.582 (0.059)
23.8	M2	SS	Damp	0.970 (NA)
30.6	M2	SS	Wet	1.148 (NA)
30.5	M2	Vinyl	Dry	0.554 (0.052)
32.7	M2	Vinyl	Damp	0.485 (0.068)
38.9 (not embedded)	M2	Carpet	Dry	0.087 (0.000)
36.4 (embedded)	M2	Carpet	Dry	0.034 (0.007)
33.8 (not embedded)	M2	Carpet	Damp	0.190 (0.002)
33.3 (embedded)	M2	Carpet	Damp	0.169 (0.11)

[a] F1 = female subject; M1 and M2 = male subjects.
[b] SS = stainless steel; vinyl linoleum; nylon carpet.
[c] Dry = no added moisture; wet = synthetic saliva moistened (moisture visible but not excessive).
[d] Dermal transfer factor = µg on hand/cm^2 of dermal contact area/µg on surface/cm^2 of surface contact. Based on mean of left and right hand presses. Standard deviation (SD) in parenthesis; NA = not available.

Source: Rodes et al., 2001.

Table 7-23. Comparison of Adherence (mg/cm²) for Contact with Carpet and Aluminum Surfaces, Averaged Across Pressure, Contact Time, Soil Type, and Soil Particle Size[a]

	Carpet Transfer	Hard Surface (aluminum) Transfer	Combined (carpet/aluminum) Transfer
Mean Soil Adherence	0.37 ± 0.4	0.42 ± 0.6	0.39 ± 0.4
Mean Soil-Skin Adherence	0.71 ± 0.5	1.18 ± 0.4	0.92 ± 0.5
Mean Soil-Cloth Adherence	0.20 ± 0.3	0.15 ± 0.4	0.17 ± 0.4

[a] Soil adherence values averaged across pressure, time, soil type, and soil size.

Source: Ferguson et al., 2009b.

Table 7-24. Film Thickness Values of Selected Liquids Under Various Experimental Conditions (10^{-3}cm)

	Mineral Oil[a]	Cooking Oil[b]	Bath Oil[c]	Oil/ Water[d]	Water[e]	Water/ Ethanol[f]
Initial Contact[g]						
No wipe[h]	1.56	2.25	1.74	2.03	2.34	3.25
Partial wipe[i]	0.62	0.82	0.59	1.55	1.83	2.93
Full wipe[j]	0.27	0.34	0.20	1.38	1.97	3.12
Secondary Contact[k]						
No wipe[h]	1.40	1.87	1.56	1.60	2.05	2.95
Partial wipe[i]	0.47	0.52	0.48	1.19	1.39	2.67
Full wipe[j]	0.06	0.07	0.08	0.92	1.32	2.60
Immersion[l]						
No wipe[h]	11.87	6.55	6.90	9.81	4.99	6.55
Partial wipe[i]	2.00	1.46	1.55	2.42	2.14	2.93
Full wipe[j]	-	-	-	-	-	-
Handling Rag[m]						
No wipe[h]	1.64	1.50	2.04	1.88	2.10	4.17
Partial wipe[i]	0.44	0.34	0.53	1.21	1.48	3.70
Full wipe[j]	0.13	0.01	0.21	0.96	1.37	3.58
Spill Cleanup[n]						
No wipe[h]	1.23	0.73	0.89	1.19	-	-
Partial wipe[i]	0.55	0.51	0.48	1.36	-	-
Full wipe[j]	-	-	-	-	-	-

a Density = 0.8720 g/cm^3.
b Density = 0.9161 g/cm^3.
c Density = 0.8660 g/cm^3.
d Density = 0.9357 g/cm^3; 50% water and 50% oil.
e Density = 0.9989 g/cm^3.
f Density = 0.9297 g/cm^3; 50% water and 50% ethanol.
g Initial contact = cloth saturated with liquid was rubbed over the front and back of both clean, dry hands for the first time during an exposure event.
h Retention of liquid on the skin was estimated without any intentional removal of liquid by wiping.
i Retention was measured after 'partial' removal of liquids on the skin by wiping. Partial wiping was defined as "lightly [wiping with a removal cloth] for 5 seconds (superficially)."
j Retention was measured after 'full' removal of liquids on the skin by wiping. Full wiping was defined as " thoroughly and completely as possible within 10 seconds removing as much liquid as possible."
k Secondary contact = cloth saturated with liquid was rubbed over the front and back of both hands for a second time, after as much as possible of the liquid that adhered to skin during the first contact event was removed using a clean cloth.
l Immersion = one hand immersed in a container of liquid, removed, and liquid allowed to drip back into container for 30 seconds (60 seconds for cooking oil).
m Handling rag = cloth saturated with liquid was rubbed over the palms of both hands for the first time during an exposure event in a manner simulating handling of a wet cloth.
n Spill cleanup = subject used a clean cloth to wipe up 50 mL of liquid poured onto a plastic laminate countertop.
\- = no data.

Note: Data for mineral oil, cooking oil, and bath oil for initial contact, secondary contact, and immersion from U.S. EPA (1992c). All other data from U.S. EPA (1987).

Source: U.S. EPA, 1987 and U.S. EPA, 1992c.

Table 7-25. Mean Transfer Efficiencies (%)[a]				
Time After Application[b]	Legs (tights)	Torso and Arms (shirt)	Feet (socks)	Hands (gloves)
0 hours				
chlorpyrifos	6.6 ± 1.6	5.6 ± 2.6	32.1 ± 13.4	17.4 ± 8.6
allethrin	5.9 ± 1.5	5.4 ± 2.4	34.3 ± 18.3	22.4 ± 12.6
6 hours				
chlorpyrifos	7.5 ± 4.6	6.3 ± 5.8	33.3 ± 12.9	16.9 ± 11.0
allethrin	5.3 ± 2.0	4.8 ± 2.5	27.1 ± 8.8	17.9 ± 9.1
12.5 hours				
chlorpyrifos	4.0 ± 1.3	3.1 ± 0.5	20.3 ± 3.5	8.1 ± 1.9
allethrin	3.0 ± 0.8	2.8 ± 0.5	13.7 ± 4.7	8.3 ± 2.7

a Clothing residue values divided by floor residues and multiplied by 100.
b After room was vented.

Source: Ross et al., 1990.

Table 7-26. Transfer Efficiencies (%) for Dry, Water-Wetted, and Saliva-Wetted Palms and PUF Roller				
	Dry Palms	Water-Wetted Palms	Saliva-Wetted Palms	PUF Roller
Chlorpyrifos				
Mean	1.53	5.22	4.38	4.19
SD	0.73	3.02	2.83	2.87
Pyrethrin				
Mean	3.64	11.87	8.89	5.66
SD	2.21	7.25	4.66	3.60
Piperonyl Butoxide				
Mean	1.41	4.85	4.06	4.28
SD	0.73	2.95	2.64	3.33

SD = Standard deviation.
PUF = Polyurethane foam.

Source: Clothier, 2000.

Table 7-27. Incremental and Overall Surface to Hand Transfer Efficiencies (%)							
	Hand Condition			Surface Type		Surface Loading	
Contact	Dry	Moist	Sticky	Carpet	Laminate	High	Low
Incremental transfer %, average (SD)							
1	3.0 (2.7)	7.1 (6.1)	14 (18)	6.4 (7.0)	10 (16)	3.9 (4.0)	13 (16)
2	2.5 (4.0)	7.7 (5.7)	7.5 (18)	8.0 (9.5)	3.6 (13)	3.7 (3.5)	8.1 (16)
3	2.0 (5.4)	4.0 (7.3)	6.9 (7.3)	3.8 (7.2)	4.8 (6.8)	1.7 (1.7)	7.0 (9.0)
4	0.9 (3.1)	1.9 (2.5)	2.3 (8.0)	1.1 (6.3)	2.3 (4.2)	0.9 (1.8)	2.7 (7.4)
5	1.3 (2.2)	1.0 (3.7)	2.0 (5.3)	1.7 (2.4)	1.3 (4.9)	0.3 (1.1)	2.5 (5.0)
Incremental transfer %, average (SD) without sticky hands							
1	3.0 (2.7)	7.1 (6.1)	-	4.9 (5.3	5.2 (4.9)	2.6 (2.1)	7.5 (6.0)
2	2.5 (4.0)	7.7 (5.7)	-	5.8 (6.0)	4.2 (4.9)	2.8 (3.0)	7.3 (6.6)
3	2.0 (5.4)	4.0 (7.3)	-	2.1 (6.4)	4.0 (6.4)	1.4 (1.3)	4.7 (8.8)
4	0.9 (3.1)	1.9 (2.5)	-	0.9 (3.0)	1.9 (2.6)	1.0 (1.8)	1.8 (3.8)
5	1.3 (2.3)	1.0 (3.7)	-	1.6 (1.6)	0.7 (3.8)	0.4 (1.2)	1.9 (3.9)
Overall transfer %, average (SD)							
1	3.0 (2.7)	7.1 (6.1)	14 (18)	6.4 (7.0)	10 (16)	3.9 (4.0)	13 (16)
2	2.8 (2.5)	7.4 (5.2)	11 (9.7)	7.2 (7.6)	6.9 (7.1)	3.8 (3.1)	10 (8.8)
3	2.5 (2.9)	6.2 (4.7)	9.7 (7.6)	6.1 (6.3)	6.2 (6.0)	3.1 (2.2)	9.3 (7.2)
4	2.1 (2.4)	5.3 (4.0)	7.9 (7.0)	5.0 (5.7)	5.4 (5.4)	2.5 (1.7)	8.2 (6.6)
5	1.6 (0.8)	4.2 (3.4)	8.2 (6.9)	4.6 (5.3)	4.6 (5.1)	1.8 (1.0)	7.1 (6.0)
Overall transfer %, average (SD) without sticky hands							
1	3.0 (2.7)	7.1 (6.1)	-	4.9 (5.3)	5.2 (4.9)	2.6 (2.1)	7.5 (6.0)
2	2.8 (2.5)	7.4 (5.2)	-	5.4 (5.0)	4.7 (4.3)	2.7 (2.1)	7.4 (5.3)
3	2.5 (2.9)	6.2 (4.7)	-	4.3 (4.0)	4.4 (4.6)	2.3 (1.4)	6.5 (5.1)
4	2.1 (2.4)	5.3 (4.0)	-	3.3 (3.3)	3.9 (4.0)	1.9 (1.1)	5.7 (4.4)
5	1.6 (0.8)	4.2 (3.4)	-	2.8 (2.4)	2.8 (3.0)	1.4 (0.5)	4.2 (3.2)

SD = Standard deviation.

Source: Cohen-Hubal et al., 2005.

Table 7-28. Lognormal Distributions for Modeling Transfer Efficiencies (fraction)[a]

Chemical	Surface	μ	σ	GM	GSD
Chlorpyrifos	Carpet	−4.26	0.54	0.01	1.70
	Vinyl	−3.30	0.85	0.04	2.34
	Foil	−0.15	0.08	0.86	1.08
Pyrethrin I	Carpet	−3.86	0.68	0.02	1.97
	Vinyl	−3.66	0.96	0.03	2.61
	Foil	−0.19	0.10	0.83	1.11
Piperonyl	Carpet	−4.00	0.51	0.02	1.67
butoxide	Vinyl	−3.63	0.81	0.03	2.25

[a] Distributions should be truncated at 1.0.
GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Beamer et al., 2009.

Table 7-29. Hand-to-Object/Surface Contact—Frequency (contacts/hour)

Object/Surface	Left Hand Average[a]	Right Hand Average[a]
Bedding/Towel	13.0	13.8
Carpet/Rug	4.3	6.0
Dirt	5.3	6.5
Food	9.3	9.3
Footwear	2.0	3.0
Grass/Vegetation	6.3	5.0
Hair	4.5	3.5
Hard Floor	10.0	9.5
Hard Surface	36.0	40.3
Hard Toy	27.3	29.3
Paper/Card	8.8	14.5
Plush Toy	4.0	4.0
Upholstered Furniture	17.0	15.5
Water/Beverage	1.3	1.8

[a] Average = mean of average hourly contact rates of 4 children of farm workers, ages 2 to 4 years.

Source: Zartarian et al., 1997.

Table 7-30. Hand-to-Objects/Surfaces—Frequency (contacts/hour)				
Object/Surface	Both Hands[a]			
	Range	Mean	Median	90th Percentile
Clothing	22.8−129.2	66.6	65.0	103.3
Dirt	0−146.3	11.4	0.3	56.4
Object	56.2−312.0	122.9	118.7	175.8
Other[b]	8.3−243.6	82.9	64.3	199.6
Smooth Surface	13.6−190.4	83.7	80.2	136.9
Textured Surface	0.2−68.7	22.1	16.3	52.2

a Based on data for 30 children (20 daycare children and 10 residential children) ages 2 to 6 years.
b Other includes items such as paper, grass, and pets.

Source: Reed et al., 1999.

Table 7-31. Median (mean ± SD) Hand Contact Frequency with Clothing, Surfaces, or Objects (contacts/hour)[a]				
Age	3 to 4 years	5 to 6 years	7 to 8 years	10 to 12 years
N	3	7	4	5
Touch Clothing	26 (34 ± 21)	22 (26 ± 23)	50 (54 ± 43)	35 (53 ± 66)
Touch Textured Surface	40 (52 ± 61)	20 (32 ± 40)	22 (58 ± 88)	16 (24 ± 31)
Touch Smooth Surface	134 (151 ± 62)	111 (120 ± 77)	120 (155 ± 119)	94 (96 ± 50)
Touch Object	130 (153 ± 108)	117 (132 ± 88)	111 (164 ± 148)	127 (179 ± 126)

a Based on 4-hour observation period.
SD = Standard deviation.
N = Number of children observed.

Source: Freeman et al., 2001.

Table 7-32. Hand Contact with Objects/Surfaces—Frequency (contacts/hour)		
Object/Surface	Right Hand[a]	
	Mean (SD)	Median (range)
Bottle	14.6 (17.9)	11.5 (1.3−63.0)
Carpet/Rug	6.3 (9.3)	1.1 (0−23.0)
Clothes	38.0 (16.4)	41.9 (12.8−66.8)
Food	9.2 (6.6)	7.3 (3.0−20.8)
Hair	5.1 (3.6)	4.1 (1.3−11.8)
Hard Floor	9.5 (6.2)	10.3 (1.3−17.5)
Object	97.7 (45.8)	96.8 (25.0−176.4)
Paper	22.9 (18.0)	21.8 (1.3−54.3)
Skin	31.5 (15.3)	26.4 (16.0−63.5)
Smooth Surface	83.9 (38.0)	88.0 (32.0−158.4)
Textured Surface	6.5 (5.7)	4.1 (1.0−20.7)
Upholstered Furniture	20.7 (15.2)	19.3 (6.8−55.5)

a Only data for the right hand were reported; data for 10 children, ages 24 to 55 months.
SD = Standard deviation.

Source: Freeman et al., 2005.

Table 7-33. Outdoor Hand Contact with Object/Surfaces, Children 1 to 6 Years[a]

Object/Surface	Both Hands											
	Range	Mean	Median	95th Percentile	Range	Mean	Median	95th Percentile	Range	Mean	Median	95th Percentile
	Frequency (contacts/hour)				Duration (seconds/contact)				Duration (minutes/hour)			
Animal	0−23.3	2.6	0	13.8	1.5−7	3.2	2.5	6.5	0−2	0.2	0	1.6
Body	17−191.7	74.8	65.1	150.4	1−4	2	2	3.2	0.6−17.8	5	4.1	11.2
Clothes/Towel	17−199.1	73.7	65.7	132	1−5	2.5	2	4.6	1.4−26.3	6.7	4.8	18.2
Fabric	0−31.5	3.7	0.4	14.7	0.5−23.5	5.9	3	15.4	0−6.6	0.7	0	3.9
Floor	0−940.4	65.8	27.9	182.7	0−13	3	2	6.5	0−16.4	4	2.4	12.2
Food	0−88.7	14.5	4.9	56.2	0−28	7.6	6	20.8	0−17.3	3.9	0.4	17
Footwear	0−23.1	3.6	1.5	11.4	0−12	3.3	2.5	8.1	0−5.6	0.5	0	2
Metal	0.6−466.2	58.3	16	206.4	0−109.5	7.3	3	15.8	0−36.3	7.4	3.2	27.3
Non-Dietary Water	0.7.4	0.5	0	2.9	0.5−9	3.3	2	8.2	0−1	0.1	0	0.6
Paper/Wrapper	0−103.8	7.3	1.5	21.4	0−53.5	9.4	4.3	28.1	0−27	1.8	0.4	7.8
Plastic	0−324.6	56.7	47	121.1	1−21.5	5.1	4	12.8	0−26.3	8	6	20.6
Rock/Brick	0−28	2.4	0	10.3	1−9	2.8	2	7.5	0−3.7	0.2	0	1
Toy	0−657.8	161.3	129.4	372.8	0−25.5	6.5	6	13.5	0−63.1	29.8	28.4	57
Vegetation/Grass	0−138.7	40.6	27.8	128.1	0−11	3.7	3	9.1	0−21.5	5.1	2.9	17.9
Wood	0.6−100.9	22.4	12.7	79.8	0−9	3.7	3	8	0−27.8	3.2	1.2	12.8
Non-Dietary Object	225.1−1,512.6	575.3	526.3	889.2	0−5	3	3	4	42.6−101.7	72.9	72.3	94.2
All Objects/Surfaces	229.9−1,517.7	589.8	540.8	889.2	0−5	3	3	4.2	42.6−102.2	76.8	77.5	99.3

[a] Based on 38 children aged 1 to 6 years in parks, playgrounds, and outdoor residential areas in California.

Source: AuYeung et al., 2006.

Table 7-34. Indoor Hand Contact with Object/Surfaces—Frequency, Children 1 to 6 Years[a] (median contacts/hour)		
Object/Surface	Left Hand	Right Hand
Carpet	7.9	8.5
Clothing	41	25.2
Hard Floor	3.2	3.9
Paper	3.8	7.4
Skin	11.6	9.9
Upholstered Furniture	13.1	7.7
Smooth Surface	61.9	62.7
Textured Surfaces	18.2	22.1

[a] Based on 9 children aged 1 to 6 years in indoor residential settings in California.

Source: AuYeung et al., 2006.

Table 7-35. Outdoor Hand Contact with Surfaces—Frequency, Children 1 to 5 Years[a] (contacts/hour)						
Object/Surface	Both Hands					
	N	Range	Geometric Mean	SD	Median	90th Percentile
Cement	37	0−240	27	0.59	36	107
Porch	22	0−104	12	0.74	16	86
Grass	34	0−183	8	0.71	7	71
Bare Soil	27	0−81	6	0.67	5	71
All Surfaces	37	3−405	70	0.44	81	193

[a] Based on observations of a total of 37 children aged 1 to 5 years (primarily low-income, Hispanic) in outdoor residential areas in Illinois.
N = Number of subjects.
SD = Standard deviation of log-transformed contacts/hour.

Source: Ko et al., 2007.

Table 7-36. Hand Contact with Object/Surfaces, Infants and Toddlers[a]

Object/Surface	Both Hands								
	Range	Mean	Median	Range	Mean	Median	Range	Mean	Median
	Frequency (contacts/hour)			Duration (minutes/hour)[b]			Duration (seconds/contact)		
Animal	0.0−4.3	0.2	0.0	0.0−0.2	0.0	0.0	1.5−2.0	1.8	1.8
Body	16.6−147.1	76.8	70.5	1.6−21.9	7.5	5.9	1.0−3.0	2.3	2.0
Clothes/Towel	39.2−237.9	113.8	100.9	4.5−31.0	13.1	12.4	1.0−4.0	2.9	3.0
Fabric	0.0−134.4	45.6	37.6	2.1−21.6	10.3	9.1	2.0−9.0	3.6	3.0
Floor	0.0−594.5	96.0	41.5	0.0−32.2	7.0	4.3	0.5−5.0	2.3	2.5
Food	0.0−170.7	51.8	42.7	0.0−37.1	14.2	12.1	2.0−24.0	7.1	7.0
Footwear	0.0−47.0	7.8	2.4	0.0−7.7	1.1	0.3	1.0−11.0	3.8	3.0
Metal	0.0−52.4	17.3	14.5	0.0−5.2	2.0	1.9	0.8−9.0	3.4	3.0
Non-Dietary Water	0.0−2.6	0.2	0.0	0.0−0.0	0.0	0.0	0.5−1.0	0.8	0.8
Paper/Wrapper	0.0−75.3	18.1	18.7	0.0−13.9	3.7	3.1	1.5−11.5	4.4	4.0
Plastic	10.9−294.9	87.1	76.1	0.9−50.6	13.5	10.9	0.5−8.0	3.8	4.0
Rock/Brick	0.0−17.4	3.4	1.6	0.0−1.8	0.3	0.1	1.0−5.0	2.7	3.0
Toy	28.3−300.4	121.2	98.8	9.8−54.1	25.2	9.8	3.0−11.5	5.8	5.0
Vegetation	0.0−16.3	3.8	0.3	0.0−2.2	0.3	0.0	0.5−4.0	2.7	3.0
Wood	0.0−65.4	24.9	27.2	0.0−10.6	3.5	3.9	1.5−8.0	3.8	3.0
Non-Dietary Object	266.8−1,180.0	600.8	568.7	62.6−106.2	83.1	83.2	2.0−5.0	3.2	3.0
All Objects/Surfaces	303.1−1,206.0	686.3	689.4	76.4−124.1	99.1	100.5	2.0−5.0	3.3	3.0

[a] Based on 23 farm worker children (ages 6 to 26 months) from California.

[b] Hourly contact duration for both hands is the sum of the hourly contact durations for the left and right hands independently.

Source: Beamer et al., 2008.

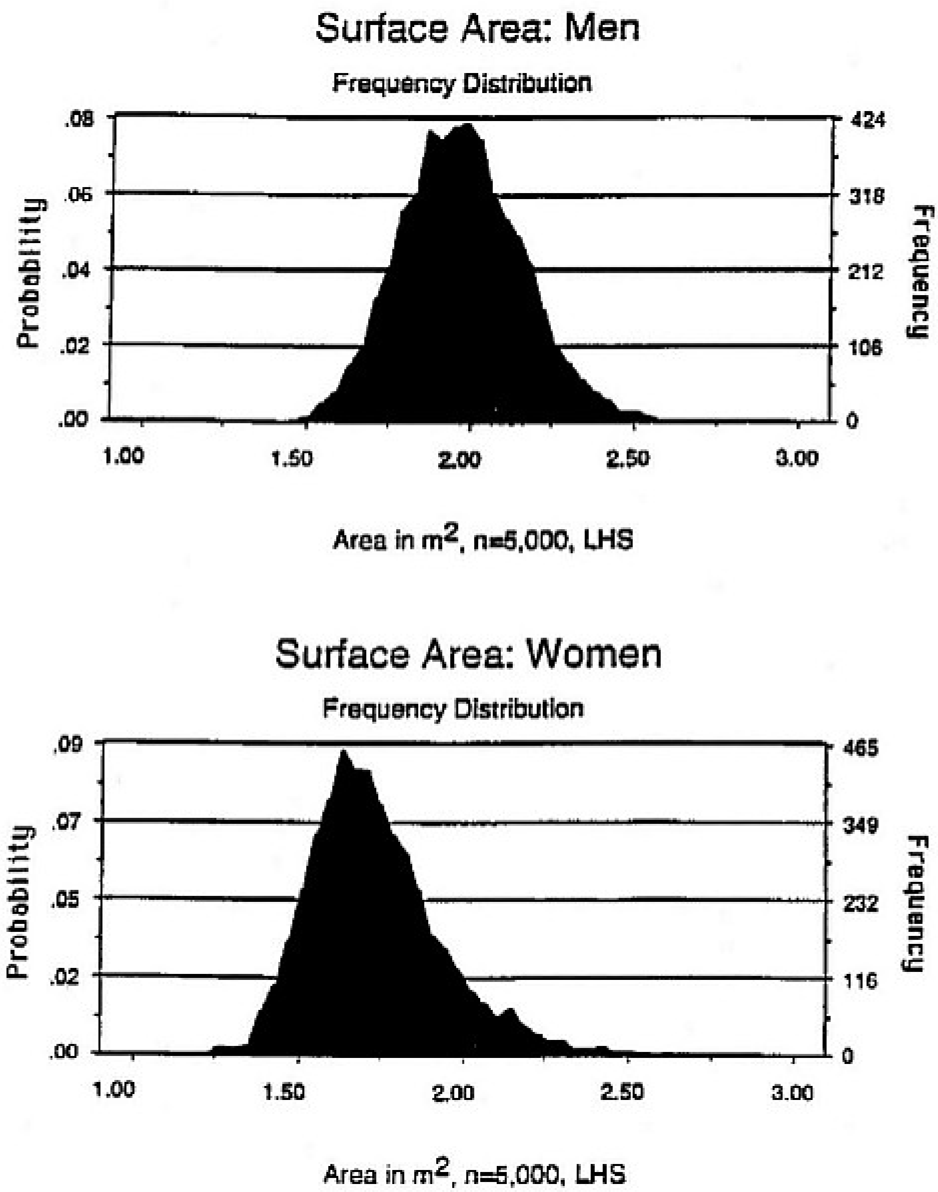

Figure 7-1. Frequency Distributions for the Surface Area of Men and Women.

Source: Murray and Burmaster, 1992.

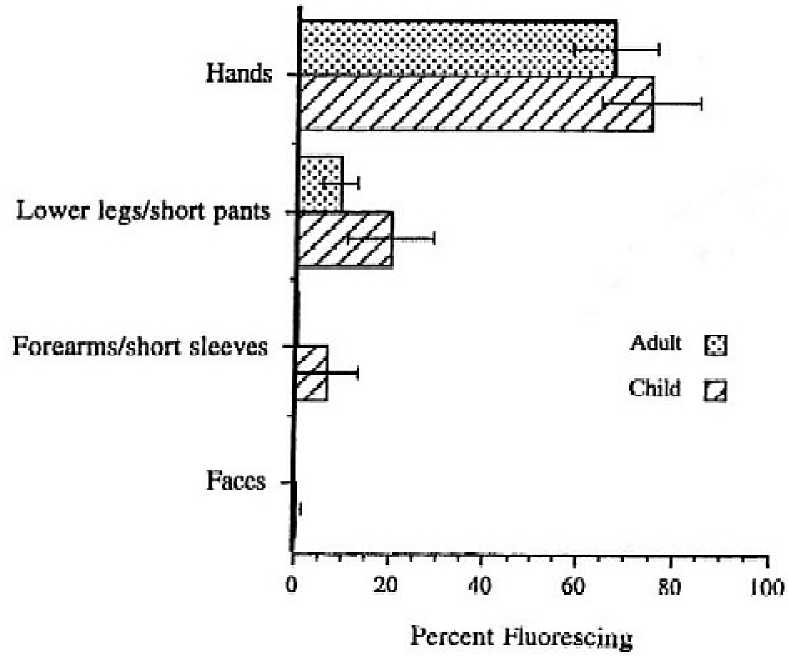

Figure 7-2. Skin Coverage as Determined by Fluorescence versus Body Part for Adults Transplanting Plants and Children Playing in Wet Soils (Bars are Arithmetic Means and Corresponding 95% Confidence Intervals).
Source: Kissel et al., 1998.

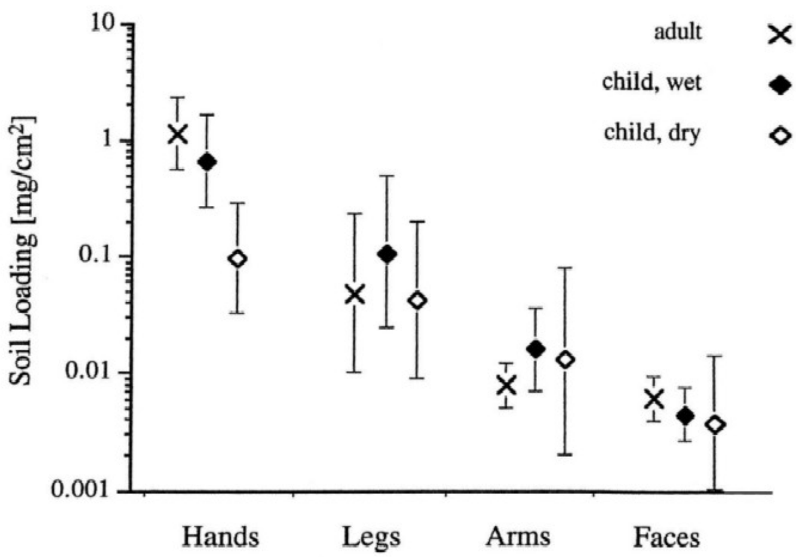

Figure 7-3. Gravimetric Loading Versus Body Part for Adults Transplanting Plants in Wet Soil and Children Playing in Wet and Dry Soils (Symbols are Geometric Means and 95% Confidence Intervals).
Source: Kissel et al., 1998.

APPENDIX 7A

FORMULAS FOR TOTAL BODY SURFACE AREA

APPENDIX 7A—FORMULAS FOR TOTAL BODY SURFACE AREA

Most formulas for estimating surface area relate height to weight to surface area. The following formula was proposed by Gehan and George (1970):

$$SA = KW^{2/3} \qquad \text{(Eqn. 7A-1)}$$

where:

SA = surface area in square meters,
W = weight in kg, and
K = constant.

While this equation has been criticized because human bodies have different specific gravities and because the surface area per unit volume differs for individuals with different body builds, it gives a reasonably good estimate of surface area.

A formula published in 1916 that still finds wide acceptance and use is that of DuBois and DuBois (1916). Their model can be written:

$$SA = a_0 H^{a_1} W^{a_2} \qquad \text{(Eqn. 7A-2)}$$

where:

SA = surface area in square meters,
H = height in centimeters, and
W = weight in kg.

The values of a_0 (0.007182), a_1 (0.725), and a_2 (0.425) were estimated from a sample of only nine individuals for whom surface area was directly measured. Boyd (1935) stated that the Dubois formula was considered a reasonably adequate substitute for measuring surface area. Nomograms for determining surface area from height and mass presented in Volume I of the Geigy Scientific Tables (1981) are based on the DuBois and DuBois formula.

Boyd (1935) developed new constants for the DuBois and DuBois model based on 231 direct measurements of body surface area found in the literature. These data were limited to measurements of surface area by coating methods (122 cases), surface integration (93 cases), and triangulation (16 cases). The subjects were Caucasians of normal body build for whom data on weight, height, and age (except for exact age of adults) were complete. Resulting values for the constants in the DuBois and DuBois model were $a_0 = 0.01787$, $a_1 = 0.500$, and $a_2 = 0.4838$. Boyd also developed a formula based exclusively on weight, which was inferior to the DuBois and DuBois formula based on height and weight.

Gehan and George (1970) proposed another set of constants for the DuBois and DuBois model. The constants were based on a total of 401 direct measurements of surface area, height, and weight of all postnatal subjects listed in Boyd (1935). The methods used to measure these subjects were coating (163 cases), surface integration (222 cases), and triangulation (16 cases).

Gehan and George (1970) used a least-squares method to identify the values of the constants. The values of the constants chosen are those that minimize the sum of the squared percentage errors of the predicted values of surface area. This approach was used because the importance of an error of 0.1 square meter depends on the surface area of the individual. Gehan and George (1970) used the 401 observations summarized in Boyd (1935) in the least-squares method. The following estimates of the constants were obtained: $a_0 = 0.02350$, $a_1 = 0.42246$, and $a_2 = 0.51456$. Hence, their equation for predicting surface area is:

$$SA = 0.02350\, H^{0.42246} W^{0.51456} \qquad \text{(Eqn. 7A-3)}$$

or in logarithmic form:

$$\ln SA = -3.75080 + 0.42246 \ln H + 0.51456 \ln W \qquad \text{(Eqn. 7A-4)}$$

where:

SA = surface area in square meters,
H = height in centimeters, and
W = weight in kg.

This prediction explains more than 99% of the variations in surface area among the 401 individuals measured (Gehan and George, 1970).

The equation proposed by Gehan and George (1970) was determined by the U.S. EPA (1985) to be the best choice for estimating total body surface area. However, the paper by Gehan and George gave insufficient information to estimate the standard error about the regression. Therefore, the 401 direct measurements of children and adults (i.e., Boyd, 1935) were reanalyzed in U.S. EPA (1985) using the formula of Dubois and Dubois (1916) and the

Statistical Processing System (SPS) software package to obtain the standard error.

The Dubois and Dubois (1916) formula uses weight and height as independent variables to predict total body surface area and can be written as:

$$SA_1 = a_0\, H_i^{a_1}\, W_i^{a_2}\, e_i \qquad \text{(Eqn. 7A-5)}$$

or in logarithmic form:

$$ln\,(SA)_i = lna_0 + a_1 lnH_i + a_2 lnW_i + lne_i \qquad \text{(Eqn. 7A-6)}$$

where:

SA_i	=	surface area of the i-th individual (m^2),
H_i	=	height of the i-th individual (cm),
W_i	=	weight of the *i*-th individual (kg),
a_0, a_1, and a_2	=	parameters to be estimated, and
e_i	=	a random error term with mean zero and constant variance.

Using the least squares procedure for the 401 observations, the following parameter estimates and their standard errors were obtained:

a_0 = −3.73 (0.18), a_1 = 0.417 (0.054), a_2 = 0.517 (0.022)

The model is then:

$$SA = 0.0239\, H^{0.417}\, W^{0.517} \qquad \text{(Eqn. 7A-7)}$$

or in logarithmic form:

$$ln\,SA = -3.73 + 0.417\, lnH + 0.517\, lnW \qquad \text{(Eqn. 7A-8)}$$

with a standard error about the regression of 0.00374. This model explains more than 99% of the total variation in surface area among the observations, and it is identical to two significant figures with the model developed by Gehan and George (1970).

When natural logarithms of the measured surface areas are plotted against natural logarithms of the surface predicted by the equation, the observed surface areas are symmetrically distributed around a line of perfect fit with only a few large percentage deviations. Only five subjects differed from the measured value by 25% or more. Because each of the five subjects weighed less than 13 pounds, the amount of difference was small. Eighteen estimates differed from measurements by 15 to 24%. Of these, 12 weighed less than 15 pounds each, one was overweight (5 feet 7 inches, 172 pounds), one was very thin (4 feet 11 inches, 78 pounds), and four were of average build. Because the same observer measured surface area for these four subjects, the possibility of some bias in measured values cannot be discounted (Gehan and George, 1970). Gehan and George (1970) also considered separate constants for different age groups: less than 5 years old, 5 years old to less than 20 years old, and greater than 20 years old. Table 7A-1 presents the different values for the constants.

The surface areas estimated using the parameter values for all ages were compared to surface areas estimated by the values for each age group for subjects at the 3rd, 50th, and 97th percentiles of weight and height. Nearly all differences in surface area estimates were less than 0.01 m^2, and the largest difference was 0.03 m^2 for an 18-year-old at the 97th percentile. The authors concluded that there is no advantage in using separate values of a_0, a_1, and a_2 by age interval.

Haycock et al. (1978), without knowledge of the work by Gehan and George (1970), developed values for the parameters a_0, a_1, and a_2 for the DuBois and DuBois model. Their interest in making the DuBois and DuBois model more accurate resulted from their work in pediatrics and the fact that DuBois and DuBois (1916) included only one child in their study group: a severely undernourished girl who weighed only 13.8 pounds at age 21 months. Haycock et al. (1978) used their own geometric method for estimating surface area from 34 body measurements for 81 subjects. Their study included newborn infants (10 cases), infants (12 cases), children (40 cases), and adult members of the medical and secretarial staffs of two hospitals (19 cases). The subjects all had grossly normal body structure, but the sample included subjects of widely varying physique ranging from thin to obese. Black, Hispanic, and Caucasian children were included in their sample. The values of the model parameters were solved for the relationship between surface area and height and weight by multiple regression analysis. The least squares best fit for this equation yielded the following values for the three co-efficients: a_0 = 0.024265, a_1 = 0.3964, and a_2 = 0.5378. The result was the following equation for estimating surface area:

$$SA = 0.024265H^{0.3964} W^{0.5378} \quad \text{(Eqn. 7A-9)}$$

expressed logarithmically as:

$$\ln SA = \ln 0.024265 + 0.3964 \ln H + 0.5378 \ln W \quad \text{(Eqn. 7A-10)}$$

The co-efficients for this equation agree remarkably with those obtained by Gehan and George (1970) for 401 measurements.

George et al. (1979) agree that a model more complex than the model of DuBois and DuBois for estimating surface area is unnecessary. Based on samples of direct measurements by Boyd (1935) and Gehan and George (1970), and samples of geometric estimates by Haycock et al. (1978), these authors have obtained parameters for the DuBois and DuBois model that are different than those originally postulated in 1916. The DuBois and DuBois model can be written logarithmically as:

$$lnSA = lna_0 + a_1 \, lnH + a_2 \, lnW \quad \text{(Eqn. 7A-11)}$$

Table 7A-2 present the values for a_0, a_1, and a_2 obtained by the various authors discussed in this section.

The agreement between the model parameters estimated by Gehan and George (1970) and Haycock et al. (1978) is remarkable in view of the fact that Haycock et al. (1978) were unaware of the previous work. Haycock et al. (1978) used an entirely different set of subjects and used geometric estimates of surface area rather than direct measurements. It has been determined that the Gehan and George model is the formula of choice for estimating total surface area of the body because it is based on the largest number of direct measurements.

Sendroy and Cecchini (1954) proposed a method of creating a *nomogram*, a diagram relating height and weight to surface area. However, they do not give an explicit model for calculating surface area. The nomogram was developed empirically based on 252 cases, 127 of which were from the 401 direct measurements reported by Boyd (1935). In the other 125 cases, the surface area was estimated using the linear method of DuBois and DuBois (1916). Because the Sendroy and Cecchini method is graphical, it is inherently less precise and less accurate than the formulas of other authors discussed in this section.

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Table 7A-1. Estimated Parameter Values for Different Age Intervals

Age Group	Number of Persons	a_0	a_1	a_2
All ages	401	0.02350	0.42246	0.51456
<5 years old	229	0.02667	0.38217	0.53937
≥5 to <20 years old	42	0.03050	0.35129	0.54375
≥20 years old	30	0.01545	0.54468	0.46336

Source: Gehan and George, 1970.

Table 7A-2. Summary of Surface Area Parameter Values for the Dubois and Dubois Model

Author (year)	Number of Persons	a_0	a_1	a_2
DuBois and DuBois (1916)	9	0.007184	0.725	0.425
Boyd (1935)	231	0.01787	0.500	0.4838
Gehan and George (1970)	401	0.02350	0.42246	0.51456
Haycock et al. (1978)	81	0.024265	0.3964	0.5378

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8. BODY-WEIGHT STUDIES

8.1. INTRODUCTION

There are several physiological factors needed to calculate potential exposures. These include skin surface area (see Chapter 7), inhalation rate (see Chapter 6) life expectancy (see Chapter 18), and body weight. The average daily dose (ADD) is a dose that is typically normalized to the average body weight of the exposed population. If exposure occurs only during childhood years, the average child body weight during the exposure period should be used to estimate risk (U.S. EPA, 1989). Conversely, if adult exposures are being evaluated, an adult body-weight value should be used.

The purpose of this chapter is to describe published studies on body weight in the general U.S. population. The recommendations for body weight are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on one key study identified by U.S. Environmental Protection Agency (EPA) for this factor. Following the recommendations, the key study on body weight is summarized. Relevant data on body weight are also provided. These relevant data are included because they may be useful for trend analysis. Since obesity is a growing concern and may increase the risk of chronic diseases during adulthood, information on body mass index (BMI) and height is also provided.

8.2. RECOMMENDATIONS

The key study described in this section was used in selecting recommended values for body weight. The recommendations for body weight are summarized in Table 8-1 and are based on data derived from the National Health and Nutrition Examination Survey (NHANES) 1999−2006. The recommended values represent mean body weights in kilograms for the age groups for children recommended by U.S. EPA in *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005) and for adults. Table 8-2 presents the confidence ratings for the body-weight recommendations.

Table 8-1 shows the mean body weight for all adults (male and female, all age groups) combined is 80 kg. Section 8.3 presents percentile data.

The mean recommended value for adults (80 kg) is different from the 70 kg commonly assumed in U.S. EPA risk assessments. Assessors are encouraged to use values that most accurately reflect the exposed population. When using values other than 70 kg, however, the assessors should consider if the dose estimate will be used to estimate risk by combining it with a dose-response relationship that was derived assuming a body weight of 70 kg. If such an inconsistency exists, the assessor may need to adjust the dose-response relationship as described in the appendix to Chapter 1.

Use of upper percentile body-weight values are not routinely recommended for calculating ADDs because inclusion of an upper percentile value in the denominator of the ADD equation would be a non-conservative approach. However, Section 8.3 provides distributions of body-weight data. These distributions may be useful if probabilistic methods are used to assess exposure. Also, if sex-specific data are needed, or if data for finer age bins are needed, the reader should refer to the tables in Section 8.3.

Table 8-1. Recommended Values for Body Weight

Age Group	Mean (kg)	Multiple Percentiles	Source
Birth to <1 month	4.8	Tables 8-3 through 8-5	U.S. EPA analysis of NHANES, 1999−2006 data
1 to <3 months	5.9		
3 to <6 months	7.4		
6 to <11 months	9.2		
1 to <2 years	11.4		
2 to <3 years	13.8		
3 to <6 years	18.6		
6 to <11 years	31.8		
11 to <16 years	56.8		
16 to <21 years	71.6		
Adults	80.0		

Table 8-2. Confidence in Recommendations for Body Weight

General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and the secondary data analysis were adequate. NHANES consisted of a large sample size; sample size varied with age. Direct measurements were taken during a physical examination.	
Minimal (or Defined) Bias	No significant biases were apparent.	
Applicability and Utility		High
Exposure Factor of Interest	The key study is directly relevant to body weight.	
Representativeness	NHANES was a nationally representative sample of the U.S. population; participants are selected using a complex, stratified, multi-stage probability cluster sampling design.	
Currency	The U.S. EPA analysis used the most current NHANES data.	
Data Collection Period	The U.S. EPA analysis was based on four data sets of NHANES data covering 1999−2006.	
Clarity and Completeness		High
Accessibility	NHANES data are available from NCHS.	
Reproducibility	The methods used were well-described; enough information was provided to allow for reproduction of results.	
Quality Assurance	NHANES follows a strict QA/QC procedures; the U.S. EPA analysis has only been reviewed internally.	
Variability and Uncertainty		High
Variability in Population	The full distributions were given in the key study.	
Uncertainty	No significant biases were apparent in the NHANES data, nor in the secondary analyses of the data.	
Evaluation and Review		Medium
Peer Review	NHANES received a high level of peer review. The U.S. EPA analysis was not published in a peer-reviewed journal.	
Number and Agreement of Studies	The number of studies is 1.	
Overall Rating		**High**

8.3. KEY BODY-WEIGHT STUDY

8.3.1. U.S. EPA Analysis of NHANES 1999−2006 Data

The U.S. EPA analyzed data from the 1999−2006 NHANES to generate distributions of body weight for various age ranges of children and adults. NHANES is conducted annually by the Center for Disease Control (CDC), National Center of Health Statistics (NCHS). The survey's target population is the civilian, non-institutionalized U.S. population. The NHANES 1999−2006 survey was conducted on a nationwide probability sample of approximately 40,000 persons for all ages, of which approximately 20,000 were children. The survey is designed to obtain nationally representative information on the health and nutritional status of the population of the United States through interviews and direct physical examinations. A number of anthropometric measurements, including body weight, were taken for each participant in the study. Unit non-response to the household interview was 19%, and an additional 4% did not participate in the physical examinations (including body-weight measurements).

The NHANES 1999−2006 survey includes over-sampling of low-income persons, adolescents 12−19 years, persons 60+ years of age, African Americans and Mexican Americans. Sample data were assigned weights to account both for the disparity in sample sizes for these groups and for other inadequacies in sampling, such as the presence of non-respondents. Because the U.S. EPA utilized four NHANES data sets in its analysis (NHANES 1999−2000, 2001−2002, 2003−2004, and 2005−2006) sample weights were developed for the combined data set in accordance with CDC guidance from the NHANES' website (http://www.cdc.gov/nchs/about/major/nhanes/nhanes2005-2006/faqs05_06.htm#question%2012).

Using the data and the weighting factors from the four NHANES data sets, U.S. EPA calculated body-weight statistics for the standard age categories. The mean value for a given group was calculated using the following formula:

$$\bar{x} = \frac{\sum_i w_i x_i}{\sum_i w_i} \quad \text{(Eqn. 8-1)}$$

where:

$\bar{x}$ = sample mean,
x_i = the i^{th} observation, and
w_i = sample weight assigned to observation x_i.

Percentile values were generated by first calculating the sum of the sample weights for all observations in a given group and multiplying this sum by the percentile of interest (e.g., multiplying by 0.25 to determine the 25th percentile). The observations were then ordered from least to greatest, and each observation was assigned a cumulative sample weight, equal to its own sample weight plus all sample weights listed before the observation. The 1st observation listed with a cumulative sample weight greater than the value calculated for the percentile of interest was selected.

Table 8-3 presents the body-weight means and percentiles, by age category, for males and females combined. Tables 8-4 and 8-5 present the body-weight means and percentiles for males and females, respectively.

The advantage of this study is that it provides body-weight distributions ranging from infancy to adults. A limitation of the study is that combining the data from various years of NHANES beginning in 1999 through 2006 may underestimate current body weights due to an observed upward trend in body weights (Ogden et al., 2004). However, these data are based on the most recent available NHANES data. The NHANES data are nationally representative and remain the principal source of body-weight data collected nationwide from a large number of subjects.

8.4. RELEVANT GENERAL POPULATION BODY-WEIGHT STUDIES

8.4.1. National Center for Health Statistics (NCHS) (1987)—Anthropometric Reference Data and Prevalence of Overweight, United States, 1976−1980

The NCHS (1987) collected anthropometric measurement data for body weight for the U.S. population as part of the 2nd National Health and Nutrition Examination Survey (NHANES II). NHANES II began in February 1976 and was completed in February 1980. The survey was conducted on a nationwide probability sample of 27,801 persons aged six months to 74 years from the civilian, non-institutionalized population of the United States. A total of 20,322 individuals in the sample were interviewed and examined, resulting in a response rate of 73.1%. The sample was selected so that certain subgroups thought to be at high risk of malnutrition (persons with low incomes, preschool children, and the elderly) were over sampled. The estimates were weighted to reflect national population estimates. The weighting was accomplished by inflating examination results for each subject by the reciprocal of selection probabilities, adjusting to account for those who were not examined, and post-stratifying by race, age, and sex.

NHANES II collected standard body measurements of sample subjects, including height and weight, that were made at various times of the day and in different seasons of the year. This technique was used because an individual's weight may vary between winter and summer and may fluctuate with patterns of food and water intake and other daily activities (NCHS, 1987). NCHS (1987) provided descriptive statistics of the body-weight data. Tables 8-6 and 8-7 present means and percentiles, by age category, for males and females, respectively. Although the NHANES data are nationally representative, a limitation of the study is the age of the data used.

8.4.2. Brainard and Burmaster (1992)—Bivariate Distributions for Height and Weight of Men and Women in the United States

Brainard and Burmaster (1992) examined data on the height and weight of adults published by the U.S. Public Health Service and fit bivariate distributions to the tabulated values for men and women, separately. Height and weight of 5,916 men and 6,588 women in the age range of 18 to 74 years were taken from the NHANES II (1976−1980) study and statistically adjusted to represent the U.S. population aged 18 to 74 years with regard to age structure, sex, and race. Estimation techniques were used to fit normal distributions to the cumulative marginal data, and goodness-of-fit tests were used to test the hypothesis that height and lognormal weight follow a normal distribution for each sex. It was found that the marginal distributions of height and lognormal weight for both men and women are Gaussian (normal) in form. This conclusion was reached by visual observation and the high R^2 values for best-fit lines obtained using linear regression. The R^2 values for men's height and lognormal weight were reported to be 0.999. The R^2 values for women's height and lognormal weight were reported as 0.999 and 0.985, respectively.

Brainard and Burmaster (1992) fit bivariate distributions to estimated numbers of men and women aged 18 to 74 years in cells representing one-inch height intervals and 10-pound weight intervals. Adjusted height and lognormal weight data for men were fit to a single bivariate normal distribution with an estimated mean height of 1.75 meters (69.2 inches) and an estimated mean weight of 78.6 kg (173.2 pounds). For women, height and lognormal weight data were fit to a pair of superimposed bivariate normal distributions (Brainard and Burmaster, 1992). The average height and weight for women were estimated from the combined bivariate analyses. Mean height for women was estimated to be 1.62 meters (63.8 inches), and mean weight was estimated to be 65.8 kg (145.0 pounds). For women, a calculation using a single bivariate normal distribution gave poor results (Brainard and Burmaster, 1992).

The advantage of this study is that it provides distributions that are suitable for use in Monte Carlo simulation. However, these distributions are now based on dated information.

8.4.3. Burmaster and Crouch (1997)—Lognormal Distributions for Body Weight as a Function of Age for Males and Females in the United States, 1976−1980

Burmaster and Crouch (1997) performed data analysis to fit normal and lognormal distributions to the body weights of females and males aged 9 months to 70 years. The data used in this analysis were from NHANES II, which was based on a national probability sample of 27,801 persons 6 months to 74 years of age in the United States. (Burmaster and Crouch, 1997). The NHANES II data had been statistically adjusted for non-response and probability of selection, and stratified by age, sex, and race to reflect the entire U.S. population prior to reporting. Burmaster and Crouch (1997) conducted exploratory and quantitative data analyses and fit normal and lognormal distributions to percentiles of body weights as a function of age. Cumulative distribution functions were plotted for female and male body weights on both linear and logarithmic scales.

Burmaster and Crouch (1997) used "maximum likelihood" estimation to fit lognormal distributions to the data. Linear and quadratic regression lines were fitted to the data. A number of goodness-of-fit measures were conducted on the data generated. The investigators found that lognormal distributions gave strong fits to the data for each sex across all age groups. Tables 8-8 and 8-9 present the statistics for the lognormal probability plots for females and males aged 9 months to 70 years, respectively. As indicated in Burmaster and Crouch (1997), Φ_2, and σ_2 are the mean and standard deviation of the logarithm of body weight for an age group. The exponential of Φ_2 provides an estimate of the median of body weight, and σ_2 is approximately equal to the coefficient of variation of the body weight. These data can be used for further analyses of body-weight distribution (i.e., application of Monte Carlo analysis).

The advantage of this study is that NHANES data were used for the analysis and the data are representative nationally. It also provides statistics for probability plot regression analyses for females and males from 9 months to 70 years of age. However, the analysis is based on an older set of NHANES data.

8.4.4. U.S. EPA (2000)—Body-Weight Estimates on NHANES III Data

U.S. EPA's Office of Water has estimated body weights by age and sex using data from NHANES III, which was conducted from 1988 to 1994. NHANES III collected body-weight data for approximately 30,000 individuals between the ages of 2 months and 44 years. Table 8-10 presents the body-weight estimates in kilograms by age and sex. Table 8-11 shows the body-weight estimates for infants 2 and 3 months of age.

The limitations of this analysis are that data were not available for infants under 2 months old, and that the data are roughly 15 to 20 years old. With the upward trends in body weight from NHANES II (1976−1980) to NHANES III, which may still be valid, the data in Tables 8-10 and 8-11 may underestimate current body weights. However, the data are national in scope and represent the general population.

8.4.5. Kuczmarski et al. (2002)—CDC Growth Charts for the United States: Methods and Development

NCHS published growth charts for infants, birth to 36 months of age, and children and adolescents, 2 to 20 years of age (Kuczmarski et al., 2002). Growth charts were developed with data from five national health examination surveys: National Health Examination Survey (NHES) II (1963−1965) for ages 6−11 years, NHES III (1966−1970) for ages 12−17 years, NHANES I (1971−1974) for ages 1−17 years, NHANES II (1976−1980) beginning at 6 months of age, and NHANES III (1988−1994) beginning at 2 months of age. Data from these national surveys were pooled because no single survey had enough observations to develop these charts. For the infant charts, a limited number of additional data points were obtained from other sources where national data were either not available or insufficient. Birth weights <1,500 grams were excluded when generating the charts for weights and lengths. Also, the length-for-age charts exclude data from NHANES III for ages <3.5 months. Supplemental birth certificate data from the U.S. vital statistics were used in the weight-for-age charts and supplemental birth certificate data from Wisconsin and Missouri vital statistics, CDC Pediatric Nutrition Surveillance System data were used for ages 0.5, 1.5, 2.5, 3.5, and 4.5 months for the length-for-age charts. The Missouri and Wisconsin birth certificate data were also used to supplement the surveys for the weight-for-length charts. Table 8-12 presents the percentiles of weight by sex and age. Figures 8-1 and 8-2 present weight by age percentiles for boys and girls, aged birth to 36 months, respectively. Figures 8-3 and 8-4 present weight by length percentiles for boys and girls, respectively. Figures 8-5 and 8-6 provide the BMI for boys and girls aged 2 to 20 years old.

The advantages of this analysis are that it is based on a nationally representative sample of the U.S. population and it provides body weight on a month-by-month basis up to 36 months of age, as well as BMI data for children through age 20 years. A limitation of this analysis is that trends in the weight data cannot be assessed because data from various years were combined. Also, the analysis is based on an older data set.

8.4.6. U.S. EPA (2004)—Estimated Per Capita Water Ingestion and Body Weight in the United States—An Update

U.S. EPA (2004) developed estimates from empirical distributions of body weights based on data from the U.S. Department of Agriculture (USDA's) 1994−1996 and the 1998 Continuing Survey of Food Intake by Individuals (CSFII). The weights recorded in the survey, and, consequently, the estimates reported, are based on self-reported data by the participants.

When viewed across sexes and all age categories, the average self-reported body weight for individuals in the United States during the 1994−1996 and 1998 period is 65 kg, or 143 lb. The estimated median body weight for all individuals is 67 kg (147 lb). Table 8-13 provides the estimated distribution of body weights for all individuals.

For the fine age categories reported in the summary data, the mean and median estimated body weights are the same for children in categories less than 2 years of age. This suggests that body weights follow an approximately normal distribution. After the age of 2 years, estimated mean body weights are higher than estimated median body weights as age categories increase. This suggests that the distributions of body weights are skewed to the right. When viewed across ages, the estimated median body weight is higher than the estimated mean body weight. This suggests that the body-weight distribution across the entire survey weighted sample is slightly skewed to the left. The limitations of this analysis are that body weights were self-reported and that it is based on an older data set.

8.4.7. Ogden et al. (2004)—Mean Body Weight, Height, and Body Mass Index, United States 1960−2002

Ogden et al. (2004) analyzed trends in body weight measured by the NHES II and III, NHANES I, II, and III, and NHANES 1999−2002. The surveys covered the period from 1960 to 2002. Table 8-14 presents the measured body weights for various age groups as measured in NHES and NHANES. Tables 8-15 and 8-16 present the mean height and BMI data for the same population, respectively. The BMI data were calculated as weight (in kilograms) divided by the square of height (in meters). Population means were calculated using sample weights to account for variation in sampling for certain subsets of the U.S. population, non-response, and non-coverage (Ogden et al., 2004). The data indicate that mean body weight has increased over the period analyzed.

There is some uncertainty inherent in such an analysis, however, because of changes in sampling methods during the 42-year time span covered by the studies. This serves to illustrate the importance of the use of timely data when analyzing body weight. Because this study is based on an analysis of NHANES data, its limitations are the same as those for that study. Another limitation is that the data are based on an older NHANES data set and may not be entirely representative of current BMI values.

8.4.8. Freedman et al. (2006)—Racial and Ethnic Differences in Secular Trends for Childhood BMI, Weight, and Height

Freedman et al. (2006) examined sex and race/ethnicity differences in secular trends for childhood BMI, overweight, weight, and height in the United States using data from NHANES I (1971−1974), NHANES II (1976–1980), NHANES III (1988–1994), and NHANES 1999−2002. The analyses includes children 2 to 17 years old. Persons with missing weight or height information were excluded from the analyses (Freedman et al., 2006). The authors categorized the data across the four examinations and presented the data for non-Hispanic White, non-Hispanic Black, or Mexican American. Freedman et al. (2006) excluded other categories of race/ethnicity, such as other Hispanics, because the sample sizes were small. Height and weight data were obtained for each survey, and BMI was calculated as weight in kilograms divided by height in meters square. Sex specific *z*-scores and percentiles of weight-for-age, height-for-age, and BMI-for-age were calculated. Childhood overweight was defined as BMI-for-age ≥95th percentile, and childhood obesity was defined as children with a BMI-for-age ≥99th percentile.

In the analyses, sample weights were used to account for differential probabilities, non-selection, non-response, and non-coverage. Table 8-17 presents the sample sizes used in the analyses by age, sex, race, and survey. Table 8-18 provides mean BMI levels for ages 2 to 17. Table 8-19 shows BMI mean levels for adults 20 years and older (Ogden et al., 2004). Table 8-18 shows that in the 1971−1974 survey total population, Mexican American children had the highest mean BMI level (18.6 kg/m^2). However, the greatest increase throughout the survey occurred among Black children, increasing from 17.8 to 20 kg/m^2 (Freedman et al., 2006). Table 8-20 shows the prevalence of overweight and obesity for children 2 to 17 years old. These results show that 2 to 5 year-old White children had slightly larger increases in overweight, but among the older children, the largest increases were among the Black and Mexican American children (Freedman et al., 2006). Overall, in most sex-age groups, Mexican Americans experienced the greater increase in BMI and overweight than what was experienced by Black and White children (Freedman et al., 2006). Black children experienced larger secular increases in BMI, weight, and height than did White children (Freedman et al., 2006). According to Freedman et al. (2006), racial/ethnicity differences were less marked in the children aged two to five years old.

The advantages of the study are that the sample size is large and the analysis was designed to represent the general population of the racial and ethnic groups studied. The disadvantage is that some ethnic population groups were excluded because of small sample sizes and that it is based on older NHANES data sets.

8.4.9. Martin et al. (2007)—Births: Final Data for 2005

Martin et al. (2007) provided statistics on the percentage of live births categorized as having low or very low birth weights in the United States. Low birth weight was defined as <2,500 grams (<5 pounds 8 ounces), and very low birth weight was defined as <1,500 grams (<three pounds four ounces). The data used in the analysis were from birth certificates registered in all states and the District of Columbia for births occurring in 2005. Data were presented for maternal demographic characteristics including race ethnicity: non-Hispanic White, non-Hispanic Black, and Hispanic.

The numbers of live births within various weight ranges, and the percentages of live births with low or very low birth weights are presented in Table 8-21. The percentage of live births with low birth weights was 8.2, and the percentage of very low birth weights was 1.5 in 2005. Non-Hispanic Blacks had the highest percentage of low birth weights (14.0%) and very low birth weights (3.3%). Martin et al. (2007) also provided statistics on the numbers and percentages of pre-term live births in the United States. Of the 4,138,349 live births in the United States in 2005, 522,913 were defined as pre-term (i.e., less than 37 weeks gestation). A total of 43.3% of these pre-term infants had low birth weights, and 11.3% had very low birth weights. The advantage of this data set is that it is nationally representative and provides data for infants. It provides data on prevalence of low birth weight in the population.

8.4.10. Portier et al. (2007)—Body Weight Distributions for Risk Assessment

Portier et al. (2007) provided age-specific distributions of body weight based on NHANES II, III, and IV data. The number of observations in these surveys is 20,322, 33,311, and 9,965, respectively. Portier et al. (2007) computed the means and standard deviations of body weight as back transformations of the weighted means and standard deviations of natural log-transformed body weights. Body-weight distributions were computed by sex and various age brackets (Portier et al., 2007). The estimated mean body weights are shown in Tables 8-22, 8-23, and 8-24 using NHANES II, III, and IV data, respectively. The sample size (*N*) shown in the tables is the observed number of individuals and not the expected population size (sum of the sample weights) in each age category (Portier et al., 2007). Table 8-25 provides estimates for age groups that are often considered in risk assessments (Portier et al., 2007). The authors concluded that the data show changes in the average body weight over time and that the changes are not constant for all ages. The reader is referred to Portier et al. (2007) for equations suggested by the authors to be used when performing risk assessments where shifts and changes in body-weight distributions need factoring in.

The advantages of this study are that it represents the U.S. general population, it provides distribution data, and can be used for trend analysis. In addition, the data are provided for both sexes and for single-year age groups. The study results are also based on a large sample size.

8.4.11. Kahn and Stralka (2008)—Estimated Daily Average Per Capita Water Ingestion by Child and Adult Age Categories Based on USDA's 1994−1996 and 1998 Continuing Survey of Food Intakes

As part of an analysis of water ingestion, Kahn and Stralka (2008) provided body-weight distributions for the U.S. population. The analysis was based on self-reported body weights from the 1994−1996, 1998 CSFII. The average body weight across all individuals was 65 kg. According to Kahn and Stralka (2008), 10 kg, which is often used as the default body weight for babies, is the 95th value of the distribution of body weight for children in the 3 to <6 months category. The median weight is 9 kg for the 6 to 12-month age category and 11 kg for the one-to-two-year old-category (Kahn and Stralka, 2008). Table 8-26 presents the body-weight distributions, and Table 8-27 presents the intervals around the mean and 90th and 95th percentiles.

The advantages of the study are its large sample size and that it is representative of the U.S. population for the age groups presented. A limitation of the study is that the data are based on self-reporting from the participants and that the data are now somewhat dated.

8.5. RELEVANT STUDIES—PREGNANT WOMEN BODY-WEIGHT STUDIES

8.5.1. Carmichael et al. (1997)—The Pattern of Maternal Weight Gain in Women with Good Pregnancy Outcomes

The Institute of Medicine (IOM) publishes recommendations for total gestational weight gain. Carmichael et al. (1997) conducted a study in a cohort of 7,002 who had good pregnancy outcomes to obtain the distribution of maternal weight gain by trimester and to compare these with women who achieved the IOM recommendations. Good outcome was defined as having a vaginal delivery, 37 weeks or more of gestation, delivery of a live infant of an average size for gestational age, and from mothers with no diabetes or hypertension. The women were selected from records from the Department of

Obstetrics, Gynecology and Reproductive Sciences Perinatal Database at the University of California, San Francisco. Distributions were derived for 4,218 women for whom complete data on pattern of gain for all trimesters were obtained. The mean age of the women was 27.7 years with a mean pre-pregnancy weight of 57.6 kg. Twenty-nine percent of the women were underweight, 61% were of normal weight, 5% were overweight, and 4% were obese, based on BMI calculations. Total weight gain was calculated as the difference between the self-reported pre-pregnancy weight and the last measured weight. A linear regression was applied to estimate the rate of gain in the 2nd and 3rd trimesters. Table 8-28 presents the distributions of weight gain in underweight, normal weight, overweight, and obese women during the 1st, 2nd, and 3rd trimesters. The average weight gains for the 1st, 2nd, and 3rd trimesters were 1.98 kg, 6.73 kg, and 6.37 kg, respectively. The weight gain for the 2nd and 3rd trimesters was calculated by taking the gain rate from Table 8-28 and multiplying it by 13 weeks. These data can be used to calculate the average weight of pregnant women for the 1st, 2nd, and 3rd trimesters by adding the average weight gain for the 1st trimester to the average pre-pregnancy weight of 57.6 kg and subsequently adding the average weight gain for the 2nd and 3rd trimesters to the resulting weight from the previous trimester. These calculations result in a total weight of 59.6 kg, 66.3 kg, and 72.7 kg for the 1st, 2nd, and 3rd trimesters, respectively.

The advantages of this study are that it has a large sample size, and it provides distributional data. The sample, however, may not be representative of the United States. The sample also only included pregnancies with good outcomes. The study did not provide estimates of the weight for each trimester. Instead, it provides weight gain for the 1st trimester and the rates of weight gain for the 2nd and 3rd trimesters. The total weight was estimated by the U.S. EPA based on the mean weight gain for each trimester.

8.5.2. U.S. EPA Analysis of 1999−2006 NHANES Data on Body Weight of Pregnant Women

In 2010, U.S. EPA analyzed the combined 1999−2006 NHANES data sets to examine body weight of pregnant women. Data for 1,248 pregnant women with weight measurements were extracted based from the data set based on either a positive lab pregnancy test or self-reporting of pregnancy at the examination. The NHANES data included a few very large and improbable body weights, as extreme as 186 kg from a respondent in the 1st trimester. These outliers were removed from the database (N = 26) using SAS. Table 8-29 presents the body-weight data by trimester, based on the remaining 1,222 respondents. The statistically weighted average body weight of all pregnant women was 75 kg. Due to a few large weight (>90 kg) respondents with very large sample weights (>18,000), the weighted mean body weight of 1st trimester women (76 kg) is larger than that of 2nd trimester women (73 kg).

The advantage of this study is that by combining eight years of the most recent NHANES data, an adequate sample size was achieved to estimate body weight of pregnant women by trimester. A limitation of this analysis is that high-weight respondents with large sample weight may result in uncertainties as described above.

8.6. RELEVANT FETAL WEIGHT STUDIES

8.6.1. Brenner et al. (1976)—A Standard of Fetal Growth for the United States of America

Brenner et al. (1976) determined fetal weights for 430 fetuses aborted at 8 to 20 weeks of gestation and for 30,772 liveborn infants delivered at 21 to 44 weeks of gestation. Gestational age for the aborted fetuses was determined through a combination of the physician's estimate of uterine size and the patient's stated last normal menstrual period. Data were not used when these two estimates differed by more than two weeks. To determine fetal growth, the fetuses were weighed and measured (crown-to-rump and crown-to-heel lengths). All abortions were legally performed at Memorial Hospital, University of North Carolina, at Chapel Hill, from 1972 to 1975. For the liveborn infants, data were analyzed from single birth deliveries with the infant living at the onset of labor, among pregnancies not complicated by pre-eclampsia, diabetes or other disorders. Infants were weighed on a balance scale immediately after delivery. The liveborn infants were delivered at MacDonald House, University Hospitals of Cleveland, OH, from 1962 to 1969.

Table 8-30 shows percentiles for fetal weight, calculated from the data at each week of gestation. The resulting percentile curves were smoothed with two-point weighted means. Variables associated with significant differences in fetal weight in the latter part of pregnancy (after 34−38 weeks of gestation) included maternal parity and race, and fetal sex.

The advantage of this study is the large sample size. Limitations of the study are that the data were collected more than 30 years ago in only two U.S. states. In addition, a number of variables that may affect fetal weight (i.e., maternal smoking, disease, nutrition, and addictions) were not evaluated in this study.

8.6.2. Doubilet et al. (1997)—Improved Birth Weight Table for Neonates Developed from Gestations Dated by Early Ultrasonography

Doubilet et al. (1997) matched a database of obstetrical ultrasonograms over a period of five years from 1988 to 1993 to birth records for 3,718 infants (1,857 males and 1,861 females). The study population included 1,514 Whites, 770 Blacks, 1,256 Hispanics, and 178 who were either unclassified, or classified as "other." Birth weights were obtained from hospital records, and a gestational age was assigned based on the earliest 1st trimester sonogram. The database was screened for possible outliers, defined as infants with birth weights that exceeded 5,000 grams. Labor and delivery records and mother-infant medical records were retrieved to correct any errors in data entry for infants with birth weights exceeding 5,000 grams. The mean gestational age at initial sonogram was 9.5 ± 2.3 weeks. Regression analysis techniques were used to derive weight tables for neonates at each gestational age for 25 weeks of gestation onward. Weights for each gestational age were found to conform to a natural logarithm distribution. Polynomial equations were derived from the regression analysis to estimate mean weight by gestational age for males, females, and males and females combined. Table 8-31 provides the distribution of neonatal weights by gestational age from 25 weeks of gestation onward. The advantage of this study is that it provides body weights for neonates based on a relatively large sample. A limitation is the age of the data.

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Table 8-3. Mean and Percentile Body Weights (kg) Derived from NHANES (1999−2006) Male and Female Combined

Age Group	*N*	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	158	4.8	3.6	3.9	4.1	4.2	4.8	5.1	5.5	5.8	6.2
1 to <3 months	284	5.9	4.5	4.7	4.9	5.2	5.9	6.6	6.9	7.1	7.3
3 to <6 months	489	7.4	5.7	6.1	6.3	6.7	7.3	8.0	8.4	8.7	9.1
6 to <12 months	927	9.2	7.1	7.5	7.9	8.3	9.1	10.1	10.5	10.8	11.3
1 to <2 years	1,176	11.4	8.9	9.3	9.7	10.3	11.3	12.4	13.0	13.4	14.0
2 to <3 years	1,144	13.8	10.9	11.5	11.9	12.4	13.6	14.9	15.8	16.3	17.1
3 to <6 years	2,318	18.6	13.5	14.4	14.9	15.8	17.8	20.3	22.0	23.6	26.2
6 to <11 years	3,593	31.8	19.7	21.3	22.3	24.4	29.3	36.8	42.1	45.6	52.5
11 to <16 years	5,297	56.8	34.0	37.2	40.6	45.0	54.2	65.0	73.0	79.3	88.8
16 to <21 years	4,851	71.6	48.2	52.0	54.5	58.4	67.6	80.6	90.8	97.7	108.0
21 to <30 years	3,232	78.4	50.8	54.7	57.9	63.3	75.2	88.2	98.5	106.0	118.0
30 to <40 years	3,176	80.8	53.5	57.4	60.1	66.1	77.9	92.4	101.0	107.0	118.0
40 to <50 years	3,121	83.6	54.3	58.8	62.1	68.3	81.4	95.0	104.0	111.0	122.0
50 to <60 years	2,387	83.4	54.7	59.0	62.8	69.1	80.8	95.5	104.0	110.0	120.0
60 to <70 years	2,782	82.6	55.2	59.8	63.3	69.0	80.5	94.2	103.0	109.0	116.0
70 to <80 years	2,033	76.4	52.0	56.5	59.7	64.4	74.9	86.8	93.8	98.0	106.0
Over 80 years	1,430	68.5	46.9	51.4	53.8	58.2	67.4	77.4	82.6	87.2	93.6

Source: U.S. EPA Analysis of NHANES 1999−2006 data.

Table 8-4. Mean and Percentile Body Weights (kg) for Male Derived from NHANES (1999−2006)

Age Group	*N*	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	88	4.9	3.6	3.6	4.0	4.4	4.8	5.5	5.8	6.2	6.8
1 to <3 months	153	6.0	4.6	5.0	5.1	5.4	6.1	6.8	7.0	7.2	7.3
3 to <6 months	255	7.6	5.9	6.4	6.6	6.9	7.5	8.2	8.6	8.8	9.1
6 to <12 months	472	9.4	7.3	7.9	8.2	8.5	9.4	10.3	10.6	10.8	11.5
1 to <2 years	632	11.6	9.0	9.7	10.0	10.5	11.5	12.6	13.2	13.5	14.3
2 to <3 years	558	14.1	11.4	12.0	12.2	12.8	14.0	15.2	15.9	16.4	17.0
3 to <6 years	1,158	18.8	13.5	14.4	14.9	15.9	18.1	20.8	22.6	23.8	26.2
6 to <11 years	1,795	31.9	20.0	21.8	22.9	24.8	29.6	36.4	41.2	45.2	51.4
11 to <16 years	2,593	57.6	33.6	36.3	38.9	44.2	55.5	66.5	75.5	81.2	91.8
16 to <21 years	2,462	77.3	54.5	57.6	60.0	63.9	73.1	86.0	96.8	104.0	113.0
21 to <30 years	1,359	84.9	58.7	63.0	66.2	70.7	81.2	94.0	103.0	111.0	123.0
30 to <40 years	1,445	87.0	61.1	65.7	68.7	73.8	84.0	96.5	104.0	110.0	124.0
40 to <50 years	1,545	90.5	64.9	69.5	73.0	77.7	87.4	99.7	109.0	114.0	125.0
50 to <60 years	1,189	89.5	64.1	68.8	71.4	77.0	87.8	99.8	107.0	112.0	123.0
60 to <70 years	1,360	89.1	63.4	67.5	71.6	77.2	86.9	99.4	108.0	113.0	120.0
70 to <80 years	1,079	83.9	60.6	64.6	68.3	73.1	82.1	93.8	98.6	104.0	113.0
Over 80 years	662	76.1	56.7	60.6	63.9	67.2	75.1	84.0	89.4	92.5	100.0

Source: U.S. EPA Analysis of NHANES 1999–2006 data.

Table 8-5. Mean and Percentile Body Weights (kg) for Female Derived from NHANES (1999−2006)											
Age Group	*N*	Mean	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	70	4.6	3.6	4.0	4.1	4.2	4.6	4.9	5.0	5.2	5.9
1 to <3 months	131	5.7	4.3	4.6	4.74	5.1	5.5	6.4	6.6	6.9	7.3
3 to <6 months	234	7.2	5.5	5.9	6.2	6.4	7.2	7.9	8.2	8.4	9.0
6 to <12 months	455	9.0	7.1	7.3	7.6	8.0	8.9	9.8	10.3	10.6	11.2
1 to <2 years	544	11.1	8.7	9.1	9.4	10.0	11.1	12.2	12.9	13.2	13.7
2 to <3 years	586	13.5	10.5	11.0	11.5	12.1	13.2	14.6	15.5	16.2	17.1
3 to <6 years	1,160	18.3	13.5	14.3	14.7	15.6	17.5	19.7	21.3	23.2	26.2
6 to <11 years	1,798	31.7	19.3	20.9	22.0	23.9	29.0	37.3	43.1	46.7	53.4
11 to <16 years	2,704	55.9	34.9	38.6	41.6	45.7	53.3	62.8	70.7	76.5	86.3
16 to <21 years	2,389	65.9	46.2	48.6	51.1	54.5	61.5	73.3	83.4	89.9	99.7
21 to <30 years	1,873	71.9	48.0	51.4	53.8	57.8	67.9	81.4	90.2	98.7	109.0
30 to <40 years	1,731	74.8	50.9	54.0	56.2	60.0	70.2	85.0	95.1	104.0	113.0
40 to <50 years	1,576	77.1	51.7	54.7	57.3	61.7	72.7	88.0	97.8	105.0	118.0
50 to <60 years	1,198	77.5	52.2	55.7	57.9	62.8	73.6	87.7	97.7	105.0	117.0
60 to <70 years	1,422	76.8	51.9	56.5	59.2	63.9	73.9	86.6	95.4	102.0	112.0
70 to <80 years	954	70.8	49.6	53.3	55.7	60.3	69.0	79.4	85.6	91.4	98.2
Over 80 years	768	64.1	45.5	48.7	51.3	54.9	62.8	71.8	77.0	80.5	89.1

Source: U.S. EPA Analysis of NHANES 1999−2006 data.

Table 8-6. Weight in Kilograms for Male 2 Months−21 Years of Age—Number Examined, Mean, and Selected Percentiles, by Age Category: United States, 1976–1980[a]

Age Group	Number of Persons Examined	Mean (kg)	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	-	-	-	-	-	-	-	-	-	-	-
1 to <2 months	-	-	-	-	-	-	-	-	-	-	-
2 to <3 months	103	6.6	5.3	5.5	5.7	5.9	6.8	7.2	7.6	7.8	8.4
3 to <6 months	287	7.7	6.3	6.6	6.7	7.0	7.7	8.4	8.9	9.2	9.6
6 to <12 months	589	9.4	7.5	7.9	8.1	8.6	9.4	10.2	10.6	10.9	11.4
1 to <2 years	613	11.7	9.4	9.8	10.1	10.8	11.7	12.6	13.1	13.7	14.5
2 to <3 years	627	13.7	11.4	11.8	12.2	12.6	13.6	14.6	15.2	15.8	16.5
3 to <6 years	1,556	18.0	13.7	14.6	14.9	15.7	17.5	19.7	21.0	22.0	24.0
6 to <11 years	1,373	30.7	19.5	21.1	22.1	24.0	28.5	35.2	40.5	43.5	48.7
11 to <16 years	1,037	55.2	34.0	36.5	38.7	42.8	53.0	63.0	69.4	74.8	84.3
16 to <21 years	890	71.8	54.1	56.6	58.3	61.8	68.7	77.9	84.3	89.7	101.0

[a] Includes clothing weight, estimated as ranging from 0.09 to 0.28 kg.
\- No data available for infants less than 2 months old.

Source: NCHS, 1987.

Table 8-7. Weight in Kilograms for Female 6 Months−21 Years of Age—Number Examined, Mean, and Selected Percentiles, by Age Category: United States, 1976−1980[a]

Age Group	Number of Persons Examined	Mean (kg)	Percentiles								
			5th	10th	15th	25th	50th	75th	85th	90th	95th
Birth to <1 month	-	-	-	-	-	-	-	-	-	-	-
1 to <2 months	-	-	-	-	-	-	-	-	-	-	-
2 to <3 months	131	6.0	4.7	5.1	5.2	5.6	6.0	6.5	7.1	7.3	7.8
3 to <6 months	269	7.1	5.8	5.9	6.1	6.4	7.1	7.7	7.9	8.4	8.7
6 to <12 months	574	8.8	7.2	7.5	7.7	8.0	8.7	9.4	10.1	10.4	10.8
1 to <2 years	617	11.0	9.1	9.4	9.6	9.9	10.9	11.9	12.6	12.9	13.4
2 to <3 years	597	13.4	10.8	11.2	11.6	12.1	13.2	14.6	15.4	15.6	16.3
3 to <6 years	1,658	18.0	13.3	14.0	14.5	15.4	17.2	19.7	21.1	22.6	25.1
6 to <11 years	1,321	30.6	19.0	20.5	21.3	23.4	28.9	35.0	39.6	44.3	50.2
11 to <16 years	1,144	53.2	34.1	37.2	40.4	45.2	51.6	60.0	67.2	70.6	78.2
16 to <21 years	1,001	62.2	46.7	48.2	49.7	52.2	58.9	68.3	74.7	80.8	92.6

[a] Includes clothing weight, estimated as ranging from 0.09 to 0.28 kg.
- No data available for infants less than 2 months old.

Source: NCHS, 1987.

Table 8-8. Statistics for Probability Plot Regression Analyses: Female Body Weights 6 Months to 70 Years of Age

Age Midpoint (years)	Lognormal Probability Plots Linear Curve	
	μ_2 [a]	σ_2 [a]
0.75	2.16	0.145
1.5	2.38	0.129
2.5	2.56	0.112
3.5	2.69	0.136
4.5	2.83	0.134
5.5	2.98	0.164
6.5	3.10	0.174
7.5	3.19	0.174
8.5	3.31	0.156
9.5	3.46	0.214
10.5	3.57	0.199
11.5	3.71	0.226
12.5	3.82	0.213
13.5	3.92	0.215
14.5	3.99	0.187
15.5	4.00	0.156
16.5	4.05	0.167
17.5	4.08	0.165
18.5	4.07	0.147
19.5	4.10	0.149
21.5	4.10	0.168
30	4.15	0.204
40	4.19	0.207
50	4.20	0.208
60	4.20	0.205
70	4.18	0.198

[a] Φ_2, σ_2—correspond to the mean and the standard deviation, respectively, of the logarithm of body weight (kg) for an age group.

Source: Burmaster and Crouch, 1997.

Table 8-9. Statistics for Probability Plot Regression Analyses: Male Body Weights 6 Months to 70 Years of Age

Age Midpoint (years)	Lognormal Probability Plots Linear Curve	
	μ_2[a]	σ_2[a]
0.75	2.23	0.131
1.5	2.46	0.120
2.5	2.60	0.120
3.5	2.75	0.114
4.5	2.87	0.133
5.5	2.98	0.138
6.5	3.13	0.145
7.5	3.21	0.151
8.5	3.33	0.181
9.5	3.43	0.165
10.5	3.59	0.195
11.5	3.69	0.252
12.5	3.78	0.224
13.5	3.88	0.215
14.5	4.02	0.181
15.5	4.09	0.159
16.5	4.20	0.168
17.5	4.19	0.167
18.5	4.25	0.159
19.5	4.26	0.154
21.5	4.29	0.163
30	4.35	0.163
40	4.38	0.165
50	4.38	0.166
60	4.35	0.157
70	4.29	0.174

[a] Φ_2, σ_2—correspond to the mean and the standard deviation, respectively, of the logarithm of body weight (kg) for an age group.

Source: Burmaster and Crouch, 1997.

Table 8-10. Body-Weight Estimates (kg) by Age and Sex, U.S. Population Derived from NHANES III (1988−1994)

Age Group	Sample Size	Population	Male and Female		Male		Female	
			Median	Mean	Median	Mean	Median	Mean
2 to 6 months	1,020	1,732,702	7.4	7.4	7.6	7.7	7.0	7.0
7 to 12 months	1,072	1,925,573	9.4	9.4	9.7	9.7	9.1	9.1
1 year	1,258	3,935,114	11.3	11.4	11.7	11.7	10.9	11.0
2 years	1,513	4,459,167	13.2	12.9	13.5	13.1	13.0	12.5
3 years	1,309	4,317,234	15.3	15.1	15.5	15.2	15.1	14.9
4 years	1,284	4,008,079	17.2	17.1	17.2	17.0	17.3	17.2
5 years	1,234	4,298,097	19.6	19.4	19.7	19.3	19.6	19.4
6 years	750	3,942,457	21.3	21.7	21.5	22.1	20.9	21.3
7 years	736	4,064,397	25.0	25.5	25.4	25.5	24.1	25.6
8 years	711	3,863,515	27.4	28.1	27.2	28.4	27.9	27.9
9 years	770	4,385,199	31.8	32.7	32.0	32.3	31.1	33.0
10 years	751	3,991,345	35.2	35.6	35.9	36.0	34.3	35.2
11 years	754	4,270,211	40.6	41.5	38.8	40.0	43.4	42.8
12 years	431	3,497,661	47.2	46.9	48.1	49.1	45.7	48.6
13 years	428	3,567,181	53.0	55.1	52.6	54.5	53.7	55.9
14 years	415	4,054,117	56.9	61.1	61.3	64.5	53.7	57.9
15 years	378	3,269,777	59.6	62.8	62.6	66.9	57.1	59.2
16 years	427	3,652,041	63.2	65.8	66.6	69.4	56.3	61.6
17 years	410	3,719,690	65.1	67.5	70.0	72.4	60.7	62.2
≥1 years	31,311	251,097,002	66.5	64.5	73.9	89.0	80.8	80.3
1 to 3 years	4,080	12,711,515	13.2	13.1	13.4	13.4	13.0	12.9
1 to 14 years	12,344	56,653,796	24.9	29.9	25.1	30.0	24.7	29.7
15 to 44 years	10,393	118,430,653	70.8	73.5	77.5	80.2	63.2	67.3

Source: U.S. EPA, 2000.

Table 8-11. Body-Weight Estimates (in kg) by Age, U.S. Population Derived From NHANES III (1988−1994)

Age Group (months)	Sample Size	Population	Male and Female		
			Median	Mean	95% CI
2	243	408,837	6.3	6.3	6.1−6.4
3	190	332,823	7.0	6.9	6.7−7.1
3 and younger	433	741,660	6.6	6.6	6.4−6.7

CI = Confidence Interval.

Source: U.S. EPA, 2000.

Table 8-12. Observed Mean, Standard Deviation, and Selected Percentiles for Weight (kg) by Sex and Age: Birth to 36 Months

Age Group (mo)	Mean	SD	Percentile					
			10th	25th	50th	75th	90th	95th
Boys								
Birth	3.4	0.6	2.7	3.1	3.4	3.8	4.1	4.3
0 to <1	-	-	-	-	-	-	-	-
1 to <2	-	-	-	-	-	-	-	-
2 to <3	6.5	0.8	5.6	5.8	6.7	6.9	7.4	7.5
3 to <4	7.0	0.9	5.9	6.5	7.0	7.5	8.2	8.5
4 to <5	7.2	0.8	6.3	6.7	7.2	7.7	8.0	8.4
5 to <6	7.9	0.9	6.7	7.5	7.8	8.6	9.4	9.6
6 to <7	8.4	1.1	7.3	7.6	8.4	9.0	10.2	10.7
7 to <8	8.6	1.1	7.1	7.8	8.6	9.5	10.1	10.4
8 to <9	9.3	1.1	7.9	8.6	9.2	10.1	10.5	11.0
9 to <10	9.3	0.9	8.2	8.6	9.3	10.0	10.8	10.9
10 to <11	9.5	1.1	8.3	8.7	9.3	10.1	11.3	11.5
11 to <12	10.0	1.0	8.7	9.5	10.0	10.6	11.1	11.6
12 to <15	10.6	1.2	9.2	9.8	10.6	11.3	12.1	12.4
15 to < 8	11.4	1.9	9.9	10.5	11.3	12.0	12.8	13.5
18 to <21	12.1	1.5	10.4	11.0	11.9	12.7	13.9	15.5
21 to <24	12.4	1.3	10.9	11.6	12.4	13.1	14.4	14.7
24 to <30	13.1	1.7	11.3	12.1	12.9	14.1	15.1	15.9
30 to <36	14.0	1.5	12.0	13.0	13.8	14.7	16.0	16.6
Girls								
Birth	3.3	0.5	2.6	3.0	3.3	3.6	3.9	4.1
0 to <1	-	-	-	-	-	-	-	-
1 to <2	-	-	-	-	-	-	-	-
2 to <3	5.4	0.5	4.8	5.0	5.6	5.9	6.0	-
3 to <4	6.3	0.7	5.6	5.8	6.3	6.8	7.4	7.8
4 to <5	6.7	0.9	5.8	6.1	6.6	7.4	8.0	8.3
5 to <6	7.3	0.9	6.3	6.7	7.1	7.7	8.5	8.8
6 to <7	7.7	0.8	6.6	7.1	7.6	8.1	8.9	9.0
7 to <8	8.0	1.4	6.7	7.4	7.8	8.6	9.4	9.8
8 to <9	8.3	0.9	7.3	7.8	8.3	8.9	9.4	9.8
9 to <10	8.9	0.9	7.8	8.1	8.7	9.4	10.1	10.5
10 to <11	9.0	1.1	7.8	8.4	9.0	9.5	10.4	10.9
11 to <12	9.3	1.0	7.9	8.6	9.2	10.1	10.6	10.9
12 to <15	9.8	1.1	8.5	9.1	9.8	10.4	11.3	11.6
15 to <18	10.4	1.1	9.1	9.7	10.3	11.2	11.8	12.0
18 to <21	11.1	1.4	9.6	10.2	11.0	11.9	12.8	13.5
21 to <24	11.8	1.3	10.1	10.9	11.8	12.8	13.5	13.9
24 to <30	12.5	1.5	10.8	11.5	12.4	13.3	14.5	15.1
30 to <36	13.6	1.7	11.8	12.5	13.4	14.52	15.7	16.4

\- No data available.

Source: Kuczmarski et al., 2002.

Table 8-13. Estimated Distribution of Body Weight by Fine Age Categories All Individuals, Male and Female Combined (kg)

Ages (years)	Sample Size	Population	Mean	Percentiles					
				10th	25th	50th	75th	90th	95th
<0.5	744	1,890,461	6	3	4	6	7	8	9
0.5 to 0.9	678	1,770,700	9	7	8	9	10	11	12
1 to 3	3,645	11,746,146	14	10	11	13	16	18	19
4 to 6	2,988	11,570,747	21	16	17	20	22	26	28
7 to 10	1,028	14,541,011	32	22	26	29	36	43	48
11 to 14	790	15,183,156	51	35	42	50	58	68	79
15 to 19	816	17,825,164	67	50	56	63	73	85	99
20 to 24	676	18,402,877	72	53	59	68	81	94	104
25 to 54	4,830	111,382,877	77	54	63	75	86	100	109
55 to 64	1,516	20,691,260	77	57	65	75	87	99	105
65+	2,139	30,578,210	72	54	62	71	81	93	100
		Summary Data							
20 +	9,161	181,055,224	76	54	63	73	86	98	107
<2	2,424	7,695,535	10	5	7	10	11	13	14
2 to 15	7,449	49,006,686	33	15	19	28	43	56	63
15+	9,977	198,880,388	75	54	61	72	84	97	106
<6	7,530	23,160,174	15	8	11	14	18	21	23
6 to 15	2,343	33,542,047	40	22	27	36	50	59	68
All ages	**19,850**	**255,582,609**	**65**	**22**	**52**	**67**	**81**	**95**	**104**

Note: 757 individuals did not report body weight. They represent 6,314,627 individuals in the population.

Source: U.S. EPA, 2004 (based on 1994−1996, 1998 USDA CSFII).

Table 8-14. Mean Body Weight (kg) by Age and Sex Across Multiple Surveys

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			NHANES, 1999−2002		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
Male															
2	-	-	-	-	-	-	370	13.4	0.1	644	13.6	0.1	262	13.7	0.1
3	-	-	-	-	-	-	421	15.5	0.1	516	15.8	0.2	216	15.9	0.2
4	-	-	-	-	-	-	405	17.6	0.1	549	17.6	0.2	179	18.5	0.2
5	-	-	-	-	-	-	393	19.7	0.1	497	20.1	0.2	147	21.3	0.5
6	575	22.0	0.1	-	-	-	146	22.8	0.4	283	23.2	0.6	182	23.5	0.4
7	632	24.7	0.2	-	-	-	150	24.9	0.4	269	26.3	0.4	185	27.2	0.4
8	618	27.8	0.2	-	-	-	145	28.0	0.6	266	30.2	0.8	214	32.7	1.0
9	603	31.2	0.4	-	-	-	141	30.7	0.6	281	34.4	1.0	174	36.0	0.7
10	576	33.7	0.3	-	-	-	165	36.2	0.7	297	37.3	0.9	187	38.6	0.8
11	595	38.2	0.3	-	-	-	153	39.7	0.9	281	42.5	0.9	182	43.7	1.1
12	-	-	-	643	42.9	0.4	147	44.1	1.0	203	49.1	1.1	299	50.4	1.3
13	-	-	-	626	50.0	0.5	165	49.5	1.2	187	54.0	1.0	298	53.9	1.9
14	-	-	-	618	56.7	0.6	188	56.4	0.9	188	64.1	3.6	266	63.9	1.6
15	-	-	-	613	61.6	0.4	180	61.2	1.0	187	66.9	1.9	283	68.3	1.1
16	-	-	-	556	64.8	0.6	180	66.5	1.2	194	68.7	1.6	306	74.4	1.4
17	-	-	-	458	68.1	0.4	183	66.7	0.8	196	72.9	1.3	313	75.6	1.4
18	-	-	-	-	-	-	156	71.1	1.2	176	71.3	1.7	284	75.6	1.1
19	-	-	-	-	-	-	150	71.8	0.8	168	73.0	2.2	270	78.2	1.3
20 to 29	-	-	-	-	-	-	1,261	76.3	0.5	1,638	78.4	0.6	712	83.4	0.7
30 to 39	-	-	-	-	-	-	871	79.8	0.4	1,468	82.9	0.9	704	86.0	0.9
40 to 49	-	-	-	-	-	-	695	81.7	0.5	1,220	85.1	0.8	776	89.1	0.7
50 to 59	-	-	-	-	-	-	691	80.0	0.6	851	86.0	0.5	598	88.8	0.9
60 to 74	-	-	-	-	-	-	2,086	76.1	0.5	1,683	82.2	0.5	1,001	87.1	0.6
75+	-	-	-	-	-	-	-	-	-	895	75.4	0.7	523	78.5	0.6

Table 8-14. Mean Body Weight (kg) by Age and Sex Across Multiple Surveys (continued)

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			NHANES, 1999−2002		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
Female															
2	-	-	-	-	-	-	330	12.8	0.1	624	13.2	0.1	248	13.3	0.1
3	-	-	-	-	-	-	367	14.8	0.1	587	15.4	0.1	178	15.2	0.2
4	-	-	-	-	-	-	388	16.8	0.2	537	17.9	0.3	191	17.9	0.3
5	-	-	-	-	-	-	369	19.4	0.3	554	20.2	0.2	186	20.6	0.6
6	536	21.5	0.2	-	-	-	150	21.9	0.4	272	22.6	0.6	171	22.4	0.5
7	609	24.2	0.2	-	-	-	154	24.6	0.5	274	26.4	0.8	196	25.9	0.5
8	613	27.5	0.2	-	-	-	125	27.5	0.4	248	29.9	0.6	184	31.9	1.2
9	581	31.4	0.4	-	-	-	154	31.7	0.7	280	34.4	1.2	183	35.4	0.7
10	584	35.2	0.4	-	-	-	128	35.7	0.6	258	37.9	1.2	164	40.0	1.0
11	525	39.8	0.4	-	-	-	143	41.4	0.9	275	44.1	1.1	194	47.9	1.3
12	-	-	-	547	46.6	0.4	146	46.1	0.9	236	49.0	1.2	316	52.0	1.1
13	-	-	-	582	50.5	0.5	155	50.9	1.2	220	55.8	1.6	321	57.7	1.4
14	-	-	-	586	54.2	0.4	181	54.3	1.0	218	58.5	1.4	324	59.9	1.0
15	-	-	-	503	56.5	0.5	144	55.0	0.8	191	58.1	1.1	266	61.1	1.7
16	-	-	-	536	58.1	0.7	167	57.7	0.9	208	61.3	1.4	273	63.0	1.2
17	-	-	-	442	57.6	0.6	134	59.6	1.0	201	62.4	1.2	256	61.7	1.2
18	-	-	-	-	-	-	156	59.0	1.0	175	61.2	1.9	243	65.2	1.5
19	-	-	-	-	-	-	158	59.8	1.0	177	63.2	1.9	225	67.9	1.2
20 to 29	-	-	-	-	-	-	1,290	61.7	0.5	1,663	64.4	0.6	656	71.1	0.9
30 to 39	-	-	-	-	-	-	964	66.1	0.6	1,773	70.2	0.8	699	74.1	0.9
40 to 49	-	-	-	-	-	-	765	67.6	0.6	1,355	71.6	0.8	787	76.5	1.1
50 to 59	-	-	-	-	-	-	793	68.4	0.6	996	74.3	0.8	593	76.9	1.1
60 to 74	-	-	-	-	-	-	2,349	66.8	0.4	1,674	70.1	0.5	1,010	74.9	0.6
75+	-	-	-	-	-	-	-	-	-	1,022	63.4	0.6	554	66.6	0.9

- = Data not available.
N = Number of individuals.
SE = Standard error.

Source: Ogden et al., 2004.

Table 8-15. Mean Height (cm) by Age and Sex Across Multiple Surveys

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			NHANES, 1999−2002		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
Male															
2	-	-	-	-	-	-	350	91.1	0.2	589	90.9	0.2	254	91.2	0.3
3	-	-	-	-	-	-	421	98.7	0.3	513	98.8	0.3	222	98.6	0.3
4	-	-	-	-	-	-	405	105.5	0.4	551	105.2	0.4	183	106.5	0.4
5	-	-	-	-	-	-	393	112.3	0.3	497	112.3	0.3	156	113.0	0.5
6	575	118.9	0.2	-	-	-	146	119.1	0.5	283	118.9	0.7	188	119.2	0.5
7	632	124.5	0.3	-	-	-	150	124.5	0.5	270	125.9	0.6	187	126.2	0.6
8	618	130.0	0.3	-	-	-	145	129.6	0.7	269	131.3	0.6	217	132.5	0.7
9	603	135.5	0.4	-	-	-	141	135.0	0.6	280	137.7	0.7	177	138.1	0.4
10	576	140.2	0.3	-	-	-	165	141.3	0.6	297	142.0	1.1	188	141.4	0.6
11	595	145.5	0.3	-	-	-	153	145.5	0.6	285	147.4	0.7	187	148.7	0.9
12	-	-	-	643	152.3	0.4	147	152.5	0.7	207	155.5	1.1	301	154.8	0.7
13	-	-	-	626	159.8	0.4	165	158.3	0.8	190	161.6	0.8	298	160.1	0.8
14	-	-	-	618	166.7	0.5	188	166.8	0.6	191	169.0	0.9	267	168.5	0.9
15	-	-	-	613	171.4	0.3	180	171.2	0.7	188	172.8	1.0	287	173.8	0.6
16	-	-	-	556	174.3	0.4	180	173.4	0.5	197	175.0	0.9	310	175.3	0.6
17	-	-	-	458	175.6	0.4	183	174.8	0.5	196	176.5	0.9	317	175.3	0.6
18	-	-	-	-	-	-	156	177.3	0.6	176	177.3	1.0	289	176.4	0.7
19	-	-	-	-	-	-	150	176.1	0.5	169	175.5	0.6	275	176.7	0.6
20 to 29	-	-	-	-	-	-	1,261	177.1	0.3	1,639	176.1	0.3	724	176.7	0.3
30 to 39	-	-	-	-	-	-	871	176.3	0.3	1,468	176.6	0.3	717	176.4	0.3
40 to 49	-	-	-	-	-	-	695	175.9	0.3	1,220	176.3	0.3	784	177.2	0.3
50 to 59	-	-	-	-	-	-	691	174.7	0.3	851	175.8	0.3	601	175.8	0.3
60 to 74	-	-	-	-	-	-	2,086	172.1	0.2	1,684	173.6	0.2	1,010	174.4	0.3
75+	-	-	-	-	-	-	-	-	-	895	170.7	0.3	505	171.3	0.4

Table 8-15. Mean Height (cm) by Age and Sex Across Multiple Surveys (continued)

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES II, 1976−1980			NHANES III, 1988−1994			NHANES, 1999−2002		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
Female															
2	-	-	-	-	-	-	314	89.4	0.3	564	89.7	0.2	233	90.1	0.4
3	-	-	-	-	-	-	367	97.1	0.2	590	98.2	0.2	187	97.6	0.5
4	-	-	-	-	-	-	388	104.2	0.4	535	105.1	0.3	195	105.9	0.5
5	-	-	-	-	-	-	369	111.2	0.4	557	112.2	0.5	190	112.4	0.7
6	536	117.8	0.3	-	-	-	150	117.9	0.6	274	117.9	0.6	172	117.1	0.7
7	609	123.5	0.2	-	-	-	154	123.4	0.7	275	124.3	0.7	200	124.4	0.5
8	613	129.4	0.3	-	-	-	125	129.5	0.5	247	131.1	0.6	184	130.9	0.6
9	581	135.5	0.3	-	-	-	154	134.1	0.5	282	136.6	0.7	189	136.9	0.7
10	584	140.9	0.3	-	-	-	128	141.7	0.6	262	142.7	0.6	164	143.3	0.9
11	525	147.3	0.3	-	-	-	143	147.4	0.7	275	150.2	0.7	194	151.4	0.7
12	-	-	-	547	46.6	0.3	146	143.8	0.6	239	155.5	0.7	318	156.0	0.7
13	-	-	-	582	50.5	0.3	155	158.7	0.5	225	159.9	0.9	324	159.1	0.6
14	-	-	-	586	54.2	0.3	181	160.7	0.7	224	161.2	0.7	326	161.8	0.6
15	-	-	-	503	56.5	0.5	144	163.3	0.5	195	162.8	0.6	271	162.0	0.6
16	-	-	-	536	58.1	0.3	167	162.8	0.5	214	163.0	0.7	275	161.9	0.5
17	-	-	-	442	57.6	0.3	134	163.5	0.6	201	163.6	0.6	258	163.2	0.6
18	-	-	-	-	-	-	156	162.8	0.5	175	163.2	0.9	249	163.0	0.5
19	-	-	-	-	-	-	158	163.2	0.4	178	163.4	0.7	231	163.1	0.7
20 to 29	-	-	-	-	-	-	1,290	163.3	0.2	1,665	162.8	0.2	663	162.8	0.3
30 to 39	-	-	-	-	-	-	964	163.1	0.2	1,776	163.4	0.3	708	163.0	0.3
40 to 49	-	-	-	-	-	-	765	162.3	0.3	1,354	162.8	0.3	794	163.4	0.2
50 to 59	-	-	-	-	-	-	793	160.5	0.3	998	161.8	0.3	601	162.3	0.3
60 to 74	-	-	-	-	-	-	2,349	158.8	0.2	1,680	159.8	0.2	1,004	160.0	0.2
75+	-	-	-	-	-	-	-	-	-	1,025	156.2	0.4	538	157.4	0.3

\- = Data not available.
N = Number of individuals.
SE = Standard error.

Source: Ogden et al., 2004.

Table 8-16. Mean Body Mass Index (kg/m^2) by Age and Sex Across Multiple Surveys

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES I, 1971−1974			NHANES II, 1976−1980			NHANES III, 1988−1994			NHANES, 1999−2002		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
Male																		
2	-	-	-	-	-	-	298	16.3	0.1	350	16.2	0.1	588	16.5	0.1	225	16.6	0.1
3	-	-	-	-	-	-	308	16.0	0.1	421	15.9	0.1	512	16.1	0.2	209	16.2	0.1
4	-	-	-	-	-	-	304	15.7	0.1	405	15.8	0.1	547	15.9	0.1	178	16.3	0.2
5	-	-	-	-	-	-	273	15.6	0.1	393	15.6	0.1	495	15.9	0.1	147	16.5	0.3
6	575	15.6	0.1	-	-	-	179	15.7	0.2	146	16.0	0.2	282	16.3	0.3	182	16.4	0.2
7	632	15.9	0.1	-	-	-	164	15.8	0.2	150	16.0	0.2	269	16.5	0.2	185	17.0	0.2
8	618	16.3	0.1	-	-	-	152	15.8	0.2	145	16.5	0.2	266	17.3	0.4	214	18.4	0.4
9	603	16.9	0.2	-	-	-	169	17.1	0.3	141	16.8	0.2	279	18.0	0.7	174	18.7	0.3
10	576	17.1	0.1	-	-	-	184	17.3	0.2	165	18.0	0.3	297	18.4	0.3	187	19.1	0.3
11	595	17.9	0.1	-	-	-	178	18.0	0.3	153	18.6	0.3	280	19.4	0.3	182	19.6	0.4
12	-	-	-	643	18.4	0.1	200	18.7	0.2	147	18.8	0.3	203	20.1	0.3	299	20.7	0.4
13	-	-	-	626	19.4	0.1	174	19.6	0.3	165	19.5	0.4	187	20.5	0.3	298	20.7	0.5
14	-	-	-	618	20.2	0.2	174	20.2	0.3	188	20.2	0.2	188	22.3	1.1	266	22.3	0.4
15	-	-	-	613	20.9	0.1	171	20.5	0.3	180	20.8	0.3	187	22.3	0.5	283	22.5	0.3
16	-	-	-	556	21.3	0.1	169	21.8	0.3	180	22.0	0.3	194	22.3	0.5	306	24.1	0.4
17	-	-	-	458	22.1	0.1	176	21.9	0.3	183	21.8	0.2	196	23.4	0.4	313	24.5	0.4
18	-	-	-	-	-	-	124	23.7	0.3	156	22.6	0.4	176	22.6	0.5	284	24.2	0.3
19	-	-	-	-	-	-	136	23.3	0.5	150	23.1	0.3	168	23.7	0.6	269	24.9	0.4
20 to 29	-	-	-	-	-	-	986	24.5	0.1	1,261	24.3	0.1	1,638	25.2	0.2	712	26.6	0.2
30 to 39	-	-	-	-	-	-	654	26.1	0.2	871	25.6	0.1	1,468	26.5	0.2	704	27.5	0.3
40 to 49	-	-	-	-	-	-	715	26.2	0.2	695	26.4	0.2	1,220	27.3	0.2	774	28.4	0.3
50 to 59	-	-	-	-	-	-	717	26.0	0.2	691	26.2	0.2	851	27.8	0.2	594	28.7	0.3
60 to 74	-	-	-	-	-	-	1,920	25.4	0.1	2,086	25.7	0.1	1,683	27.2	0.2	991	28.6	0.2
75+	-	--	-	--	-	-	-	-	-	-	-	-	895	25.9	0.2	487	26.8	0.2

Table 8-16. Mean Body Mass Index (kg/m^2) by Age and Sex Across Multiple Surveys (continued)

Sex and Age (years)	NHES II, 1963−1965			NHES III, 1966−1970			NHANES I, 1971−1974			NHANES II, 1976−1980			NHANES III, 1988−1994			NHANES, 1999−2002		
	N	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
Female																		
2	-	-	-	-	-	-	272	15.9	0.1	314	16.1	0.1	562	16.5	0.1	214	16.4	0.1
3	-	-	-	-	-	-	292	15.7	0.1	367	15.6	0.1	582	15.9	0.1	173	16.0	0.1
4	-	-	-	-	-	-	281	15.5	0.1	388	15.5	0.1	533	16.0	0.2	190	15.9	0.2
5	-	-	-	-	-	-	314	15.5	0.1	369	15.6	0.1	554	15.9	0.1	186	16.1	0.3
6	536	115.4	0.1	-	-	-	176	15.4	0.1	150	15.6	0.2	272	16.1	0.3	170	16.2	0.2
7	609	15.8	0.1	-	-	-	169	15.6	0.2	154	16.1	0.2	274	16.9	0.3	196	16.6	0.2
8	613	16.4	0.1	-	-	-	152	16.4	0.2	125	16.3	0.2	247	17.3	0.3	184	18.3	0.5
9	581	17.0	0.1	-	-	-	171	17.2	0.2	154	17.5	0.3	280	18.2	0.5	183	18.7	0.3
10	584	17.6	0.2	-	-	-	197	17.1	0.2	128	17.7	0.3	258	18.4	0.4	163	19.3	0.3
11	525	18.2	0.2	-	-	-	166	18.6	0.3	143	18.9	0.3	275	19.4	0.4	194	20.7	0.4
12	-	-	-	547	19.2	0.1	177	19.5	0.4	146	19.3	0.3	236	20.2	0.5	315	21.2	0.4
13	-	-	-	582	19.9	0.1	198	20.4	0.3	155	20.1	0.4	220	21.8	0.6	321	22.6	0.4
14	-	-	-	586	20.8	0.1	184	21.1	0.3	181	21.0	0.3	218	22.4	0.5	324	22.9	0.4
15	-	-	-	503	21.4	0.2	167	21.1	0.3	144	20.6	0.3	191	21.9	0.4	266	23.2	0.5
16	-	-	-	536	21.9	0.2	171	21.7	0.3	167	21.8	0.3	208	23.0	0.5	273	24.0	0.4
17	-	-	-	442	21.7	0.2	150	22.6	0.5	134	22.3	0.4	201	23.3	0.5	255	23.1	0.4
18	-	-	-	-	-	-	141	21.5	0.3	156	22.3	0.4	175	22.9	0.6	243	24.4	0.5
19	-	-	-	-	-	-	130	22.5	0.6	158	22.4	0.3	177	23.7	0.8	225	25.5	0.4
20 to 29	-	-	-	-	-	-	2,122	23.0	0.1	1,290	23.1	0.2	1,663	24.3	0.2	654	26.8	0.3
30 to 39	-	-	-	-	-	-	1,654	24.7	0.2	964	24.9	0.2	1,773	26.3	0.3	698	27.9	0.3
40 to 49	-	-	-	-	-	-	1,232	25.7	0.2	765	25.7	0.2	1,354	27.1	0.3	783	28.6	0.4
50 to 59	-	-	-	-	-	-	780	26.2	0.2	793	26.5	0.2	996	28.4	0.3	591	29.2	0.4
60 to 74	-	-	-	-	-	-	2,131	26.5	0.2	2,349	26.5	0.1	1,673	27.4	0.2	993	29.2	0.2
75+	-	-	-	-	-	-	-	-	-	-	-	-	1,021	25.9	0.2	524	26.8	0.4

- = Data not available.
N = Number of individuals.
SE = Standard error.

Source: Ogden et al., 2004.

Table 8-17. Sample Sizes by Age, Sex, Race, and Examination

Age Group (years)	Sex	Race[a]	NHANES Examination		
			II (1976−1980)	III (1988−1994)	1999−2002
Overall (2 to 17)			6,395 (10.6)[b]	9,610 (9.9)	6,710 (10.1)
2 to 5	Boys	White	1,082 (4.1)	605 (4.0)	226 (3.9)
		Black	273 (4.1)	693 (3.9)	234 (4.0)
		Mexican American	105 (4.2)	732 (4.0)	231 (3.9)
	Girls	White	1,028 (4.0)	639 (4.0)	235 (4.1)
		Black	234 (4.0)	684 (3.9)	222 (4.0)
		Mexican American	102 (4.2)	800 (3.9)	238 (4.1
6 to 11	Boys	White	667 (9.0)	446 (8.9)	298 (8.9)
		Black	137 (9.0)	584 (9.0)	371 (9.0)
		Mexican American	60 (9.2)	565 (9.0)	384 (9.0)
	Girls	White	631 (9.1)	428 (9.1)	293 (8.9)
		Black	155 (9.0)	538 (9.0)	363 (9.1)
		Mexican American	40 (9.3)	581 (8.9)	361 (9.0)
12 to 17	Boys	White	786 (15.1)	282 (14.9)	449 (14.9)
		Black	155 (15.1)	412 (15.0)	543 (14.9)
		Mexican American	49 (15.0)	406 (15.0)	648 (15.0)
	Girls	White	695 (15.1)	344 (15.0)	456 (14.9)
		Black	159 (15.0)	450 (14.9)	528 (14.8)
		Mexican American	37 (15.2)	421 (14.8)	631 (14.9)
20 to 39	Male	White	-	-	607
		Black	-	-	279
		Mexican American	-	-	399
	Female	White	-	-	569
		Black	-	-	298
		Mexican American	-	-	358
40 to 59	Male	White	-	-	676
		Black	-	-	289
		Mexican American	-	-	310
	Female	White	-	-	632
		Black	-	-	297
		Mexican American	-	-	332
60 and over[c]	Male	White	-	-	866
		Black	-	-	256
		Mexican American	-	-	318
	Female	White	-	-	862
		Black	-	-	275
		Mexican American	-	-	329

[a] Race was recorded in the 1st two examinations (using data concerning ancestry/national origin) to create comparable categories in all surveys.

[b] Mean ages are shown in parentheses. There are no mean ages available for the older age group data (ages 20 and above).

[c] Data from Ogden et al., 2004.

\- No data available.

Sources: Freeman et al., 2006; Ogden et al., 2004.

Table 8-18. Mean BMI (kg/m²) Levels and Change in the Mean *Z*-Scores by Race-Ethnicity and Sex (Ages 2 to 17)

	Race	Examination Year[a]				Increase in Mean *z*-score from 1971−1974 to 1999−2002		
		1971−1974	1976−1980	1988−1994	1999−2002	BMI	Weight	Height
Overall	White	18.0[b]	18.0	18.8	19.0	+0.33	+0.36	+0.20
	Black	17.8	18.2	19.1	20.0	+0.61	+0.63	+0.31
	Mexican American	18.6	18.8	19.5	20.1	+0.32	+0.52	+0.39
Sex								
Boys	White	17.9	18.0	18.8	19.0	+0.37	+0.42	+0.25
	Black	17.7	17.8	18.8	19.6	+0.53	+0.58	+0.32
	Mexican American	18.6	18.9	19.4	20.3	+0.38	+0.67	+0.57
Girls	White	18.0	18.0	18.7	19.0	+0.30	+0.32	+0.16
	Black	17.9	18.6	19.5	20.4	+0.71	+0.69	+0.30
	Mexican American	18.5	18.6	19.6	19.9	+0.25	+0.35	+0.21
Age (years)								
2 to 5	White	15.8	15.7	16.0	16.2	+0.21	+0.22	+0.13
	Black	15.8	15.7	15.9	16.2	+0.34	+0.32	+0.18
	Mexican American	16.5	16.2	16.5	16.5	-0.02	+0.29	+0.43
6 to 11	White	16.7	16.9	17.6	17.9	+0.42	+0.47	+0.30
	Black	16.5	17.1	17.9	18.7	+0.67	+0.69	+0.36
	Mexican American	16.9	17.7	18.5	18.8	+0.50	+0.65	+0.41
12 to 17	White	20.7	20.6	21.8	22.0	+0.32	+0.35	+0.15
	Black	20.4	20.9	22.4	23.7	+0.72	+9,77	+0.33
	Mexican American	21.6	21.5	22.6	24.0	+0.37	+0.55	+0.34

[a] Secular trends for BMI, BMI-for-age, weight-for-age, and height-for-age were each statistically significant at the 0.001 level. Trends in BMI, BMI-for-age, and weight also differed ($p < 0.001$) by race.

[b] Mean BMI levels have been adjusted for differences in age and sex across exams.

Source: Freedman et al., 2006.

Table 8-19. Mean Body Mass Index (kg/m^2) by Survey, Sex, Race/Ethnicity, and Age Group; Adults: United States									
	HHANES, 1982−1984			NHANES III, 1988−1994			NHANES, 1999−2002		
Sex, Race/Ethnicity, and Age (years)	Sample Size	Mean	Standard Error of the Mean	Sample Size	Mean	Standard Error of the Mean	Sample Size	Mean	Standard Error of the Mean
Male									
Non-Hispanic White:[a]									
20 and over	-	-	-	3,152	26.8	0.1	2,116	27.9	0.2
20 to 39	-	-	-	846	25.9	0.2	607	27.1	0.2
40 to 59	-	-	-	842	27.6	0.2	673	28.7	0.3
60 and over	-	-	-	1,464	27.0	0.1	836	28.3	0.1
Non-Hispanic Black:									
20 and over[a]	-	-	-	2,091	26.6	0.1	820	27.5	0.2
20 to 39 yr[a]	-	-	-	985	26.3	0.2	279	27.1	0.3
40 to 59	-	-	-	583	27.1	0.2	289	27.7	0.4
60 and over[a]	-	-	-	523	26.4	0.3	252	28.0	0.3
Mexican American:[a]									
20 and over	-	-	-	2,229	27.3	0.1	1,018	28.0	0.2
20 to 74	2,273	26.2	0.2	2,127	27.3	0.1	959	28.1	0.2
20 to 39	1,133	25.6	0.3	1,143	26.1	0.2	399	27.1	0.3
40 to 59	856	26.9	0.1	558	28.6	0.2	309	28.9	0.3
60 to 74	284	26.3	0.2	426	27.4	0.3	251	28.6	0.3
60 and over	-	-	-	528	27.1	0.3	310	28.1	0.3
Female									
Non-Hispanic white:[a]									
20 and over	-	-	-	3,554	26.1	0.2	2,026	27.6	0.2
20 to 39	-	-	-	1,030	24.7	0.2	567	26.7	0.3
40 to 59	-	-	-	950	27.2	0.3	629	28.3	0.4
60 and over	-	-	-	1,574	26.7	0.2	830	28.2	0.2
Non-Hispanic Black:[a]									
20 and over	-	-	-	2,451	29.1	0.2	863	31.1	0.3
20 to 39	-	-	-	1,191	27.6	0.3	298	30.2	0.5
40 to 59	-	-	-	721	30.4	0.3	294	32.1	0.5
60 and over	-	-	-	539	29.4	0.4	271	31.1	0.6
Mexican American:									
20 and over	-	-	-	2,106	28.4	0.2	1,012	29.0	0.3
20 to 74[a]	3,039	27.1	0.1	2,013	28.5	0.2	960	29.1	0.3
20 to 39[a]	1,482	25.6	0.2	1,063	27.2	0.2	358	27.8	0.4
40–to 59[a]	1,159	28.2	0.2	557	29.7	0.3	332	30.4	0.5
60 to 74[a]	398	28.1	0.3	393	29.2	0.4	270	29.5	0.3
60 and over	-	-	-	486	28.7	0.4	322	28.9	0.4

[a] Statistically significant trend or difference $p < 0.05$ for all years available.

\- Data not available.

Notes: BMI is calculated as weight in kilograms divided by square of height in meters. HHANES: Hispanic Health and Nutrition Examination Survey.

Source: Ogden et al., 2004.

Table 8-20. Prevalence of Overweight and Obesity[a] Among Children

			Examination Year				Increase in Prevalence from 1971−1974 to 1999−2002	
			1971−1974	1976−1980	1988−1994	1999−2002	Overweight	Obesity
Overall		White	5% (1)[b]	5% (1)	9% (2)	12% (3)	+8	+2
		Black	6% (1)	7% (2)	12% (3)	18% (5)	+12	+4
		Mexican American	8% (1)	10% (1)	14% (4)	21% (5)	+12	+4
Sex								
	Boys	White	5% (1)	5% (1)	10% (2)	13% (4)	+8	+3
		Black	6% (2)	5% (1)	11% (3)	16% (5)	+10	+3
		Mexican American	8% (1)	12% (1)	15% (4)	24% (4)	+16	+6
	Race Girls	White	5% (1)	5% (1)	9% (2)	12% (2)	+7	+1
		Black	6% (1)	9% (2)	14% (3)	21% (6)	+14	+5
		Mexican American	8% (2)	7% (0)	14% (3)	17% (4)	+9	+2
Age (yr)								
	2 to 5	White	4% (1)	3% (1)	5% (1)	9% (3)	+5	+2
		Black	7% (3)	4% (0)	8% (3)	9% (4)	+2	+1
		Mexican American	10% (5)	11% (3)	12% (5)	13% (5)	+3	0
	6 to 11	White	4% (0)	6% (1)	11% (3)	13% (4)	+10	+3
		Black	4% (0)	9% (3)	15% (3)	20% (5)	+15	+4
		Mexican American	6% (0)	11% (0)	17% (4)	22% (5)	+16	+5
	12 to 17	White	6% (1)	4% (0)	11% (2)	13% (2)	+7	+1
		Black	8% (1)	8% (1)	13% (3)	22% (6)	+14	+5
		Mexican American	9% (0)	8% (1)	14% (2)	25% (5)	+15	+5

[a] Overweight is defined as a BMI ≥95th percentile or ≥30 kg/m²; obesity is defined as a BMI ≥99th percentile or ≥40 kg/m².
[b] Values are percentage of overweight children (percentage of obese children).

Source: Freedman et al., 2006.

Table 8-21. Numbers of Live Births by Weight and Percentages of Live Births with Low and Very Low Birth Weights, by Race, and Hispanic Origin of Mother: United States, 2005				
	All Races[a]	Non-Hispanic White[b]	Non-Hispanic Black[b]	Hispanic[c]
Total Births	4,138,349	2,279,768	583,759	985,505
Weight (g)	Number of Live Births			
<500	6,599	2,497	2,477	1,212
500−999	23,864	10,015	8,014	4,586
1,000−1,499	31,325	14,967	8,573	5,988
1,500−1,999	66,453	33,687	15,764	12,710
2,000−2,499	210,324	104,935	46,846	43,300
2,500−2,999	748,042	364,726	144,803	176,438
3,000−3,499	1,596,944	857,136	221,819	399,295
3,500−3,999	1,114,887	672,270	108,698	266,338
4,000−4,499	289,098	167,269	22,149	64,704
4,500−4,999	42,119	27,541	3,203	9,167
>5,000	4,715	2,840	405	1,174
Not stated	3,979	1,885	1,008	593
	% of Total			
Low Birth Weight[d]	8.2	7.3	14.0	6.9
Very Low Birth Weight[e]	1.5	1.2	3.3	1.2

a All Races includes White, Black, and races other than White and Black and origin not stated.
b Race categories are consistent with the 1977 Office of Management and Budget standards.
c Hispanic includes all persons of Hispanic origin of any race.
d Low birth weight is birth weight less than 2,500 g (5 lb 8 oz).
e Very low birth weight is birth weight less than 1,500 g (3 lb 4 oz).

Source: Martin et al., 2007.

Table 8-22. Estimated Mean Body Weights of Male and Female by Single-Year Age Groups Using NHANES II Data

Age Group[a] (years)	Male (kg)			Female (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
0 to 1	9.4	1.3	179	8.8	1.3	177	9.1	1.2	356
1 to 2	11.8	1.6	370	10.8	1.4	336	11.3	1.5	706
2 to 3	13.6	1.8	375	13.0	1.5	336	13.3	1.6	711
3 to 4	15.6	1.9	418	14.9	2.1	366	15.2	1.8	784
4 to 5	17.8	2.4	404	17.0	2.3	396	17.4	2.4	800
5 to 6	19.8	2.8	397	19.6	3.2	364	19.7	2.8	761
6 to 7	23.0	3.7	133	22.1	3.9	135	22.5	3.6	268
7 to 8	25.1	3.8	148	24.7	4.6	157	24.8	3.8	305
8 to 9	28.2	5.6	147	27.8	4.8	123	28.1	5.6	270
9 to 10	31.1	5.8	145	31.8	7.3	149	31.4	5.9	294
10 to 11	36.4	7.2	157	36.1	7.7	136	36.2	7.1	293
11 to 12	40.2	9.8	155	41.8	10.1	140	41.0	9.9	295
12 to 13	44.2	9.8	145	46.4	10.1	147	45.4	10.0	292
13 to 14	49.8	11.4	173	50.9	11.2	162	50.4	11.5	335
14 to 15	57.1	10.7	186	54.7	10.7	178	55.9	10.5	364
15 to 16	61.0	10.4	184	55.1	9.0	145	58.0	9.9	329
16 to 17	67.1	11.7	178	58.1	9.6	170	62.4	10.9	348
17 to 18	66.7	11.3	173	59.6	10.4	134	63.3	10.7	307
18 to 19	71.0	12.0	164	59.0	10.2	170	64.6	10.9	334
19 to 20	71.7	11.3	148	60.1	10.1	158	65.3	10.3	306
20 to 21	71.6	12.0	114	60.5	10.7	162	65.2	10.9	276
21 to 22	74.76	12.73	150	60.39	11.14	170	66.71	11.35	320
22 to 23	76.10	12.88	135	60.51	10.11	150	67.30	11.39	285
23 to 24	75.93	11.76	148	61.21	11.48	133	68.43	10.60	281
24 to 25	75.18	11.65	129	62.71	13.44	123	68.43	10.60	252
25 to 26	76.34	11.52	118	62.64	12.46	120	68.80	10.38	238
26 to 27	79.49	14.18	127	61.74	11.77	118	70.57	12.59	245
27 to 28	76.17	12.34	112	62.83	12.18	130	68.24	11.06	242
28 to 29	79.80	14.15	104	63.79	14.34	138	69.79	12.38	242
29 to 30	77.64	11.63	124	63.33	12.92	122	69.97	10.48	246
30 to 31	78.63	13.63	103	64.90	13.71	139	70.44	12.21	242
31 to 32	78.19	14.19	108	67.71	14.45	116	72.33	13.13	224
32 to 33	79.15	12.99	102	68.94	17.51	104	73.43	12.05	206
33 to 34	80.73	12.67	86	63.43	11.77	92	71.82	11.27	178
34 to 35	81.24	14.83	83	63.03	14.43	91	70.91	12.94	174
35 to 36	79.04	12.81	91	67.30	15.62	113	72.24	11.71	204
36 to 37	80.41	14.10	79	65.41	11.27	84	72.03	12.63	163
37 to 38	79.06	12.41	83	66.81	13.08	97	71.82	11.27	180
38 to 39	83.01	15.40	65	66.56	15.72	71	74.14	13.76	136
39 to 40	79.85	13.02	71	67.21	13.85	79	73.19	11.94	150
40 to 41	84.20	13.22	76	70.56	17.70	77	76.49	12.01	153
41 to 42	81.20	15.07	73	65.25	12.91	70	73.47	13.63	143
42 to 43	79.67	11.86	74	65.81	12.14	98	71.23	10.60	172
43 to 44	81.50	14.04	68	68.45	14.89	84	73.38	12.64	152
44 to 45	82.76	13.41	65	66.96	15.19	71	73.70	11.94	136
45 to 46	80.91	13.77	62	65.18	14.78	65	72.33	12.31	127
46 to 47	82.83	15.28	68	70.45	15.91	82	75.24	13.89	150
47 to 48	82.29	11.83	55	68.02	13.67	73	73.42	10.55	128
48 to 49	81.52	12.63	77	67.39	15.71	67	74.28	11.51	144
49 to 50	80.60	13.31	77	66.83	14.54	79	73.07	12.06	156
50 to 51	81.14	14.23	79	70.81	14.67	98	75.12	13.17	177
51 to 52	81.25	11.27	69	67.20	11.99	67	73.81	10.23	136
52 to 53	82.38	15.03	73	66.07	14.58	88	72.70	13.27	161
53 to 54	79.37	12.94	69	68.83	14.83	73	73.71	12.02	142

Table 8-22. Estimated Mean Body Weights of Male and Female by Single-Year Age Groups Using NHANES II Data (continued)

Age Group[a] (years)	Male (kg)			Female (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
54 to 55	76.63	13.36	61	67.62	14.64	71	71.52	12.47	132
55 to 56	81.92	15.12	62	71.93	16.17	90	75.32	13.90	152
56 to 57	77.36	11.28	69	70.82	15.40	67	73.59	10.73	136
57 to 58	79.85	13.02	64	66.87	14.41	99	71.60	11.68	163
58 to 59	79.23	12.52	73	68.73	13.60	70	73.28	11.58	143
59 to 60	80.00	12.47	72	64.43	12.88	70	71.45	11.14	142
60 to 61	79.76	12.92	183	67.28	12.83	218	72.75	11.79	401
61 to 62	78.42	11.75	169	68.12	13.83	176	72.68	10.89	345
62 to 63	77.06	12.33	188	66.09	13.69	184	71.00	11.36	372
63 to 64	77.07	11.31	162	66.41	14.03	178	70.72	10.38	340
64 to 65	77.27	13.63	185	67.45	13.77	177	72.26	12.74	362
65 to 66	77.36	13.25	158	68.48	14.68	185	71.84	12.30	343
66 to 67	75.35	13.21	138	67.36	13.95	182	70.40	12.34	320
67 to 68	73.98	12.82	143	65.98	13.47	149	69.19	11.99	292
68 to 69	74.14	14.60	124	68.87	13.63	161	71.02	13.98	285
69 to 70	74.40	13.20	129	65.59	13.39	119	69.37	12.30	248
70 to 71	75.17	13.03	128	65.04	12.47	136	69.32	12.01	264
71 to 72	74.45	12.60	115	65.62	13.53	139	69.00	11.67	254
72 to 73	73.47	12.36	100	64.89	11.58	135	68.17	11.46	235
73 to 74	72.80	12.17	82	65.59	12.71	108	68.36	11.43	190
74+	75.89	13.38	82	67.20	14.48	102	70.55	12.44	184

[a] Data were converted from ages in months to ages in years. For instance, age 1–2 yr represents ages from 12 to 23 mo.
SD = Standard deviation.
N = Number of individuals.

Source: Portier et al., 2007.

Table 8-23. Estimated Mean Body Weights of Male and Female by Single-Year Age Groups Using NHANES III Data									
Age Group[a] (years)	Male (kg)			Female (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
0 to 1	8.5	1.5	902	7.8	1.6	910	8.17	1.7	1,812
1 to 2	11.6	1.5	660	10.9	1.4	647	11.2	1.5	1,307
2 to 3	13.6	1.5	644	13.2	1.8	624	13.4	1.8	1,268
3 to 4	15.8	2.3	516	15.4	2.2	587	15.6	2.2	1,103
4 to 5	17.6	2.4	549	17.9	3.2	537	17.8	3.2	1,086
5 to 6	20.1	3.0	497	20.2	3.5	554	20.2	3.5	1,051
6 to 7	23.2	5.0	283	22.6	4.7	272	22.9	4.8	555
7 to 8	26.3	5.0	269	26.3	6.2	274	26.4	6.2	543
8 to 9	30.1	6.9	266	29.8	6.7	248	30.0	6.7	514
9 to 10	34.4	7.9	281	34.3	9.0	280	34.4	9.0	561
10 to 11	37.3	8.6	297	37.9	9.5	258	37.7	9.4	555
11 to 12	42.5	10.5	281	44.2	10.5	275	43.4	10.3	556
12 to 13	49.1	11.1	203	49.1	11.6	236	49.1	11.7	439
13 to 14	54.0	12.9	187	55.7	13.2	220	54.8	13.0	407
14 to 15	63.7	17.1	188	58.3	11.8	220	60.6	12.2	408
15 to 16	66.8	14.9	187	58.3	10.1	197	61.7	10.7	384
16 to 17	68.6	14.9	194	61.5	12.8	215	65.2	13.6	409
17 to 18	72.7	13.3	196	62.4	11.9	217	67.6	12.9	413
18 to 19	71.2	14.3	176	61.5	14.2	193	66.4	15.3	369
19 to 20	73.0	12.8	168	63.6	14.5	193	68.3	15.6	361
20 to 21	72.5	13.4	149	61.7	12.9	180	66.1	13.8	329
21 to 22	72.92	12.86	161	65.01	16.03	188	69.24	17.08	349
22 to 23	76.34	14.72	160	64.07	13.61	193	69.48	14.75	353
23 to 24	77.85	14.37	172	66.99	16.24	205	72.72	17.63	377
24 to 25	78.56	15.38	187	62.79	12.62	200	70.16	14.10	387
25 to 26	80.33	17.89	171	66.19	16.05	157	74.11	17.97	328
26 to 27	75.88	12.84	143	64.89	15.19	184	69.73	16.33	327
27 to 28	81.17	14.90	176	65.10	14.43	184	73.33	16.25	360
28 to 29	81.10	18.23	154	66.97	15.26	190	73.28	16.70	344
29 to 30	81.93	16.89	156	65.89	13.65	177	73.33	15.19	333
30 to 31	83.56	16.71	163	67.76	16.85	202	75.11	18.68	365
31 to 32	79.48	13.12	155	72.48	19.32	204	77.04	20.54	359
32 to 33	81.65	15.82	159	67.53	17.22	179	74.33	18.95	338
33 to 34	84.03	16.63	153	68.49	16.03	176	75.09	17.58	329
34 to 35	82.95	15.56	162	67.55	14.27	186	76.47	16.16	348
35 to 36	81.24	16.16	143	71.45	17.47	188	76.02	18.59	331
36 to 37	87.67	21.26	163	66.02	14.29	180	77.32	16.74	343
37 to 38	83.33	17.61	123	72.04	17.69	202	76.42	18.77	325
38 to 39	82.53	14.47	136	71.58	17.43	183	76.85	18.71	319
39 to 40	82.62	12.46	122	74.57	19.41	157	79.34	20.65	279
40 to 41	85.84	15.23	152	68.70	15.80	198	75.55	17.37	350
41 to 42	86.19	18.93	148	70.11	13.80	183	78.34	15.42	331
42 to 43	85.12	16.76	161	72.72	19.46	171	79.25	21.21	332
43 to 44	86.37	17.71	139	68.94	15.35	123	77.80	17.33	262
44 to 45	90.62	20.37	120	72.61	17.15	152	79.13	18.69	272
45 to 46	83.58	13.46	108	71.78	15.76	125	78.22	17.18	233
46 to 47	80.70	13.00	102	72.07	15.53	113	76.30	16.44	215
47 to 48	85.54	17.28	116	72.09	15.98	102	79.28	17.57	218
48 to 49	82.29	14.93	93	75.80	16.09	95	79.21	16.82	188
49 to 50	82.25	16.11	85	73.41	18.26	106	77.95	19.39	191
50 to 51	81.69	13.24	77	74.05	18.03	118	77.31	18.82	195
51 to 52	85.78	15.39	84	79.48	19.60	85	83.81	20.67	169
52 to 53	87.02	13.66	93	72.00	16.86	100	79.97	18.72	193
53 to 54	89.44	14.86	86	73.92	17.08	97	81.86	18.91	183

Table 8-23. Estimated Mean Body Weights of Male and Female by Single-Year Age Groups Using NHANES III Data (continued)

Age Group[a] (years)	Male (kg)			Female (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
54 to 55	86.02	16.76	86	74.63	19.97	113	79.88	21.38	199
55 to 56	83.10	14.99	82	72.56	14.06	102	76.59	14.84	184
56 to 57	87.16	15.10	96	77.69	16.74	105	83.15	17.91	201
57 to 58	86.31	15.04	89	75.65	17.87	97	82.12	19.40	186
58 to 59	83.54	15.67	81	72.26	16.47	100	76.89	17.52	181
59 to 60	87.93	16.14	74	74.00	15.33	82	80.48	16.67	156
60 to 61	83.54	14.22	130	68.73	13.60	104	75.88	15.02	234
61 to 62	81.91	15.03	119	72.26	15.42	141	76.50	16.32	260
62 to 63	81.98	15.47	116	72.97	17.54	114	77.18	18.55	230
63 to 64	84.15	14.50	118	71.32	14.48	111	76.88	15.61	229
64 to 65	84.28	15.73	116	74.34	17.40	126	78.86	18.46	242
65 to 66	85.10	14.75	127	67.47	16.08	118	76.14	18.14	245
66 to 67	81.43	15.03	102	71.82	14.58	118	76.49	15.53	220
67 to 68	84.35	15.22	117	68.98	15.22	95	76.08	16.78	212
68 to 69	80.60	11.75	98	70.72	16.56	110	76.07	17.81	208
69 to 70	84.81	18.18	113	66.57	11.74	97	74.84	13.20	210
70 to 71	80.18	14.14	92	68.36	15.72	124	72.95	16.78	216
71 to 72	79.34	14.64	126	70.74	17.89	98	75.64	19.13	224
72 to 73	78.97	13.36	119	66.70	13.89	101	72.76	15.15	220
73 to 74	82.07	17.26	109	68.24	14.14	115	74.37	15.41	224
74 to 75	79.32	15.37	84	69.08	13.67	97	73.57	14.56	181
75 to 76	77.18	10.47	75	68.58	13.50	85	72.89	14.35	160
76 to 77	79.30	14.88	64	65.68	13.88	94	70.38	14.87	158
77 to 78	80.70	13.98	64	67.33	14.16	86	72.43	15.23	150
78 to 79	75.21	11.34	50	63.67	14.31	63	67.94	15.27	113
79 to 80	78.75	11.32	45	60.21	14.41	61	67.28	16.10	106
80 to 81	76.94	15.15	108	63.55	13.10	101	68.77	14.18	209
81 to 82	73.70	13.30	96	63.17	12.70	112	66.94	13.45	208
82 to 83	73.25	12.32	81	61.96	12.01	69	67.05	12.99	150
83 to 84	72.10	15.31	63	62.78	12.23	63	65.80	12.82	126
84 to 85	72.09	10.73	62	63.68	11.43	57	66.74	11.97	119
85+	70.08	11.64	189	59.67	11.69	240	63.11	12.36	429

[a] Data were converted from ages in months to ages in years. For instance, age 1–2 yr represents ages from 12 to 23 mo.
SD = Standard deviation.
N = Number of individuals.

Source: Portier et al., 2007.

Table 8-24. Estimated Mean Body Weights of Male and Female by Single-Year Age Groups Using NHANES IV Data

Age Group[a] (years)	Male (kg)			Female (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
0 to 1	9.3	1.8	116	9.3	1.5	101	9.3	1.5	217
1 to 2	11.3	1.4	144	11.5	1.9	98	11.4	1.8	242
2 to 3	13.7	2.0	130	13.3	1.9	113	13.5	2.0	243
3 to 4	16.4	2.3	105	15.2	2.1	77	15.9	2.2	182
4 to 5	18.8	2.6	95	18.1	3.2	87	18.5	3.3	182
5 to 6	20.2	3.3	65	20.7	4.9	92	20.6	4.9	157
6 to 7	22.9	4.3	94	22.0	4.5	74	22.5	4.6	168
7to 8	28.1	5.6	100	26.0	6.2	82	27.4	6.5	182
8 to 9	31.9	8.6	100	30.8	7.2	89	31.3	7.3	189
9 to 10	36.1	7.5	76	36.0	8.4	84	36.2	8.5	160
10 to 11	39.5	9.0	92	39.4	10.2	84	39.5	10.2	176
11 to 12	42.0	10.2	84	47.2	12.2	97	44.6	11.6	181
12 to 13	49.4	12.7	158	51.6	12.3	160	50.3	11.9	318
13 to 14	54.9	16.2	161	59.8	15.3	156	56.9	14.6	317
14 to 15	65.1	19.9	137	59.9	13.3	158	61.5	13.7	295
15 to 16	68.2	15.7	142	63.4	13.9	126	65.9	14.4	268
16 to 17	72.5	18.6	153	63.4	16.0	142	68.0	17.1	295
17 to 18	75.4	17.9	146	59.9	11.9	128	66.6	13.2	274
18 to 19	74.8	15.9	131	65.0	15.2	139	70.2	16.4	270
19 to 20	80.1	17.2	129	68.7	17.4	132	74.6	19.0	261
20 to 21	80.0	15.5	37	66.3	15.5	44	74.3	17.4	81
21 to 22	73.84	12.87	33	65.89	15.49	47	69.40	16.32	80
22 to 23	89.62	23.98	37	67.27	15.47	49	75.85	17.44	86
23 to 24	83.39	18.31	36	73.58	23.21	53	80.27	25.32	89
24 to 25	80.26	19.38	20	71.81	21.27	54	75.04	22.23	74
25 to 26	87.47	14.89	27	71.64	20.31	44	80.45	22.80	71
26 to 27	72.11	14.64	33	78.09	20.98	47	75.63	20.32	80
27 to 28	85.78	22.69	30	72.48	18.10	49	78.75	19.67	79
28 to 29	88.04	26.64	36	76.18	16.18	34	81.29	17.26	70
29 to 30	84.02	15.16	35	71.88	16.60	50	78.10	18.04	85
30 to 31	80.10	22.28	29	74.00	22.71	48	77.01	23.63	77
31 to 32	84.65	18.59	33	79.12	22.51	49	82.51	23.48	82
32 to 33	90.99	15.77	35	77.53	18.15	55	83.82	19.62	90
33 to 34	90.90	18.74	37	76.60	22.28	29	85.94	25.00	66
34 to 35	79.09	19.50	33	73.26	16.92	49	75.72	17.49	82
35 to 36	91.15	25.45	33	79.91	22.74	37	84.60	24.07	70
36 to 37	88.96	17.15	29	72.10	20.29	38	80.17	22.55	67
37 to 38	84.62	17.62	47	70.75	15.39	35	79.21	17.23	82
38 to 39	80.52	17.26	29	80.86	22.32	40	81.18	22.41	69
39 to 40	84.77	14.26	37	78.08	19.34	43	81.92	20.29	80
40 to 41	92.21	26.63	40	73.87	18.14	47	82.13	20.17	87
41 to 42	83.11	14.06	37	75.91	17.38	37	79.56	18.21	74
42 to 43	91.94	15.56	46	82.03	21.78	41	88.15	23.41	87
43 to 44	89.48	16.15	40	71.59	17.81	27	83.18	20.69	67
44 to 45	87.00	14.63	34	74.86	18.15	42	80.04	19.41	76
45 to 46	84.61	17.53	33	81.15	23.52	50	83.21	24.12	83
46 to 47	93.27	20.48	28	74.94	16.84	34	82.90	18.63	62
47 to 48	80.87	11.38	29	68.24	16.97	38	74.29	18.48	67
48 to 49	85.58	17.91	21	82.10	29.55	34	84.51	30.42	55
49 to 50	88.84	24.90	28	75.55	21.74	24	82.17	23.64	52
50 to 51	90.09	14.51	26	83.22	27.42	27	88.10	29.03	53
51 to 52	90.63	18.22	35	76.89	16.09	36	83.63	17.50	71
52 to 53	90.62	19.52	24	80.89	19.78	42	85.03	20.79	66
53 to 54	92.42	21.93	28	76.12	16.64	32	82.96	18.13	60

Table 8-24. Estimated Mean Body Weights of Male and Female by Single-Year Age Groups Using NHANES IV Data (continued)									
Age Group[a] (years)	Male (kg)			Female (kg)			Overall (kg)		
	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
54 to 55	90.51	21.10	32	75.19	18.07	36	81.46	19.58	68
55 to 56	84.84	18.72	20	79.87	16.71	25	82.39	17.24	45
56 to 57	84.48	18.55	26	80.68	20.24	32	82.72	20.75	58
57 to 58	86.02	20.50	26	73.07	13.79	24	80.20	15.13	50
58 to 59	89.11	21.33	19	71.21	16.01	17	79.97	17.97	36
59 to 60	83.82	16.33	25	76.28	16.36	17	80.76	17.32	42
60 to 61	89.53	17.90	60	75.97	18.66	43	83.70	20.56	103
61 to 62	86.04	15.44	34	77.01	16.67	37	81.12	17.56	71
62 to 63	84.46	16.28	41	75.78	13.13	45	79.50	13.78	86
63 to 64	86.51	20.07	24	77.95	16.96	39	80.73	17.56	63
64 to 65	91.45	16.88	39	76.75	18.29	42	83.98	20.01	81
65 to 66	89.46	18.44	41	72.95	18.37	41	80.38	20.24	82
66 to 67	90.40	20.13	49	79.00	17.67	26	86.09	19.26	75
67 to 68	85.34	19.18	36	77.76	18.21	35	81.18	19.01	71
68 to 69	84.48	12.92	26	73.28	14.12	35	78.20	15.07	61
69 to 70	92.35	16.95	24	69.94	9.20	32	80.53	10.59	56
70 to 71	81.91	16.38	47	70.50	12.94	32	76.06	13.96	79
71 to 72	79.65	21.31	25	66.22	13.04	35	68.99	13.58	60
72 to 73	84.67	17.45	32	76.89	15.30	21	81.08	16.13	53
73 to 74	89.70	15.36	35	72.75	16.80	27	81.69	18.87	62
74 to 75	80.85	17.00	17	69.21	16.35	31	73.34	17.32	48
75 to 76	84.26	11.94	25	68.61	10.42	21	75.14	11.41	46
76 to 77	86.13	15.45	20	67.42	11.34	25	73.62	12.38	45
77 to 78	81.68	14.15	18	78.35	17.45	21	80.09	17.84	39
78 to 79	81.99	16.39	26	72.30	14.16	17	77.77	15.23	43
79 to 80	80.18	10.39	19	67.95	12.54	21	73.39	13.54	40
80 to 81	75.90	12.07	27	60.97	14.46	23	65.39	15.51	50
81 to 82	73.77	7.40	31	68.76	13.75	25	71.28	14.25	56
82 to 83	81.01	13.46	20	62.93	9.81	20	68.51	10.68	40
83 to 84	76.07	10.63	12	66.24	11.68	12	70.90	12.50	24
84 to 85	73.06	12.88	12	66.29	15.04	17	68.79	15.60	29
85+	74.10	12.23	46	59.68	10.04	59	64.45	10.84	105

[a] Data were converted from ages in months to ages in years. For instance, age 1–2 yr represents ages from 12 to 23 mo.
SD = Standard deviation.
N = Number of individuals.

Source: Portier et al., 2007.

Table 8-25. Estimated Body Weights of Typical Age Groups of Interest in U.S. EPA Risk Assessments[a]

Age Group (years)	NHANES	Male (kg)			Female (kg)			Overall (kg)		
		Mean	SD	*N*	Mean	SD	*N*	Mean	SD	*N*
1 to 6	II	17.0	4.6	2,097	16.3	4.7	1,933	16.7	4.5	4,030
	III	16.9	4.7	3,149	16.5	4.9	3,221	16.8	5.0	6,370
	IV	17.1	4.9	633	17.5	5.0	541	17.3	5.0	1,174
7 to 16	II	45.2	17.6	1,618	43.9	15.9	1,507	44.8	17.5	3,125
	III	49.3	20.9	2,549	46.8	18.0	2,640	47.8	18.4	5,189
	IV	47.9	20.1	1,203	47.9	19.2	1,178	47.7	19.1	2,381
18 to 65	II	78.65	13.23	4,711	65.47	13.77	5,187	71.23	11.97	9,898
	III	82.19	16.18	6,250	69.45	16.55	7,182	75.61	18.02	13,462
	IV	85.47	19.03	1,908	74.55	19.32	2,202	79.96	20.73	4,110
65+	II	74.45	13.05	1,041	66.26	13.25	1,231	69.56	12.20	2,272
	III	79.42	14.66	1,857	66.76	14.52	1,986	72.25	15.71	3,843
	IV	83.50	16.35	547	69.59	14.63	535	75.54	15.88	1,082

[a] Estimates were weighted using the sample weights provided with each survey.
SD = Standard deviation.
N = Number of individuals.

Source: Portier et al., 2007.

Table 8-26. Estimated Percentile Distribution of Body Weight by Fine Age Categories Derived from 1994−1996, 1998 CSFII

Weight (kg)											
Age Group	Sample Size	Mean	Percentile								
			1st	5th	10th	25th	50th	75th	90th	95th	99th
Birth to 1 month	88	4	1[a]	2[a]	3[a]	3	3	4	4[a]	5[a]	5[a]
1 to <3 months	245	5	2[a]	3[a]	4	4	5	6	6	7[a]	8[a]
3 to <6 months	411	7	4[a]	5	5	6	7	8	9	10	12[a]
6 to <12 months	678	9	6[a]	7	7	8	9	10	11	12	13[a]
1 to <2 years	1,002	12	8[a]	9	9	10	11	13	14	15	19[a]
2 to <3 years	994	14	10[a]	10	11	12	14	16	18	19	22[a]
3 to <6 years	4,112	18	11	13	13	16	18	20	23	25	32
6 to <11 years	1,553	30	16[a]	18	20	23	27	35	41	45	57[a]
11 to <16 years	975	54	29[a]	33	36	44	52	61	72	82	95[a]
16 to <18 years	360	67	41[a]	46[a]	50	56	63	73	86	100[a]	114[a]
18 to <21 years	383	69	45[a]	48[a]	51	58	66	77	89	100[a]	117[a]
≥21 years	9,049	76	45	51	54	63	74	86	99	107	126
≥65 years	2,139	72	44	50	54	62	71	81	93	100	113
All ages	19,850	65	8	15	22	52	67	81	95	104	122

[a] Sample size does meet minimum reporting requirements as described in the *3rd Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: Kahn and Stralka, 2008.

Table 8-27. Estimated Percentile Distribution of Body Weight by Fine Age Categories with Confidence Interval

Weight (kg)										
Age Group	Sample Size	Mean			90th Percentile			95th Percentile		
		Estimate	90% CI		Estimate	90% BI		Estimate	90% BI	
			Lower Bound	Upper Bound		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Birth to 1 month	88	4	3	4	4[a]	[a]	[a]	[a]	[a]	[a]
1 to <3 months	245	5	5	5	6	6	7	7[a]		7
3 to <6 months	411	7	7	7	9 4	9 5	9 5	10 5	10 5	10
6 to <12 months	678	9	9	9	11	11	11	12 7	12	12
1 to <2 years	1,002	12	12	12	14	14	15	15	15	16
2 to <3 years	994	14	14	14	18	17	18	19	18	19
3 to <6 years	4,112	18	18	18	23	23	23	25	25	25
6 to <11 years	1,553	30	29	30	41	41	43	45	44	48
11 to <16 years	975	54	53	55	72	70	75	82	81	84
16 to <18 years	360	67	66	68	86	84	95	100[a]	95[a]	109[a]
18 to <21 years	383	69	68	70	89	88	95	100[a]	95[a]	104[a]
≥21 years	9,049	76	-	-	99	-	-	107	-	-
≥65 years	2,139	72	-	-	93	-	-	100	-	-
All ages	19,850	65	-	-	95	-	-	104	-	-

[a] Sample size does meet minimum reporting requirements as described in the 3rd *Report on Nutrition Monitoring in the United States* (Vol. I) (LSRO, 1995). Interval estimates may involve aggregation of variance estimation units when data are too sparse to support estimation of variance.
CI = Confidence interval.
BI = Percentile intervals estimated using percentile bootstrap method with 1,000 bootstrap replications.
- = Data unavailable.

Source: Kahn and Stralka, 2008.

Table 8-28. Distribution of 1st Trimester Weight Gain and 2nd and 3rd Trimesters Rates of Gain in Women with Good Pregnancy Outcomes

Trimester	Percentile of Weight Gain					
	10th	25th	50th	75th	90th	Mean ± SD
1st Trimester, kg						
Underweight	−1.81	−0.14	1.92	3.78	5.77	1.92 ± 3.06
Normal weight	−2.21	−0.09	2.20	4.37	6.59	2.19 ± 3.47
Overweight	−2.91	−0.59	2.38	4.63	7.04	2.16 ± 3.95
Obese	−3.08	−0.86	1.17	3.89	7.22	1.65 ±3. 94
2nd Trimester, kg/wk[a]						
Underweight	0.33	0.44	0.56	0.69	0.82	0.57 ± 0.20
Normal weight	0.31	0.44	0.56	0.71	0.85	0.58 ± 0.22
Overweight	0.21	0.36	0.49	0.65	0.83	0.51 ± 0.24
Obese	0.06	0.24	0.42	0.56	0.78	0.41 ± 0.27
3rd Trimester, kg/wk[a]						
Underweight	0.26	0.36	0.47	0.60	0.71	0.48 ± 0.19
Normal weight	0.26	0.37	0.50	0.64	0.77	0.51 ± 0.21
Overweight	0.21	0.34	0.47	0.63	0.77	0.49 ± 0.22
Obese	0.19	0.31	0.43	0.64	0.80	0.47 ± 0.24

a To calculate the distribution of total gain (kg) in the 2nd and 3rd trimesters, multiply the values in the table by 13 wk.
SD = Standard deviation.

Source: Carmichael et al., 1997.

Table 8-29. Estimated Body Weights of Pregnant Women—NHANES (1999−2006)

Weight (kg)

Trimester	Sample size	Mean Estimate	SD	Percentiles 5th	10th	15th	25th	th	75th	85th	90th	95th
1	204	76	3	48	50	55	60 50	74	91	98	106	108
2	430	73	1	50	53	57	61	72	83	93	95	98
3	402	80	1	60	63	65	69	77	88	99	104	108
Ref/Dk[a]	186	69	2	46	52	55	60	65	77	84	87	108
All	1,222	75	1	50	55	59	63	73	85	94	99	107

[a] Refers to pregnant women who either refused to tell which trimester they were in or didn't know or data were missing.
SD = Standard deviation.

Source: U.S. EPA Analysis of NHANES 1999−2006 data.

Table 8-30. Fetal Weight (g) Percentiles Throughout Pregnancy						
Gestational Age (wk)	Number of Women	10th	25th	50th	75th	90th
8	6	–[a]	–	6.1[b]	–	–
9	7	–	–	7.3[b]	–	–
10	15	–	–	8.1[b]	–	–
11	13	–	–	11.9[b]	–	–
12	18	–	11	21	34	–
13	43	–	23	35	55	–
14	61	–	3,405	51	77	–
15	63	–	51	77	108	–
16	59	–	80	117	151	–
17	36	–	125	166	212	–
18	58	–	172	220	298	–
19	31	–	217	283	394	–
20	21	–	255	325	460	–
21	43	280	330	410	570	860
22	69	320	410	480	630	920
23	71	370	460	550	690	990
24	74	420	530	640	780	1,080
25	48	490	630	740	890	1,180
26	86	570	730	860	1,020	1,320
27	76	660	840	990	1,160	1,470
28	91	770	980	1,150	1,350	1,660
29	88	890	1,100	1,310	1,530	1,890
30	128	1,030	1,260	1,460	1,710	2,100
31	113	1,180	1,410	1,630	1,880	2,290
32	210	1,310	1,570	1,810	2,090	2,500
33	242	1,480	1,720	2,010	2,280	2,690
34	373	1,670	1,910	2,220	2,510	2,880
35	492	1,870	2,130	2,430	2,730	3,090
36	1,085	2,190	2,470	2,650	2,950	3,290
37	1,798	2,310	2,580	2,870	3,160	3,470
38	3,908	2,510	2,770	3,030	3,320	3,610
39	5,413	2,680	2,910	3,170	3,470	3,750
40	10,586	2,750	3,010	3,280	3,590	3,870
41	3,399	2,800	3,070	3,360	3,680	3,980
42	1,725	2,830	3,110	3,410	3,740	4,060
43	507	2,840	3,110	3,420	3,780	4,100
44	147	2,790	3,050	3,390	3,770	4,110

[a] Data not available.
[b] Median fetal weights may be overestimated. They were derived from only a small proportion of the fetuses delivered at these gestational weeks.

Source: Brenner et al., 1976.

Table 8-31. Neonatal Weight by Gestational Age for Male and Female Combined

Gestational Age (weeks)	Weight (g)						
	5th	10th	25th	50th	75th	90th	95th
25	450	490	564	660	772	889	968
26	523	568	652	760	885	1,016	1,103
27	609	660	754	875	1,015	1,160	1,257
28	707	765	870	1,005	1,162	1,322	1,430
29	820	884	1,003	1,153	1,327	1,504	1,623
30	947	1,020	1,151	1,319	1,511	1,706	1,836
31	1,090	1,171	1,317	1,502	1,713	1,928	2,070
32	1,249	1,338	1,499	1,702	1,933	2,167	2,321
33	1,422	1,519	1,696	1,918	2,169	2,421	2,587
34	1,608	1,714	1,906	2,146	2,416	2,687	2,865
35	1,804	1,919	2,125	2,383	2,671	2,959	3,148
36	2,006	2,129	2,349	2,622	2,927	3,230	3,428
37	2,210	2,340	2,572	2,859	3,177	3,493	3,698
38	2,409	2,544	2,786	3,083	3,412	3,736	3,947
39	2,595	2,735	2,984	3,288	3,622	3,952	4,164
40	2,762	2,904	3,155	3,462	3,798	4,127	4,340
41	2,900	3,042	3,293	3,597	3,930	4,254	4,462
42	3,002	3,142	3,388	3,685	4,008	4,322	4,523
43	3,061	3,195	3,432	3,717	4,026	4,324	4,515

Source: Doubilet et al., 1997.

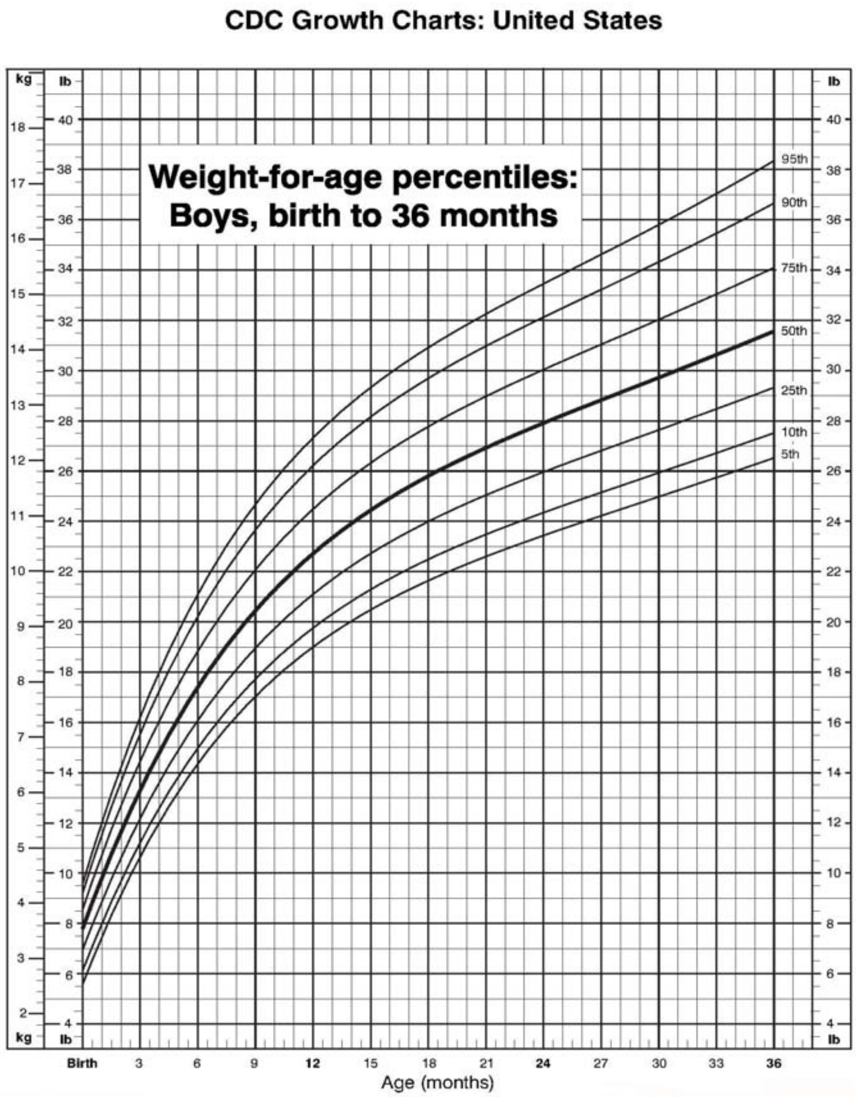

Figure 8-1. Weight by Age Percentiles for Boys Aged Birth to 36 Months.

Source: Kuczmarski et al., 2002.

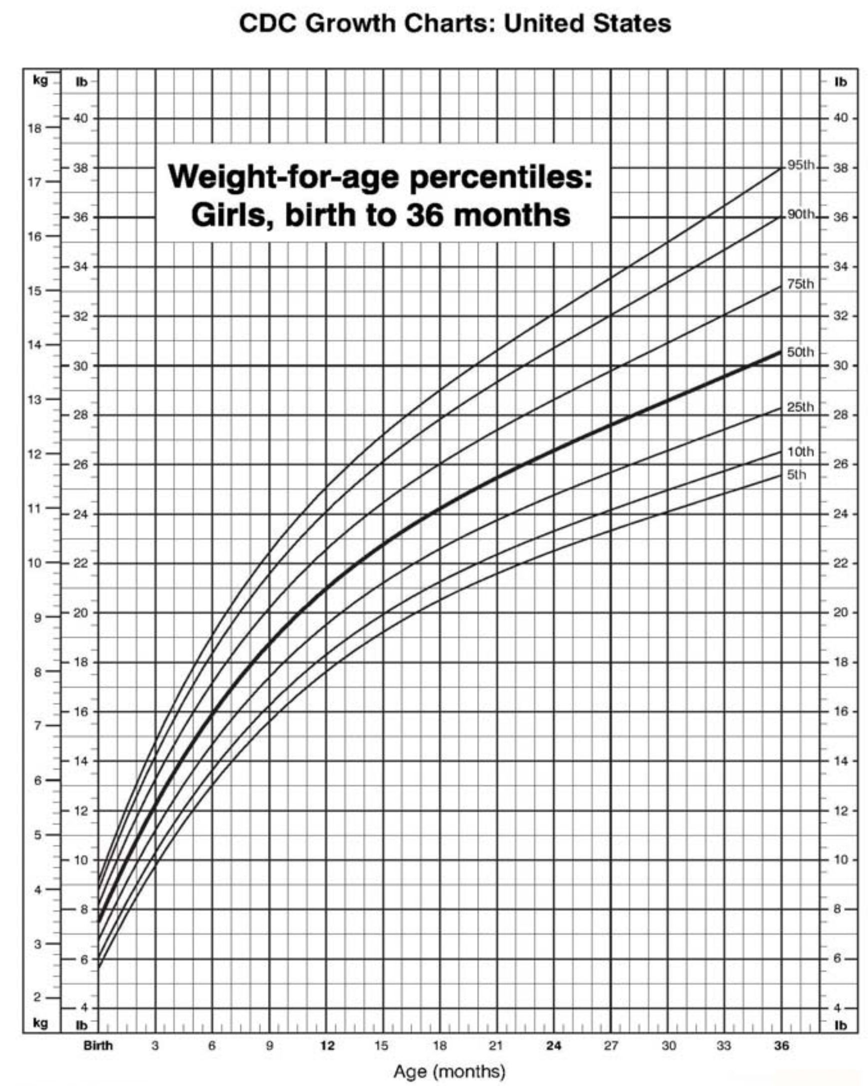

Figure 8-2. Weight by Age Percentiles for Girls Aged Birth to 36 Months.

Source: Kuczmarski et al., 2002.

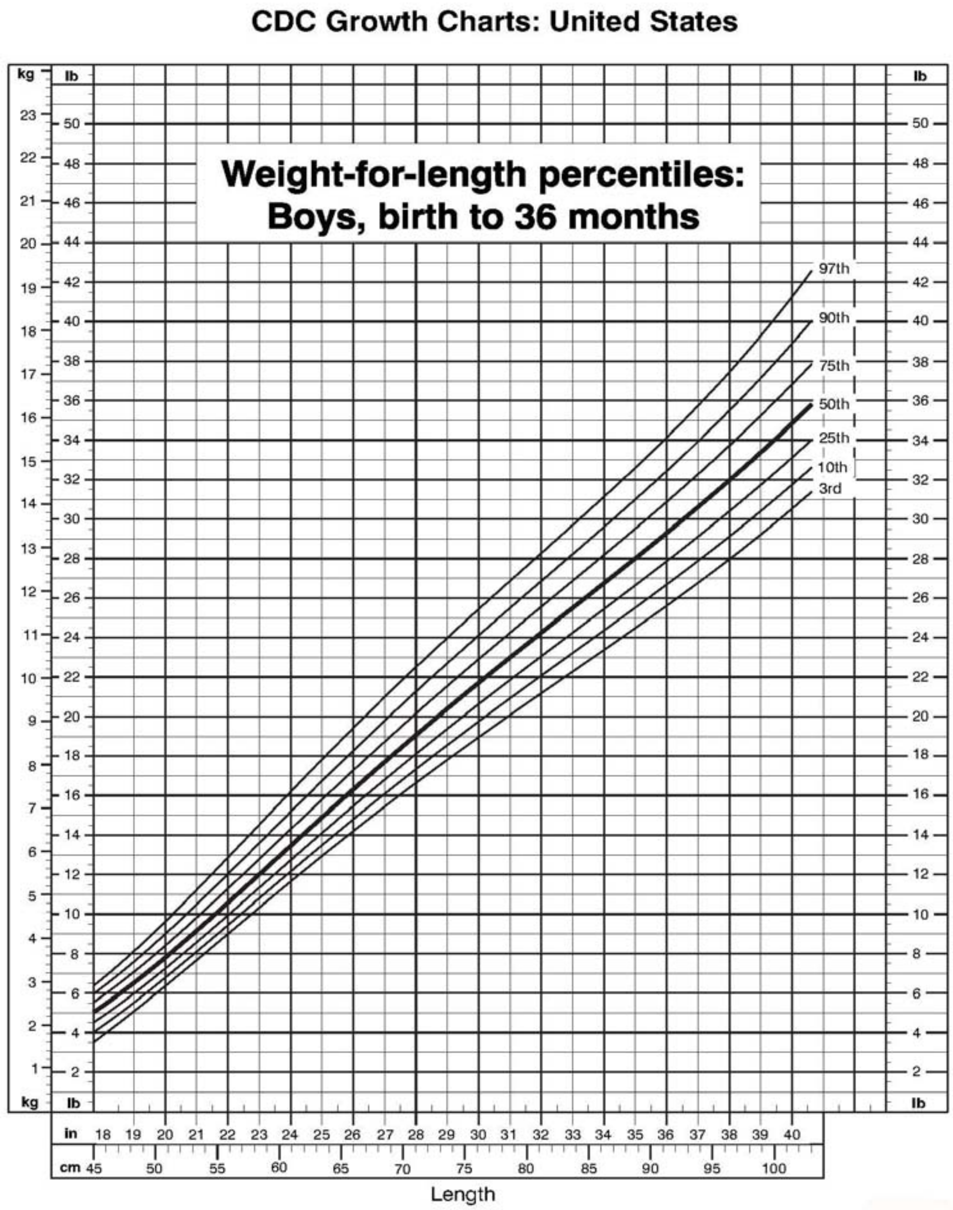

Figure 8-3. Weight by Length Percentiles for Boys Aged Birth to 36 Months.

Source: Kuczmarski et al., 2002.

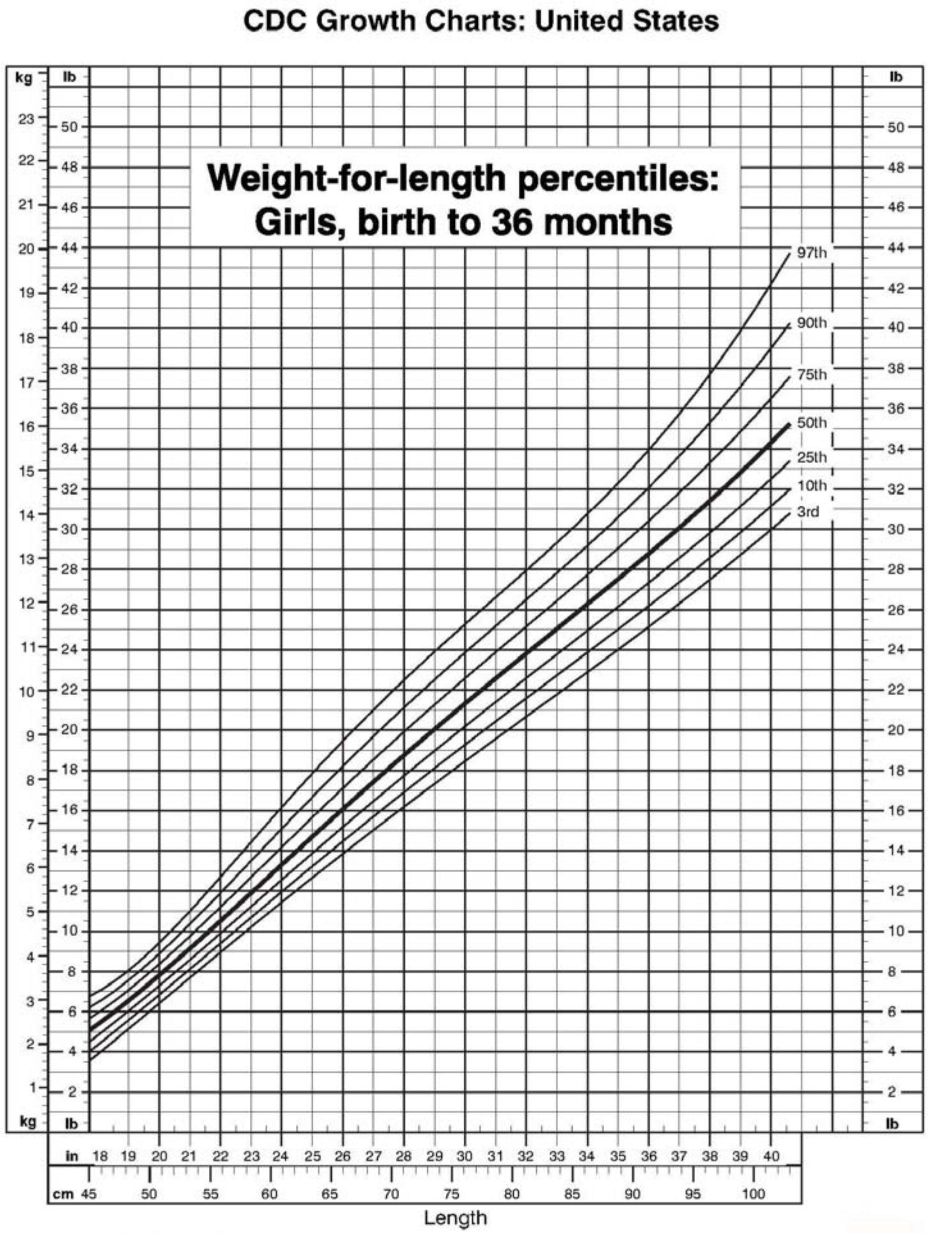

Figure 8-4. Weight by Length Percentiles for Girls Aged Birth to 36 Months.

Source: Kuczmarski et al., 2002.

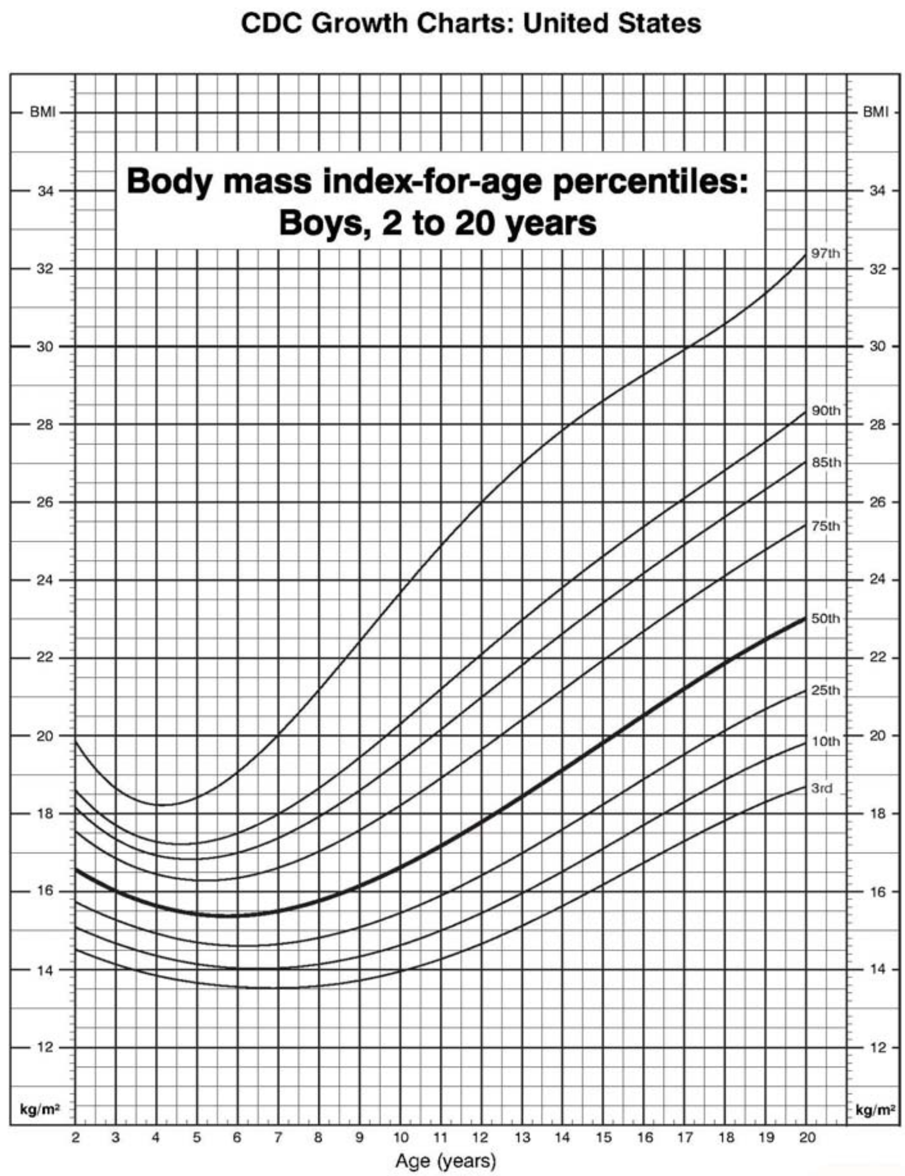

Figure 8-5. Body Mass Index-for-Age Percentiles: Boys, 2 to 20 Years.

Source: Kuczmarski et al., 2002.

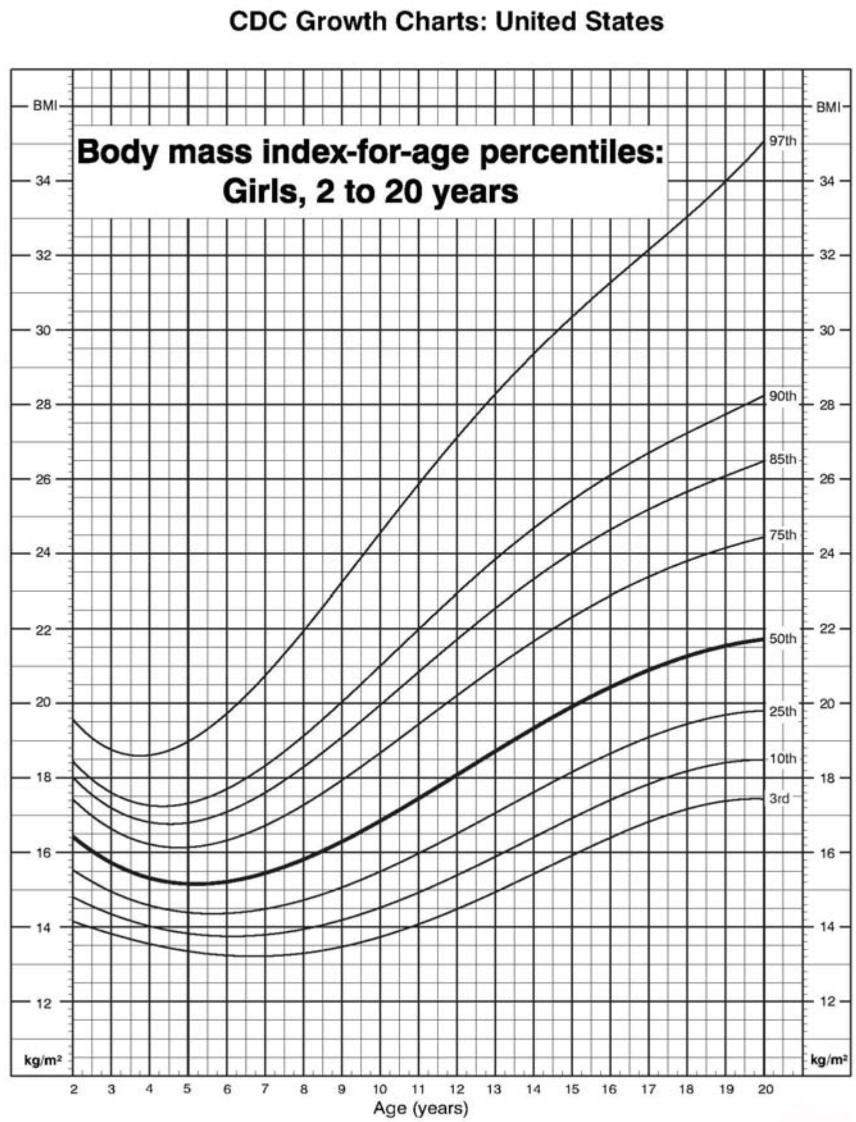

Figure 8-6. Body Mass Index-for-Age Percentiles: Girls, 2 to 20 Years.

Source: Kuczmarski et al., 2002.

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9. INTAKE OF FRUITS AND VEGETABLES

9.1. INTRODUCTION

The American food supply is generally considered to be one of the safest in the world. Nevertheless, fruits and vegetables may become contaminated with toxic chemicals by several different pathways. Ambient pollutants from the air may be deposited on or absorbed by the plants or dissolved in rainfall or irrigation waters that contact the plants. Pollutants may also be absorbed through plant roots from contaminated soil and ground water. The addition of pesticides, soil additives, and fertilizers may also result in contamination of fruits and vegetables. To assess exposure through this pathway, information on fruit and vegetable ingestion rates is needed.

A variety of terms may be used to define intake of fruits and vegetables (e.g., consumer-only intake, per capita intake, total fruit intake, total vegetable intake, as-consumed intake, dry-weight intake). These terms are defined below to assist the reader in interpreting and using the intake rates that are appropriate for the exposure scenario being assessed.

Consumer-only intake is defined as the quantity of fruits and vegetables consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who consumed these food items. Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those individuals that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessments for which average dose estimates are of interest because they represent both individuals who ate the foods during the survey period and individuals who may eat the food items at some time, but did not consume them during the survey period. Per capita intake, therefore, represents an average across the entire population of interest, but does so at the expense of underestimating consumption for the subset of the population that consumed the food in question. Total fruit intake refers to the sum of all fruits consumed in a day including canned, dried, frozen, and fresh fruits. Likewise, total vegetable intake refers to the sum of all vegetables consumed in a day including canned, dried, frozen, and fresh vegetables.

Intake rates may be expressed on the basis of the as-consumed weight (e.g., cooked or prepared) or on the uncooked or unprepared weight. As-consumed intake rates are based on the weight of the food in the form that it is consumed and should be used in assessments where the basis for the contaminant concentrations in foods is also indexed to the as-consumed weight. Some of the food ingestion values provided in this chapter are expressed as as-consumed intake rates because this is the fashion in which data were reported by survey respondents. Others are provided as uncooked weights based on analyses of survey data that account for weight changes that occur during cooking. This is of importance because concentration data to be used in the dose equation are often measured in uncooked food samples. It should be recognized that cooking can either increase or decrease food weight. Similarly, cooking can increase the mass of contaminant in food (due to formation reactions, or absorption from cooking oils or water) or decrease the mass of contaminant in food (due to vaporization, fat loss, or leaching). The combined effects of changes in weight and changes in contaminant mass can result in either an increase or decrease in contaminant concentration in cooked food. Therefore, if the as-consumed ingestion rate and the uncooked concentration are used in the dose equation, dose may be under-estimated or over-estimated. It is important for the assessor to be aware of these issues and choose intake rate data that best match the concentration data that are being used. For more information on cooking losses and conversions necessary to account for such losses, refer to Chapter 13 of this handbook.

Sometimes contaminant concentrations in food are reported on a dry-weight basis. When these data are used in an exposure assessment, it is recommended that dry-weight intake rates also be used. Dry-weight food concentrations and intake rates are based on the weight of the food consumed after the moisture content has been removed. For information on converting the intake rates presented in this chapter to dry-weight intake rates, refer to Section 9.4.

The purpose of this chapter is to provide intake data for fruits and vegetables. The recommendations for fruit and vegetable ingestion rates are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on the key study identified by U.S. Environmental Protection Agency (EPA) for this factor. Following the recommendations, the key study on fruit and vegetable ingestion is summarized. Relevant data on ingestion of fruits and vegetables are also provided. These data are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of fruits and vegetables.

9.2. RECOMMENDATIONS

Table 9-1 presents a summary of the recommended values for per capita and consumer-only intake of fruits and vegetables. Table 9-2 provides confidence ratings for the fruit and vegetable intake recommendations.

The U.S. EPA analysis of data from the 2003−2006 National Health and Nutrition Examination Survey (NHANES) was used in selecting recommended intake rates for the general population. The U.S. EPA analysis was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations presented here, childhood data were placed in the standardized age categories closest to those used in the analysis.

The NHANES data on which the recommendations are based are short-term survey data and may not necessarily reflect the long-term distribution of average daily intake rates. However, since broad categories of food (i.e., total fruits and total vegetables), are eaten on a daily basis throughout the year with minimal seasonality, the short-term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here may tend to overestimate the corresponding percentiles of the true long-term distribution. In general, the recommended values based on U.S. EPA's analysis of NHANES data represent the i.e., uncooked weight of the edible portion of fruits and vegetables.

Table 9-1. Recommended Values for Intake of Fruits and Vegetables, Edible Portion, Uncooked[a]						
Age Group (years)	**Per Capita**		**Consumers Only**		**Multiple Percentiles**	**Source**
	Mean	**95th Percentile**	**Mean**	**95th Percentile**		
	g/kg-day	**g/kg-day**	**g/kg-day**	**g/kg-day**		
Total Fruits						
Birth to 1	6.2	23.0[b]	10.1	25.8[b]	See Tables 9-3 and 9-4	U.S. EPA Analysis of NHANES 2003−2006
1 to <2	7.8	21.3[b]	8.1	21.4[b]		
2 to <3	7.8	21.3[b]	8.1	21.4[b]		
3 to <6	4.6	14.9	4.7	15.1		
6 to <11	2.3	8.7	2.5	9.2		
11 to <16	0.9	3.5	1.1	3.8		
16 to <21	0.9	3.5	1.1	3.8		
21 to <50	0.9	3.7	1.1	3.8		
≥50	1.4	4.4	1.5	4.6		
Total Vegetables						
Birth to 1	5.0	16.2[b]	6.8	18.1[b]	See Tables 9-3 and 9-4	U.S. EPA Analysis of NHANES 2003−2006
1 to <2	6.7	15.6[b]	6.7	15.6[b]		
2 to <3	6.7	15.6[b]	6.7	15.6[b]		
3 to <6	5.4	13.4	5.4	13.4		
6 to <11	3.7	10.4	3.7	10.4		
11 to <16	2.3	5.5	2.3	5.5		
16 to <21	2.3	5.5	2.3	5.5		
21 to <50	2.5	5.9	2.5	5.9		
≥50	2.6	6.1	2.6	6.1		
Individual Fruits and Vegetables—See Tables 9-5 and 9-6						

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Data were placed in the standardized age categories closest to those used in the analysis.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Table 9-2. Confidence in Recommendations for Intake of Fruits and Vegetables		
General Assessment Factors	**Rationale**	**Rating**
Soundness		High for total fruits and vegetables, low for some individual fruits and vegetables with small sample size
Adequacy of Approach	The survey methodology and data analysis were adequate. The survey sampled more than 16,000 individuals. However, sample sizes for some individual fruits and vegetables for some of the age groups are small. An analysis of primary data was conducted.	
Minimal (or Defined) Bias	No physical measurements were taken. The method relied on recent recall of fruits and vegetables eaten.	
Applicability and Utility		High
Exposure Factor of Interest	The key study was directly relevant to fruit and vegetable intake.	
Representativeness	The data were demographically representative of the U.S. population (based on stratified random sample).	
Currency	Data were collected between 2003 and 2006.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The NHANES data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	NHANES follows a strict QA/QC procedure. The U.S. EPA analysis has only been reviewed internally, but the methodology used has been peer reviewed in an analysis of previous data.	
Variability and Uncertainty		Medium to high for averages, low for long-term upper percentiles; low for individual fruits and vegetables
Variability in Population	Full distributions were provided for total fruits and total vegetables. Means were provided for individual fruits and vegetables.	
Uncertainty	Data collection was based on recall of consumption for a 2-day period; the accuracy of using these data to estimate long-term intake (especially at the upper percentiles) is uncertain. However, use of short-term data to estimate chronic ingestion can be assumed for broad categories of foods such as total fruits and total vegetables. Uncertainty is greater for individual fruits and vegetables.	
Evaluation and Review		Medium
Peer Review	The NCHS NHANES survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency, but the methodology used has been peer reviewed in an analysis of previous data.	
Number and Agreement of Studies	There was one key study.	
Overall Rating		**Medium to High** confidence in the averages; **Low** for some individual fruits and vegetables with small sample size; **Low** confidence in the long-term upper percentiles

9.3. INTAKE STUDIES

9.3.1. Key Fruits and Vegetables Intake Study

9.3.1.1. *U.S. EPA Analysis of Consumption Data from 2003−2006 National Health and Nutrition Examination Survey (NHANES)*

The key source of recent information on consumption rates of fruits and vegetables is the U.S. Centers for Disease Control and Prevention's National Center for Health Statistics' (NCHS) NHANES. Data from NHANES 2003−2006 have been used by the U.S. EPA, Office of Pesticide Programs (OPP) to generate per capita and consumer-only intake rates for both individual fruits and vegetables and total fruits and vegetables.

NHANES is designed to assess the health and nutritional status of adults and children in the United States. In 1999, the survey became a continuous program that interviews a nationally representative sample of approximately 7,000 persons each year and examines a nationally representative sample of about 5,000 persons each year, located in counties across the country, 15 of which are visited each year. Data are released on a 2-year basis, thus, for example, the 2003 data are combined with the 2004 data to produce NHANES 2003−2004.

The dietary interview component of NHANES is called *What We Eat in America* and is conducted by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). DHHS' NCHS is responsible for the sample design and data collection, and USDA's Food Surveys Research Group is responsible for the dietary data collection methodology, maintenance of the databases used to code and process the data, and data review and processing. Beginning in 2003, 2 non-consecutive days of 24-hour intake data were collected. The first day is collected in-person, and the second day is collected by telephone 3 to 10 days later. These data are collected using USDA's dietary data collection instrument, the Automated Multiple Pass Method. This method provides an efficient and accurate means of collecting intakes for large-scale national surveys. It is fully computerized and uses a 5-step interview. Details can be found at USDA's Agriculture Research Service (http://www.ars.usda.gov/ba/bhnrc/fsrg).

For NHANES 2003−2004, there were 12,761 persons selected; of these, 9,643 were considered respondents to the mobile examination center (MEC) examination and data collection. However, only 9,034 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,354 provided complete dietary intakes for Day 2. For NHANES 2005−2006, there were 12,862 persons selected; of these, 9,950 were considered respondents to the MEC examination and data collection. However, only 9,349 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,429 provided complete dietary intakes for Day 2.

The 2003−2006 NHANES surveys are stratified, multistage probability samples of the civilian non-institutionalized U.S. population. The sampling frame was organized using 2000 U.S. population census estimates. NHANES oversamples low-income persons, adolescents 12 to 19 years, persons 60 years and older, African Americans, and Mexican Americans. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all four years of the surveys can be combined. Additional information on NHANES can be obtained at http://www.cdc.gov/nchs/nhanes.htm.

In 2010, U.S. EPA, OPP used NHANES 2003−2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the USDA's Continuing Survey of Food Intake among Individuals (CSFII) (USDA, 2000; U.S. EPA, 2000) (see Section 9.3.2.4), NHANES data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean plant (or animal) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, an apple pie may contain the commodities apples, flour, fat, sugar, and spices. FCID contains approximately 558 unique commodity names and 8-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

Intake rates were generated for a variety of food items/groups based on the agricultural commodities included in the FCID. These intake rates represent intake of all forms of the product (e.g., both home produced and commercially produced) for individuals who provided data for 2 days of the survey. Note that if the person reported consuming food for only one day, their 2-day average would be half the amount reported for the one day of consumption. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the 4-year, 2-day sample weights provided in NHANES 2003−2006 to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on a consumer-only and on a per capita basis. Summary statistics, including: number of observations, percentage of the population consuming the fruits or vegetables being analyzed, mean intake rate, and standard error of the mean intake rate were calculated for total fruits, total vegetables, and selected individual fruits and vegetables. Individual fruits and vegetables were selected to be consistent with Chapter 13, which was based on having at least 30 households reporting consumption for the particular fruit or vegetable. Percentiles of the intake rate distribution (i.e., 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and the maximum value) were also provided for total fruits and total vegetables. Data were provided for the following age groups: birth to 1 year, 1 to 2 years, 3 to 5 years, 6 to 12 years, 13 to 19 years, 20 to 49 years, and ≥50 years. Data for females 13 to 49 years were also provided. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 9-3 presents per capita intake data for total fruits and total vegetables in g/kg-day; Table 9-4 provides consumer-only intake data for total fruits and total vegetables in g/kg-day. Table 9-5 provides per capita intake data for individual fruits and vegetables in g/kg-day, and Table 9-6 provides consumer-only intake data for individual fruits and vegetables in g/kg-day. In general, these data represent intake of the edible portions of uncooked foods.

The results are presented in units of g/kg-day. Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the average daily dose (ADD) equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate, because individual intake rates were indexed to the reported body weights of the survey respondents. Also, it should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) does not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. Day-to-day variation in intake among individuals will be high for fruits and vegetables that are highly seasonal and for fruits and vegetables that are eaten year-round, but that are not typically eaten every day. For these fruits and vegetables, the intake distribution generated from short-term data will not be a good reflection of the long-term distribution. On the other hand, for broad categories of foods (e.g., total fruits and total vegetables) that are eaten on a daily basis throughout the year, the short-term distribution may be a reasonable approximation of the true long-term distribution, although it will show somewhat more variability. In this chapter, distributions are provided only for broad categories of fruits and vegetables (i.e., total fruits and total vegetables). Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution. For individual foods, only the mean, standard error, and percent consuming are provided.

An advantage of using the U.S. EPA's analysis of NHANES data is that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The data set was designed to be representative of the U.S. population and includes four years of intake data combined. Another advantage is the currency of the data; the NHANES data are from 2003−2006. However, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Because these are 2-day averages, consumption estimates at the upper end of the intake distribution may be underestimated if these consumption values are used to assess acute (i.e., short-term) exposures, also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest.

9.3.2. Relevant Fruit and Vegetable Intake Studies

9.3.2.1. *U.S. Department of Agriculture (USDA) (1980, 1992, 1996a, b)—Food and Nutrient Intakes of Individuals in One Day in the United States*

USDA calculated mean intake rates for total fruits and total vegetables using data from the 1977−1978 and 1987−1988 Nationwide Food Consumption Surveys (NFCS) (USDA, 1980, 1992) and CSFII data from 1994 and 1995 (USDA, 1996a, b). Table 9-7 presents the mean per capita total intake rates for total fruits and total vegetables from the 1977−1978 NFCS. Table 9-8 presents similar data from the 1987−1988 NFCS and the 1994 and 1995 CSFII. Note that the age classifications used in these surveys were slightly different than those used in the 1977−1978 NFCS. Tables 9-7 and 9-8 include both per capita intake rates and intake rates for consumers-only for various ages of individuals. Intake rates for consumers-only were calculated by dividing the per capita consumption rate by the fraction of the population consuming vegetables or fruits in a day.

The advantages of using these data are that they provide intake estimates for all fruits or all vegetables, combined. Again, these estimates are based on one-day dietary data, which may not reflect usual consumption patterns. These data are based on older surveys and may not be entirely representative of current eating patterns.

9.3.2.2. *U.S. Department of Agriculture (USDA) (1999a)—Food Consumption, Prices, and Expenditures, 1970−1997*

The USDA's Economic Research Service calculates the amount of food available for human consumption in the United States on an annual basis (USDA, 1999a). Supply and utilization balance sheets are generated based on the flow of food items from production to end uses for the years 1970 to 1997. Total available supply is estimated as the sum of production and imports (USDA, 1999a). The availability of food for human use commonly termed as "food disappearance" is determined by subtracting exported foods from the total available supply (USDA, 1999a). USDA (1999a) calculates the per capita food consumption by dividing the total food disappearance by the total U.S. population. USDA (1999a) estimated per capita consumption data for various fruit and vegetable products from 1970−1997. Table 9-9 presents retail weight per capita data. These data have been derived from the annual per capita values in units of pounds per year, presented by USDA (1999a), by converting to units of g/day.

An advantage of this study is that it provides per capita consumption rates for fruits and vegetables that are representative of long-term intake because disappearance data are generated annually. One of the limitations of this study is that disappearance data do not account for losses from the food supply from waste or spoilage. As a result, intake rates based on these data may overestimate daily consumption because they are based on the total quantity of marketable commodity utilized. Thus, these data represent bounding estimates of intake rates only. It should also be noted that per capita estimates based on food disappearance are not a direct measure of actual consumption or quantity ingested; instead, the data are used as indicators of changes in usage over time (USDA, 1999a). These data are based on older surveys and may not be entirely representative of current consumption patterns.

9.3.2.3. *U.S. Department of Agriculture (USDA) (1999b)—Food and Nutrient Intakes by Children 1994−1996, 1998, Table Set 17*

USDA (1999b) calculated national probability estimates of food and nutrient intake by children based on four years of the CSFII (1994−1996 and 1998) for children age nine years and under, and on CSFII 1994−1996 only for children age 10 years and over. The CSFII was a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. Intake data, based on 24-hour dietary recall, were collected through in-person interviews on two non-consecutive days. Section 9.3.2.4 provides additional information on these surveys.

USDA (1999b) used sample weights to adjust for non-response, to match the sample to the U.S. population in terms of demographic characteristics, and to equalize intakes over the four quarters of the year and the seven days of the week. A total of 503 breast-fed children were excluded from the estimates, but both consumers and non-consumers were included in the analysis.

USDA (1999b) provided data on the mean per capita quantities (grams) of various food products/groups consumed per individual for one day, and the percent of individuals consuming those foods in one day of the survey. Tables 9-10 through 9-13 present data on the mean quantities (grams) of fruits and vegetables consumed per individual for one day, and the percentage of survey individuals consuming fruits and vegetables on that survey day. Data on mean intakes or mean percentages are based on respondents' Day-1 intakes.

The advantage of the USDA (1999b) study is that it uses the 1994−1996, 1998 CSFII data set, which includes four years of intake data, combined, and includes the supplemental data on children. These data are expected to be generally representative of the U.S. population, and they include data on a wide variety of fruits and vegetables. The data set is one of a series of USDA data sets that are publicly available. One limitation of this data set is that it is based on 1 day, and short-term dietary data may not accurately reflect long-term eating patterns. Other limitations of this study are that it only provides mean values of food intake rates, consumption is not normalized by body weight, and presentation of results is not consistent with U.S. EPA's recommended age groups. These data are based on older surveys and may not be entirely representative of current eating patterns.

9.3.2.4. *U.S. EPA Analysis of Continuing Survey of Food Intake Among Individuals (CSFII) 1994−1996, 1998 Based on U.S. Department of Agriculture (USDA) (2000) and U.S. EPA (2000)*

U.S. EPA/OPP, in cooperation with USDA's Agricultural Research Service, used data from the 1994−1996, 1998 CSFII to develop the FCID (U.S. EPA, 2000; USDA, 2000), as described in Section 9.3.1.1. The CSFII 1994−1996 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, DC. In each of the three survey years, data were collected for a nationally representative sample of individuals of all ages. The CSFII 1998 was conducted between December 1997 and December 1998 and surveyed children 9 years of age and younger. It used the same sample design as the CSFII 1994−1996 and was intended to be merged with CSFII 1994−1996 to increase the sample size for children. The merged surveys are designated as CSFII 1994−1996, 1998 (USDA, 2000). Additional information on the CSFII can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994−1996, 1998 collected dietary intake data through in-person interviews on 2 non-consecutive days. The data were based on 24-hour recall. A total of 21,662 individuals provided data for the first day; of those individuals, 20,607 provided data for a second day. The 2-day response rate for the 1994−1996 CSFII was approximately 76%. The 2-day response rate for CSFII 1998 was 82%. The CSFII 1994−1996, 1998 surveys were based on a complex multistage area probability sample design. The sampling frame was organized using 1990 U.S. population census estimates, and the stratification plan took into account geographic location, degree of urbanization, and socioeconomic characteristics. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all four years of the surveys can be combined. USDA recommends that all four years be combined in order to provide an adequate sample size for children.

The fruits and vegetable items/groups selected for the U.S. EPA analysis included total fruits and vegetables, and various individual fruits and vegetables. CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. Intake rates for these food items/groups were calculated, and summary statistics were generated on both a per capita and a consumer-only basis using the same general methodology as in the U.S. EPA analysis of 2003−2006 NHANES data, as described in Section 9.3.1.1. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 9-14 presents per capita intake data for total fruits and total vegetables in g/kg-day; Table 9-15 provides consumer-only intake data for total fruits and total vegetables in g/kg-day. Table 9-16 provides per capita intake data for individual fruits and vegetables, and Table 9-17 provides consumer-only intake data for individual fruits and vegetables. In general, these data represent intake of the edible portions of uncooked foods. Tables 9-18 through 9-22 present data for exposed/protected fruits and vegetables and root vegetables. These five tables were created using only CSFII 1994−1996. These data represent as-consumed intake rates.

The results are presented in units of g/kg-day. Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the ADD equation. The cautions concerning converting these intake rates into units of g/day by multiplying by a single average body weight and the discussion of the use of short term data in the NHANES description in Section 9.3.1.1, apply to the CSFII estimates as well. A strength of U.S. EPA's analysis is that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The analysis uses the 1994−1996, 1998 CSFII data set, which was designed to be representative of the U.S. population. Also, the data set includes four years of intake data combined and is based on a 2-day survey period. However, as discussed above, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest. While the CSFII data are older than the NHANES data, they provide relevant information on consumption by season, region of the United States, and urbanization, breakdowns that are not available in the publicly released NHANES data.

9.3.2.5. *Smiciklas-Wright et al. (2002)—Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994−1996*

Using data gathered in the 1994−1996 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of fruits and vegetables consumed per eating occasion by members of the U.S. population (i.e., serving sizes). The estimates of serving size were based on data obtained from 14,262 respondents, ages 2 years and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumer-only data).

Table 9-23 presents serving size data for selected fruits and vegetables, and Table 9-24 presents serving size data by age group. These data are presented on an as-consumed basis (grams) and represent the quantity of fruits and vegetables consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. Only the mean and standard deviation serving size data and percent of the population consuming the food during the 2-day survey period are presented in this handbook. Percentiles of serving sizes of the foods consumed by these age groups of the U.S. population can be found in Smiciklas-Wright et al. (2002).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed were not provided by the respondents, standard recipes were used. As a result, the estimates of quantity consumed for some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods. This study used data from the 1994 to 1996 CSFII; data from the 1998 children's supplement were not included.

9.3.2.6. *Vitolins et al. (2002)—Quality of Diets Consumed by Older Rural Adults*

Vitolins et al. (2002) conducted a survey to evaluate the dietary intake, by food groups, of older (>70 years) rural adults. The sample consisted of 130 community dwelling residents from two rural counties in North Carolina. Data on dietary intake over the preceding year were obtained in face-to-face interviews conducted in participants' homes, or in a few cases, a senior center. The food frequency questionnaire used in the survey was a modified version of the National Cancer Institute Health Habits and History Questionnaire; this modified version included an expanded food list containing a greater number of ethnic foods than the original food frequency form. Demographic and personal data collected included sex, ethnicity, age, education, denture use, marital status, chronic disease, and weight. Food items reported in the survey were separated into food groups similar to the USDA Food Guide Pyramid and the National Cancer Institute's *5 A Day for Better Health* program. These groups are: (1) fruits and vegetables; (2) bread, cereal, rice, and pasta; (3) milk, yogurt, and cheese; (4) meat, fish, poultry, beans, and eggs; and (5) fats, oils, sweets, and snacks. Medians, ranges, frequencies, and percentages were used to summarize intake of each food group, broken down by demographic and health characteristics. To assess the univariate associations of these characteristics with consumption, Wilcoxon rank-sum tests were used. In addition, multivariate regression models were used to determine which demographic and health factors were jointly predictive of intake of each of the five food groups.

Thirty-four percent of the survey participants were African American, 36% were European

American, and 30% were Native American. Sixty-two percent were female, 62% were not married at the time of the interview, and 65% had some high school education or were high school graduates. Almost all of the participants (95%) had one or more chronic diseases. Sixty percent of the respondents were between 70 and 79 years of age; the median age was 78 years old. Table 9-25 presents the median servings of fruits and vegetables broken down by demographic and health characteristic. The only variable predictive of fruit and vegetable intake was ethnicity ($p = 0.02$), with European Americans consuming significantly more than either African Americans or Native Americans. The multiple regression model indicated a statistically significant interaction between sex and ethnicity ($p = 0.04$) and a significant main effect for chronic disease ($p = 0.04$) for fruit and vegetable consumption. Among males, European Americans consumed significantly more fruits and vegetables than either African Americans or Native Americans. Men and women did not differ significantly in their fruit and vegetable consumption, except for African Americans, where women had a significantly greater intake ($p = 0.01$).

An advantage of this study is that dietary information was collected on older individuals (>70 years of age). One limitation of the study, as noted by the study authors, is that the study did not collect information on the length of time the participants had been practicing the dietary behaviors reported in the survey. Also, the survey results are based on dietary recall; the questionnaire required participants to report the frequency of food consumption during the past year. The study authors noted that, currently, there are no dietary assessment tools that allow collecting comprehensive dietary data over years of food consumption. Another limitation of the study is that the small sample size used makes associations by sex and ethnicity difficult.

9.3.2.7. *Fox et al. (2004)—Feeding Infants and Toddlers Study: What Foods Are Infants and Toddlers Eating*

Fox et al. (2004) used data from the *Feeding Infants and Toddlers Study* (FITS) to assess food consumption patterns in infants and toddlers. The FITS was sponsored by Gerber Products Company and was conducted to obtain current information on food and nutrient intakes of children, ages 4 to 24 months old, in the 50 states and the District of Columbia. The FITS is described in detail in Devaney et al. (2004). FITS was based on a random sample of 3,022 infants and toddlers for which dietary intake data were collected by telephone from their parents or caregivers between March and July 2002. An initial recruitment and household interview was conducted, followed by an interview to obtain information on intake based on 24-hour recall. The interview also addressed growth, development, and feeding patterns. A second dietary recall interview was conducted for a subset of 703 randomly selected respondents. The study over-sampled children in the 4 to 6 and 9 to 11 months age groups; sample weights were adjusted for non-response, over-sampling, and under-coverage of some population groups. The response rate for the FITS was 73% for the recruitment interview. Of the recruited households, there was a response rate of 94% for the dietary recall interviews (Devaney et al., 2004). Table 9-26 shows the characteristics of the FITS study population.

Fox et al. (2004) analyzed the first set of 24-hour recall data collected from all study participants. For this analysis, children were grouped into six age categories: 4 to 6 months, 7 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Table 9-27 provides the percentage of infants and toddlers consuming different types of vegetables at least once in a day. The percentages of children eating any type of vegetable ranged from 39.9% for 4 to 6 month olds to 81.6% for 19 to 24 month olds. Table 9-28 provides the top five vegetables consumed by age group. Some of the highest percentages ranged from baby food carrots (9.6%) in the 4 to 6 month old group to French fries (25.5%) in the 19 to 24 month old group. Table 9-29 provides the percentage of children consuming different types of fruit at least once per day. The percentages of children eating any type of fruit ranged from 41.9% to 4 to 6 month olds to 77.2% for 12 to 14 month olds. Table 9-30 provides information on the top five fruits eaten by infants and toddlers at least once per day. The highest percentages were for bananas among infants 9 to 24 months, and baby food applesauce among infants 4 to 8 months old.

The advantages of this study are that the study population represented the U.S. population and the sample size was large. One limitation of the analysis done by Fox et al. (2004) was that only frequency data were provided; no information on actual intake rates was included. In addition, Devaney et al. (2004) noted several limitations associated with the FITS data. For the FITS, a commercial list of infants and toddlers was used to obtain the sample used in the study. Since many of the households could not be located and did not have children in the target population, a lower response rate than would have occurred in a true national sample was obtained

(Devaney et al., 2004). In addition, the sample was likely from a higher socioeconomic status when compared with all U.S. infants in this age group (4 to 24 months old), and the use of a telephone survey may have omitted lower-income households without telephones (Devaney et al., 2004).

9.3.2.8. *Ponza et al. (2004)—Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in Women, Infants, and Children (WIC)*

Ponza et al. (2004) conducted a study using selected data from the FITS to assess feeding patterns, food choices, and nutrient intake of infants and toddlers participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Ponza et al. (2004) evaluated FITS data for the following age groups: 4 to 6 months ($N = 862$), 7 to 11 months ($N = 1{,}159$), and 12 to 24 months ($N = 996$). Table 9-31 shows the total sample size described by WIC participants and non-participants.

The foods consumed were analyzed by tabulating the percentage of infants who consumed specific foods/food groups per day (Ponza et al., 2004). Weighted data were used in all of the analyses used in the study (Ponza et al., 2004). Table 9-31 presents the demographic data for WIC participants and non-participants. Table 9-32 provides information on the food choices for the infants and toddlers studied. There was little difference in vegetable choices among WIC participants and non-participants (see Table 9-32). However, there were some differences for fruits.

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. A limitation of the study is that intake values for foods were not provided. Other limitations are those associated with the FITS data, as described previously in Section 9.3.2.7.

9.3.2.9. *Fox et al. (2006)—Average Portion of Foods Commonly Eaten by Infants and Toddlers in the United States*

Fox et al. (2006) estimated average portion sizes consumed per eating occasion by children 4 to 24 months of age who participated in the FITS. Section 9.3.2.7 describes the FITS, which is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers. It included a stratified random sample of 3,022 children between 4 and 24 months of age.

Using the 24-hour recall data, Fox et al. (2006) derived average portion sizes for major food groups, including fruits and vegetables. Average portion sizes for select individual foods within these major groups were also estimated. For this analysis, children were grouped into six age categories: 4 to 5 months, 6 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Tables 9-33 and 9-34 present the average portion sizes for fruits and vegetables for infants and toddlers, respectively.

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. Limitations are those associated with the FITS data, as described previously in Section 9.3.2.7.

9.3.2.10. *Menella et al. (2006)—Feeding Infants and Toddlers Study: The Types of Foods Fed to Hispanic Infants and Toddlers*

Menella et al. (2006) investigated the types of food and beverages consumed by Hispanic infants and toddlers in comparison to the non-Hispanic infants and toddlers in the United States. The FITS 2002 data for children between 4 and 24 months of age were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Menella et al., 2006). Menella et al. (2006) grouped the infants as follows: 4 to 5 months ($N = 84$ Hispanic; 538 non-Hispanic), 6 to 11 months ($N = 163$ Hispanic; 1,228 non-Hispanic), and 12 to 24 months ($N = 124$ Hispanic; 871 non-Hispanic) of age.

Table 9-35 provides the percentages of Hispanic and non-Hispanic infants and toddlers consuming fruits and vegetables. In most instances, the percentages consuming the different types of fruits and vegetables were similar. However, 4-to-5-month-old Hispanic infants were more likely to eat fruits than non-Hispanic infants in this age group. Table 9-36 provides the top five fruits and vegetables consumed and the percentage of children consuming these foods at least once in a day. Apples and bananas were the foods with the highest percent consuming for both the Hispanic and non-Hispanic study groups. Potatoes and carrots were the vegetables with the highest percentage of infants and toddlers consuming in both study groups.

The advantage of the study is that it provides information on food preferences for Hispanic and non-Hispanic infants and toddlers. A limitation is that the study did not provide food intake data, but provided frequency-of-use data instead. Other limitations are those noted previously in Section 9.3.2.7 for the FITS data.

9.4. CONVERSION BETWEEN WET- AND DRY-WEIGHT INTAKE RATES

The intake data presented in this chapter are reported in units of wet weight (i.e., as-consumed or edible portion uncooked fruits and vegetables consumed per day or per eating occasion). However, data on the concentration of contaminants in fruits and vegetables may be reported in units of either wet or dry weight (e.g., mg contaminant per gram dry weight of fruits and vegetables). It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of fruits and vegetables, then the dry-weight units should be used for their intake values).

If necessary, wet-weight (e.g., as-consumed) intake rates may be converted to dry-weight intake rates using the moisture content percentages presented in Table 9-37 (USDA, 2007) and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 9-1)}$$

where:

IR_{dw} = dry-weight intake rate,
IR_{ww} = wet-weight intake rate, and
W = percent water content.

Alternatively, dry-weight residue levels in fruits and vegetables may be converted to wet-weight residue levels for use with wet-weight (e.g., as-consumed) intake rates as follows:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 9-2)}$$

where:

C_{ww} = wet-weight concentration,
C_{dw} = dry-weight concentration, and
W = percent water content.

Table 9-37 presents moisture data for selected fruits and vegetables taken from USDA (2007).

9.5. REFERENCES FOR CHAPTER 9

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Table 9-3. Per Capita Intake of Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits														
Whole Population	16,783	85	1.6	0.05	0.0	0.0	0.0	0.0	0.7	2.0	4.0	6.1	14.6	65.6*
Age Group														
Birth to 1 year	865	61	6.2	0.46	0.0*	0.0*	0.0	0.0	2.2	10.2	17.6	23.0*	35.9*	56.5*
1 to 2 years	1,052	97	7.8	0.42	0.0*	0.0*	0.2	2.2	5.6	11.7	16.8	21.3*	39.3*	65.6*
3 to 5 years	978	97	4.6	0.25	0.0*	0.0	0.0	0.9	3.2	6.6	11.1	14.9	20.0*	32.1*
6 to 12 years	2,256	93	2.3	0.12	0.0*	0.0	0.0	0.1	1.3	3.2	6.4	8.7	13.8*	24.4*
13 to 19 years	3,450	80	0.9	0.04	0.0	0.0	0.0	0.0	0.2	1.3	2.6	3.5	6.1	16.7*
20 to 49 years	4,289	81	0.9	0.04	0.0	0.0	0.0	0.0	0.3	1.3	2.6	3.7	6.2	15.9*
Female 13 to 49 years	4,103	85	1.0	0.05	0.0	0.0	0.0	0.0	0.4	1.4	2.8	3.7	6.4	16.7*
50 years and older	3,893	89	1.4	0.05	0.0	0.0	0.0	0.1	0.9	2.0	3.4	4.4	6.5	17.3*
Race														
Mexican American	4,450	87	2.3	0.11	0.0	0.0	0.0	0.1	1.1	2.7	5.8	9.6	18.3	39.2*
Non-Hispanic Black	4,265	82	1.2	0.06	0.0	0.0	0.0	0.0	0.2	1.3	3.2	5.0	12.4	39.1*
Non-Hispanic White	6,757	85	1.5	0.05	0.0	0.0	0.0	0.0	0.7	1.9	3.8	5.5	14.0	65.6*
Other Hispanic	562	87	2.1	0.20	0.0*	0.0	0.0	0.0	1.0	2.8	4.9	7.1	19.5*	32.7*
Other Race—Including Multiple	749	89	2.0	0.13	0.0*	0.0	0.0	0.1	0.9	2.6	5.2	8.6	15.3*	42.1*
Vegetables														
Whole Population	16,783	100	2.9	0.04	0.0	0.4	0.7	1.3	2.3	3.7	5.7	7.5	13.2	36.1*
Age Group														
Birth to 1 year	865	73	5.0	0.28	0.0*	00*	0.0	0.0	3.3	8.7	12.9	16.2*	22.7*	36.1*
1 to 2 years	1,052	100	6.7	0.26	0.0*	1.0*	1.6	3.0	5.7	8.9	13.3	15.6*	28.7*	32.8*
3 to 5 years	978	100	5.4	0.25	0.1*	0.6	1.5	2.3	4.2	7.2	10.6	13.4	21.4*	30.3*
6 to 12 years	2,256	100	3.7	0.18	0.1*	0.5	0.9	1.5	2.8	4.8	7.6	10.4	14.8*	23.1*
13 to 19 years	3,450	100	2.3	0.05	0.0	0.3	0.5	1.1	1.8	3.0	4.3	5.5	8.9	20.0*
20 to 49 years	4,289	100	2.5	0.06	0.1	0.4	0.7	1.3	2.2	3.3	4.9	5.9	8.6	18.3*
Female 13 to 49 years	4,103	100	2.5	0.08	0.1	0.4	0.6	1.2	2.0	3.3	4.7	5.9	8.9	18.3*
50 years and older	3,893	100	2.6	0.05	0.0	0.4	0.7	1.3	2.2	3.4	4.9	6.1	9.1	22.6*
Race														
Mexican American	4,450	99	3.2	0.06	0.0	0.5	0.8	1.5	2.5	4.1	6.4	8.6	13.5	36.1*
Non-Hispanic Black	4,265	100	2.4	0.05	0.0	0.2	0.5	0.9	1.7	3.0	4.7	6.5	11.5	30.3*
Non-Hispanic White	6,757	100	2.9	0.05	0.0	0.4	0.7	1.4	2.3	3.7	5.6	7.2	12.8	29.5*
Other Hispanic	562	99	3.1	0.16	0.0*	0.2	0.7	1.2	2.2	3.8	6.3	9.4	16.3*	26.2*
Other Race—Including Multiple	749	100	3.4	0.20	0.1*	0.4	0.7	1.5	2.7	4.2	6.8	9.3	15.6*	32.8*

N = Sample size.
SE = Standard error.
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-4. Consumer-Only Intake of Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits													
Whole Population	14,362	1.9	0.05	0.0	0.0	0.0	0.2	1.0	2.3	4.4	6.7	15.2	65.6*
Age Group													
Birth to 1 year	536	10.1	0.59	0.0*	0.3*	*0.8	3.6	8.1	14.7	21.2*	25.8*	43.7*	56.5*
1 to 2 years	1,002	8.1	0.43	0.0*	0.1*	0.5	2.6	6.2	11.8	16.8	21.4*	39.3*	65.6*
3 to 5 years	924	4.7	0.24	0.0*	0.0	0.1	1.1	3.5	6.7	11.3	15.1	20.0*	32.1*
6 to 12 years	2,077	2.5	0.12	0.0*	0.0	0.0	0.2	1.6	3.4	6.6	9.2	14.5*	24.4*
13 to 19 years	2,830	1.1	0.04	0.0	0.0	0.0	0.0	0.7	1.6	2.9	3.8	6.2	16.7*
20 to 49 years	3,529	1.1	0.05	0.0	0.0	0.0	0.1	0.6	1.6	2.9	3.8	6.7	15.9*
Female 13 to 49 years	3,508	1.2	0.06	0.0	0.0	0.0	0.1	0.7	1.7	3.1	4.1	6.5	16.7*
50 years and older	3,464	1.5	0.05	0.0	0.0	0.0	0.4	1.1	2.2	3.6	4.6	6.7	17.3*
Race													
Mexican American	3,835	2.6	0.12	0.0	0.0	0.0	0.4	1.4	3.0	6.3	10.6	19.3	39.2*
Non-Hispanic Black	3,595	1.4	0.07	0.0	0.0	0.0	0.0	0.6	1.7	3.8	5.7	12.9	39.1*
Non-Hispanic White	5,795	1.8	0.05	0.0	0.0	0.0	0.2	1.0	2.2	4.1	6.1	14.5	65.6*
Other Hispanic	478	2.5	0.23	0.0*	0.0	0.0	0.3	1.5	3.0	5.0	8.6	19.5*	32.7*
Other Race—Including Multiple	659	2.3	0.16	0.0*	0.0	0.0	0.2	1.1	2.8	6.0	9.4	15.3*	42.1*
Vegetables													
Whole Population	16,531	2.9	0.04	0.0	0.4	0.7	1.3	2.3	3.7	5.7	7.5	13.2	36.1*
Age Group													
Birth to 1 year	623	6.8	0.33	0.0*	0.1*	0.4*	2.6	5.5	10.1	14.5*	18.1*	22.7*	36.1*
1 to 2 years	1,048	6.7	0.26	0.0*	1.0*	1.7	3.0	5.7	8.9	13.3	15.6*	28.7*	32.8*
3 to 5 years	977	5.4	0.25	0.1*	0.6	1.5	2.3	4.2	7.2	10.6	13.4	21.4*	30.3*
6 to 12 years	2,256	3.7	0.18	0.1*	0.5	0.9	1.5	2.8	4.8	7.6	10.4	14.8*	23.1*
13 to 19 years	3,447	2.3	0.05	0.0	0.3	0.5	1.1	1.8	3.0	4.3	5.5	8.9	20.0*
20 to 49 years	4,288	2.5	0.06	0.1	0.4	0.7	1.3	2.2	3.3	4.9	5.9	8.6	18.3*
Female 13 to 49 years	4,102	2.5	0.08	0.1	0.4	0.6	1.2	2.0	3.3	4.7	5.9	8.9	18.3*
50 years and older	3,892	2.6	0.05	0.0	0.4	0.7	1.3	2.2	3.4	4.9	6.1	9.1	22.6*
Race													
Mexican American	4,341	3.3	0.06	0.1	0.5	0.8	1.5	2.5	4.1	6.4	8.6	13.5	36.1*
Non-Hispanic Black	4,228	2.4	0.05	0.0	0.3	0.5	0.9	1.7	3.0	4.7	6.5	11.5	30.3*
Non-Hispanic White	6,683	2.9	0.05	0.1	0.4	0.7	1.4	2.3	3.7	5.6	7.2	12.8	29.5*
Other Hispanic	544	3.1	0.16	0.1*	0.3	0.7	1.3	2.2	3.8	6.4	9.4	16.3*	26.2*
Other Race—Including Multiple	735	3.4	0.21	0.2*	0.4	0.7	1.5	2.7	4.3	6.9	9.3	15.6*	32.8*

N = Sample size.
SE = Standard error.
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).
Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Apples			Asparagus			Bananas			Beans		
Whole Population	16,783	33	0.41	0.01	2	0.01	0.00	55	0.37	0.01	45	0.24	0.01
Age Group													
Birth to 1 year	865	39	2.23	0.24	1	0.00	0.00	46	1.83	0.19	30	0.54	0.06
1 to 2 years	1,052	50	1.96	0.14	2	0.03	0.01	77	2.35	0.26	49	0.69	0.06
3 to 5 years	978	42	1.21	0.10	1	0.01	0.01	73	1.00	0.09	43	0.61	0.07
6 to 12 years	2,256	39	0.74	0.06	1	0.01	0.00	68	0.42	0.04	37	0.30	0.03
13 to 19 years	3,450	27	0.27	0.02	1	0.00	0.00	50	0.15	0.01	31	0.13	0.01
20 to 49 years	4,289	28	0.21	0.02	2	0.01	0.00	48	0.20	0.01	46	0.19	0.01
Female 13 to 49 years	4,103	29	0.23	0.02	2	0.01	0.00	50	0.20	0.01	45	0.17	0.01
50 years and older	3,893	38	0.28	0.02	3	0.02	0.00	58	0.33	0.02	51	0.22	0.01
Race													
Mexican American	4,450	33	0.58	0.03	1	0.00	0.00	56	0.56	0.04	59	0.32	0.01
Non-Hispanic Black	4,265	27	0.31	0.02	0	0.00	0.00	55	0.25	0.02	43	0.25	0.01
Non-Hispanic White	6,757	35	0.40	0.02	3	0.02	0.00	54	0.36	0.02	43	0.22	0.01
Other Hispanic	562	32	0.47	0.06	1	0.00	0.00	55	0.53	0.06	58	0.25	0.03
Other Race—Including Multiple	749	32	0.47	0.04	3	0.01	0.00	58	0.43	0.04	50	0.30	0.04

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Beets			Berries and Small Fruit			Broccoli			Bulb Vegetables		
Whole Population	16,783	3	0.01	0.00	67	0.30	0.01	15	0.10	0.01	97	0.18	0.00
Age Group													
Birth to 1 year	865	5	0.00	0.00	19	0.24	0.09	6	0.07	0.02	39	0.07	0.01
1 to 2 years	1,052	1	0.00	0.00	83	1.46	0.14	16	0.30	0.06	94	0.28	0.02
3 to 5 years	978	1	0.01	0.01	84	0.97	0.11	12	0.19	0.04	96	0.28	0.02
6 to 12 years	2,256	0	0.00	0.00	80	0.46	0.04	11	0.10	0.02	98	0.21	0.02
13 to 19 years	3,450	1	0.00	0.00	64	0.19	0.01	9	0.05	0.01	98	0.15	0.01
20 to 49 years	4,289	2	0.01	0.00	62	0.17	0.01	16	0.09	0.01	98	0.19	0.01
Female 13 to 49 years	4,103	2	0.01	0.00	67	0.20	0.01	17	0.09	0.01	97	0.16	0.01
50 years and older	3,893	5	0.01	0.00	71	0.28	0.02	16	0.09	0.01	97	0.16	0.00
Race													
Mexican American	4,450	1	0.00	0.00	59	0.23	0.02	12	0.07	0.01	96	0.27	0.01
Non-Hispanic Black	4,265	1	0.00	0.00	64	0.18	0.01	12	0.07	0.01	96	0.13	0.01
Non-Hispanic White	6,757	4	0.01	0.00	69	0.33	0.02	15	0.10	0.01	97	0.17	0.00
Other Hispanic	562	3	0.00	0.00	59	0.30	0.05	16	0.13	0.04	93	0.23	0.01
Other Race—Including Multiple	749	1	0.00	0.00	66	0.38	0.06	19	0.13	0.03	97	0.25	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cabbage			Carrots			Citrus Fruits			Corn		
Whole Population	16,783	13	0.05	0.00	47	0.14	0.00	20	0.16	0.01	96	0.43	0.01
Age Group													
Birth to 1 year	865	1	0.01	0.01	15	0.17	0.05	2	0.05	0.02	56	0.62	0.10
1 to 2 years	1,052	7	0.05	0.02	50	0.47	0.04	25	0.65	0.08	97	1.13	0.05
3 to 5 years	978	5	0.04	0.01	45	0.32	0.05	18	0.46	0.06	100	1.26	0.07
6 to 12 years	2,256	7	0.04	0.01	43	0.21	0.03	15	0.21	0.02	99	0.88	0.03
13 to 19 years	3,450	6	0.02	0.00	35	0.08	0.01	13	0.08	0.01	96	0.37	0.01
20 to 49 years	4,289	13	0.05	0.01	46	0.11	0.01	20	0.11	0.01	96	0.32	0.01
Female 13 to 49 years	4,103	12	0.05	0.01	46	0.11	0.01	21	0.11	0.01	96	0.31	0.01
50 years and older	3,893	18	0.08	0.00	54	0.12	0.01	25	0.14	0.01	96	0.27	0.01
Race													
Mexican American	4,450	10	0.03	0.00	45	0.15	0.01	27	0.37	0.03	96	0.78	0.03
Non-Hispanic Black	4,265	12	0.06	0.01	36	0.08	0.01	16	0.17	0.03	96	0.46	0.02
Non-Hispanic White	6,757	13	0.05	0.00	49	0.14	0.01	20	0.12	0.01	97	0.37	0.01
Other Hispanic	562	9	0.03	0.01	49	0.17	0.02	23	0.26	0.03	94	0.45	0.05
Other Race—Including Multiple	749	17	0.12	0.02	52	0.23	0.02	21	0.20	0.05	91	0.41	0.03

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cucumbers			Cucurbits			Fruiting Vegetables			Leafy Vegetables		
Whole Population	16,783	40	0.09	0.00	48	0.34	0.03	95	0.80	0.02	92	0.54	0.01
Age Group													
Birth to 1 year	865	3	0.02	0.01	20	0.64	0.09	31	0.30	0.05	40	0.22	0.04
1 to 2 years	1,052	24	0.14	0.02	37	1.01	0.18	93	1.45	0.07	82	0.71	0.07
3 to 5 years	978	26	0.19	0.03	36	0.66	0.08	95	1.53	0.08	87	0.61	0.06
6 to 12 years	2,256	30	0.11	0.01	38	0.56	0.11	97	1.05	0.05	90	0.43	0.02
13 to 19 years	3,450	34	0.06	0.01	40	0.20	0.02	96	0.75	0.03	89	0.35	0.01
20 to 49 years	4,289	45	0.09	0.01	52	0.26	0.03	97	0.76	0.02	94	0.55	0.02
Female 13 to 49 years	4,103	44	0.10	0.01	51	0.30	0.04	96	0.70	0.03	93	0.58	0.03
50 years and older	3,893	43	0.08	0.01	54	0.31	0.02	95	0.66	0.03	93	0.60	0.02
Race													
Mexican American	4,450	30	0.07	0.01	42	0.27	0.02	96	1.13	0.03	90	0.40	0.02
Non-Hispanic Black	4,265	37	0.06	0.01	42	0.18	0.02	94	0.62	0.03	90	0.46	0.02
Non-Hispanic White	6,757	43	0.10	0.01	51	0.37	0.03	96	0.78	0.02	92	0.56	0.02
Other Hispanic	562	33	0.09	0.02	41	0.25	0.05	92	0.97	0.06	90	0.48	0.05
Other Race—Including Multiple	749	38	0.11	0.03	47	0.44	0.14	92	0.75	0.04	91	0.69	0.07

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Legumes			Lettuce			Onions			Peaches		
Whole Population	16,783	96	0.45	0.01	53	0.23	0.01	96	0.18	0.00	49	0.11	0.01
Age Group													
Birth to 1 year	865	58	1.58	0.15	1	0.01	0.00	38	0.07	0.01	27	0.77	0.09
1 to 2 years	1,052	97	1.65	0.24	21	0.15	0.02	94	0.27	0.02	70	0.55	0.08
3 to 5 years	978	98	1.07	0.17	29	0.23	0.03	95	0.26	0.02	68	0.31	0.05
6 to 12 years	2,256	97	0.48	0.04	37	0.17	0.01	98	0.20	0.02	67	0.13	0.02
13 to 19 years	3,450	95	0.23	0.01	53	0.20	0.01	97	0.15	0.01	45	0.05	0.01
20 to 49 years	4,289	96	0.34	0.02	62	0.26	0.01	97	0.18	0.01	43	0.04	0.01
Female 13 to 49 years	4,103	95	0.32	0.02	60	0.28	0.01	96	0.16	0.01	46	0.05	0.01
50 years and older	3,893	98	0.41	0.02	56	0.24	0.01	97	0.16	0.00	51	0.10	0.01
Race													
Mexican American	4,450	95	0.46	0.03	52	0.20	0.01	96	0.26	0.01	44	0.12	0.02
Non-Hispanic Black	4,265	96	0.39	0.02	45	0.15	0.01	95	0.13	0.01	52	0.09	0.01
Non-Hispanic White	6,757	97	0.42	0.02	55	0.25	0.01	97	0.17	0.00	50	0.11	0.01
Other Hispanic	562	96	0.63	0.17	50	0.19	0.03	93	0.22	0.01	38	0.09	0.03
Other Race—Including Multiple	749	95	0.76	0.10	51	0.22	0.03	96	0.24	0.02	46	0.09	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Pears			Peas			Pome Fruit			Pumpkins		
Whole Population	16,783	10	0.09	0.01	19	0.07	0.00	38	0.50	0.02	2	0.00	0.00
Age Group													
Birth to 1 year	865	19	0.70	0.10	36	0.66	0.07	45	2.94	0.29	0	0.00	0.00
1 to 2 years	1,052	25	0.44	0.07	27	0.29	0.04	61	2.40	0.15	0	0.01	0.01
3 to 5 years	978	25	0.32	0.06	17	0.17	0.02	54	1.53	0.11	0	0.00	0.00
6 to 12 years	2,256	17	0.13	0.02	13	0.06	0.01	48	0.87	0.06	1	0.01	0.00
13 to 19 years	3,450	8	0.03	0.00	13	0.04	0.01	31	0.30	0.02	1	0.00	0.00
20 to 49 years	4,289	6	0.04	0.01	18	0.05	0.00	31	0.25	0.02	2	0.00	0.00
Female 13 to 49 years	4,103	8	0.04	0.01	18	0.05	0.00	32	0.28	0.02	2	0.00	0.00
50 years and older	3,893	9	0.07	0.01	23	0.07	0.00	42	0.35	0.02	3	0.00	0.00
Race													
Mexican American	4,450	10	0.13	0.02	15	0.05	0.01	39	0.71	0.04	5	0.01	0.00
Non-Hispanic Black	4,265	9	0.05	0.01	20	0.08	0.01	31	0.36	0.02	0	0.00	0.00
Non-Hispanic White	6,757	10	0.08	0.01	19	0.07	0.00	39	0.48	0.02	2	0.00	0.00
Other Hispanic	562	8	0.07	0.02	19	0.07	0.02	35	0.54	0.08	4	0.01	0.01
Other Race—Including Multiple	749	11	0.16	0.05	27	0.13	0.02	36	0.63	0.06	2	0.00	0.00

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Root Tuber Vegetables			Stalk/Stem Vegetables			Stone Fruit			Strawberries		
Whole Population	16,783	99	1.15	0.02	19	0.05	0.00	52	0.16	0.01	41	0.10	0.01
Age Group													
Birth to 1 year	865	69	2.66	0.19	3	0.01	0.00	32	0.94	0.11	10	0.06	0.03
1 to 2 years	1,052	100	3.15	0.13	13	0.07	0.02	72	0.67	0.08	52	0.36	0.06
3 to 5 years	978	100	2.60	0.16	10	0.05	0.02	72	0.41	0.06	53	0.27	0.05
6 to 12 years	2,256	100	1.79	0.07	11	0.03	0.00	68	0.21	0.03	50	0.14	0.03
13 to 19 years	3,450	100	0.99	0.04	12	0.02	0.00	47	0.08	0.01	35	0.07	0.01
20 to 49 years	4,289	100	0.89	0.03	24	0.05	0.00	46	0.08	0.01	36	0.06	0.01
Female 13 to 49 years	4,103	100	0.87	0.02	21	0.04	0.00	49	0.09	0.01	39	0.07	0.01
50 years and older	3,893	100	0.91	0.03	21	0.05	0.01	55	0.17	0.02	45	0.10	0.01
Race													
Mexican American	4,450	99	1.17	0.04	12	0.02	0.00	47	0.18	0.03	34	0.07	0.01
Non-Hispanic Black	4,265	99	1.09	0.03	12	0.02	0.00	54	0.13	0.01	29	0.04	0.01
Non-Hispanic White	6,757	100	1.14	0.03	21	0.06	0.00	54	0.17	0.01	44	0.11	0.01
Other Hispanic	562	98	1.24	0.09	15	0.03	0.01	41	0.13	0.03	33	0.09	0.02
Other Race—Including Multiple	749	99	1.35	0.08	27	0.06	0.01	49	0.13	0.03	36	0.10	0.02

Table 9-5. Per Capita Intake of Individual Fruits and Vegetables Based on the 2003−2006 (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Tomatoes			Tropical Fruits			White Potatoes					
Whole Population	16,783	87	0.72	0.02	66	0.46	0.02	91	0.65	0.02			
Age Group													
Birth to 1 year	865	26	0.29	0.04	48	1.97	0.20	46	0.52	0.08			
1 to 2 years	1,052	83	1.40	0.07	83	2.65	0.28	94	1.74	0.10			
3 to 5 years	978	85	1.46	0.08	81	1.19	0.09	94	1.38	0.15			
6 to 12 years	2,256	91	0.99	0.04	75	0.52	0.04	93	0.96	0.07			
13 to 19 years	3,450	89	0.69	0.03	59	0.22	0.02	92	0.61	0.03			
20 to 49 years	4,289	89	0.66	0.02	61	0.27	0.02	91	0.54	0.02			
Female 13 to 49 years	4,103	88	0.62	0.02	64	0.28	0.02	90	0.50	0.02			
50 years and older	3,893	84	0.59	0.03	68	0.40	0.02	93	0.54	0.03			
Race													
Mexican American	4,450	91	0.99	0.03	70	0.73	0.05	87	0.65	0.03			
Non-Hispanic Black	4,265	84	0.57	0.02	64	0.32	0.03	91	0.64	0.03			
Non-Hispanic White	6,757	87	0.71	0.02	65	0.42	0.02	93	0.65	0.03			
Other Hispanic	562	86	0.90	0.05	71	0.86	0.09	86	0.66	0.08			
Other Race—Including Multiple	749	82	0.66	0.03	68	0.59	0.04	87	0.69	0.06			

N = Sample size.
SE = Standard error.
Note: Data for fruits and vegetables for which only small percentages of the population reported consumption may be less reliable than data for fruits and vegetables with higher percentages consuming.

Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Apples			Asparagus			Bananas			Beans			Beets		
Whole Population	5,743	1.23	0.03	204	0.63	0.05	9,644	0.68	0.02	7,635	0.53	0.01	353	0.29	0.04
Age Group															
Birth to 1 year	318	5.79	0.38	1	0.21	---	396	3.97	0.31	235	1.80	0.20	30	0.01	0.00
1 to 2 years	508	3.95	0.23	8	1.61	0.15	795	3.04	0.34	530	1.41	0.10	12	0.00	0.00
3 to 5 years	432	2.91	0.21	5	0.77	0.31	716	1.37	0.12	461	1.42	0.13	11	0.97	0.63
6 to 12 years	837	1.88	0.12	15	0.60	0.15	1,553	0.61	0.05	936	0.79	0.05	8	0.78	0.33
13 to 19 years	938	1.00	0.05	13	0.26	0.06	1,817	0.31	0.02	1,264	0.41	0.02	20	0.10	0.03
20 to 49 years	1,233	0.75	0.04	61	0.50	0.07	2,142	0.41	0.03	2,141	0.41	0.01	81	0.30	0.09
Female 13 to 49 years	1,195	0.81	0.05	41	0.42	0.07	2,215	0.39	0.03	1,845	0.39	0.01	58	0.39	0.13
50 years and older	1,477	0.75	0.03	101	0.73	0.06	2,225	0.58	0.02	2,068	0.43	0.01	191	0.28	0.05
Race															
Mexican American	1,601	1.72	0.09	18	0.44	0.08	2,490	1.00	0.05	2,482	0.54	0.02	55	0.07	0.04
Non-Hispanic Black	1,228	1.16	0.05	14	0.57	0.13	2,533	0.46	0.04	1,722	0.58	0.03	42	0.21	0.04
Non-Hispanic White	2,458	1.15	0.04	154	0.67	0.05	3,863	0.66	0.03	2,809	0.52	0.02	235	0.31	0.05
Other Hispanic	202	1.45	0.19	3	0.61	0.25	322	0.98	0.08	291	0.44	0.05	12	0.12	0.04
Other Race—Including Multiple	254	1.45	0.13	15	0.38	0.11	436	0.74	0.07	331	0.61	0.06	9	0.11	0.07

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Berries and Small Fruit			Broccoli			Bulb Vegetables			Cabbage			Carrots		
Whole Population	10,981	0.45	0.02	2,047	0.65	0.03	15,773	0.19	0.00	1,833	0.43	0.02	7,231	0.30	0.01
Age Group															
Birth to 1 year	166	1.26	0.42	45	1.14	0.19	346	0.19	0.03	13	0.96	0.44	166	1.13	0.23
1 to 2 years	839	1.76	0.15	132	1.84	0.27	1,003	0.30	0.02	72	0.73	0.26	525	0.93	0.08
3 to 5 years	788	1.15	0.12	108	1.50	0.25	947	0.29	0.02	67	0.71	0.15	449	0.71	0.09
6 to 12 years	1,751	0.57	0.05	228	0.96	0.12	2,216	0.21	0.02	164	0.56	0.16	912	0.49	0.05
13 to 19 years	2,210	0.30	0.02	289	0.53	0.04	3,354	0.16	0.01	218	0.31	0.04	1,152	0.24	0.02
20 to 49 years	2,601	0.27	0.01	664	0.53	0.03	4,194	0.19	0.01	577	0.41	0.03	1,948	0.24	0.01
Female 13 to 49 years	2,705	0.31	0.02	560	0.54	0.04	3,994	0.17	0.01	461	0.41	0.05	1,755	0.24	0.01
50 years and older	2,626	0.40	0.02	581	0.56	0.02	3,713	0.17	0.00	722	0.43	0.02	2,079	0.23	0.01
Race															
Mexican American	2,563	0.38	0.02	456	0.61	0.07	4,132	0.28	0.01	390	0.32	0.04	1,912	0.33	0.02
Non-Hispanic Black	2,899	0.28	0.02	474	0.61	0.04	4,022	0.14	0.01	442	0.51	0.04	1,471	0.22	0.01
Non-Hispanic White	4,686	0.47	0.02	925	0.65	0.04	6,410	0.18	0.00	852	0.41	0.02	3,220	0.29	0.01
Other Hispanic	333	0.51	0.08	82	0.85	0.22	514	0.25	0.01	48	0.32	0.04	272	0.34	0.05
Other Race—Including Multiple	500	0.58	0.10	110	0.66	0.09	695	0.25	0.02	101	0.70	0.08	356	0.44	0.04

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Citrus Fruits			Corn			Cucumbers			Cucurbits			Fruiting Vegetables		
Whole Population	3,398	0.77	0.04	15,899	0.44	0.01	5,728	0.23	0.01	7,109	0.70	0.05	15,483	0.84	0.02
Age Group															
Birth to 1 year	30	2.90	0.96	465	1.12	0.14	25	0.70	0.31	138	3.16	0.16	281	0.98	0.12
1 to 2 years	256	2.61	0.30	1,028	1.16	0.06	210	0.58	0.09	332	2.75	0.42	987	1.56	0.07
3 to 5 years	191	2.50	0.29	971	1.26	0.07	247	0.74	0.12	335	1.86	0.25	926	1.61	0.09
6 to 12 years	440	1.39	0.09	2,237	0.88	0.04	666	0.37	0.03	828	1.47	0.22	2,192	1.08	0.05
13 to 19 years	549	0.66	0.04	3,332	0.38	0.01	1,191	0.18	0.01	1,347	0.50	0.06	3,304	0.78	0.03
20 to 49 years	896	0.55	0.05	4,134	0.33	0.01	1,827	0.20	0.01	2,138	0.50	0.06	4,155	0.78	0.02
Female 13 to 49 years	860	0.53	0.04	3,967	0.32	0.01	1,596	0.24	0.01	1,874	0.59	0.08	3,945	0.73	0.03
50 years and older	1,036	0.57	0.04	3,732	0.28	0.01	1,562	0.19	0.01	1,991	0.57	0.03	3,638	0.69	0.03
Race															
Mexican American	1,148	1.40	0.06	4,185	0.81	0.03	1,218	0.25	0.02	1,733	0.65	0.05	4,079	1.18	0.03
Non-Hispanic Black	669	1.04	0.14	4,058	0.48	0.02	1,471	0.17	0.01	1,647	0.44	0.04	3,943	0.66	0.03
Non-Hispanic White	1,323	0.59	0.04	6,454	0.39	0.01	2,627	0.23	0.01	3,211	0.73	0.06	6,293	0.82	0.02
Other Hispanic	127	1.10	0.14	516	0.48	0.05	166	0.26	0.05	212	0.60	0.10	498	1.05	0.06
Other Race—Including Multiple	131	0.96	0.24	686	0.45	0.03	246	0.29	0.06	306	0.94	0.29	670	0.81	0.04

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Leafy Vegetables			Legumes			Lettuce			Onions			Peaches		
Whole Population	14,824	0.59	0.01	15,808	0.46	0.01	7,946	0.44	0.01	15,695	0.18	0.00	8,542	0.22	0.01
Age Group															
Birth to 1 year	351	0.55	0.09	459	2.74	0.21	17	0.34	0.16	342	0.19	0.02	215	2.80	0.31
1 to 2 years	896	0.86	0.08	1,011	1.70	0.25	216	0.70	0.09	998	0.28	0.02	700	0.79	0.10
3 to 5 years	861	0.70	0.06	957	1.09	0.17	297	0.78	0.11	941	0.28	0.02	676	0.45	0.07
6 to 12 years	2,035	0.48	0.02	2,198	0.49	0.04	931	0.45	0.02	2,209	0.20	0.02	1,517	0.20	0.03
13 to 19 years	3,106	0.39	0.01	3,256	0.24	0.01	1,882	0.38	0.02	3,333	0.15	0.01	1,675	0.11	0.02
20 to 49 years	4,008	0.59	0.02	4,135	0.35	0.02	2,576	0.43	0.02	4,177	0.19	0.01	1,845	0.10	0.01
Female 13 to 49 years	3,789	0.62	0.03	3,915	0.34	0.02	2,379	0.47	0.02	3,969	0.16	0.01	1,996	0.11	0.01
50 years and older	3,567	0.65	0.02	3,792	0.42	0.02	2,027	0.43	0.01	3,695	0.16	0.00	1,914	0.21	0.02
Race															
Mexican American	3,847	0.44	0.02	4,089	0.49	0.03	2,120	0.38	0.02	4,115	0.27	0.01	1,951	0.28	0.04
Non-Hispanic Black	3,786	0.51	0.03	4,044	0.41	0.02	1,803	0.34	0.02	4,004	0.14	0.01	2,432	0.18	0.02
Non-Hispanic White	6,046	0.61	0.02	6,454	0.44	0.02	3,438	0.46	0.01	6,369	0.17	0.00	3,530	0.22	0.01
Other Hispanic	475	0.53	0.06	517	0.66	0.18	248	0.39	0.05	514	0.24	0.01	250	0.25	0.08
Other Race—Including Multiple	670	0.76	0.07	704	0.79	0.10	337	0.43	0.04	693	0.25	0.02	379	0.19	0.04

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Pears			Peas			Pome Fruit			Pumpkins			Root Tuber Vegetables		
Whole Population	1,965	0.89	0.04	3,133	0.39	0.02	6,699	1.31	0.03	285	0.22	0.02	16,478	1.16	0.02
Age Group															
Birth to 1 year	144	3.77	0.38	236	1.83	0.11	371	6.50	0.42	3	0.73	0.39	583	3.88	0.24
1 to 2 years	243	1.79	0.21	257	1.05	0.11	621	3.92	0.23	4	2.13	0.41	1,050	3.15	0.13
3 to 5 years	221	1.31	0.20	180	0.97	0.13	537	2.82	0.18	8	0.80	0.21	978	2.60	0.16
6 to 12 years	403	0.77	0.12	309	0.51	0.06	1,071	1.82	0.10	35	0.55	0.16	2,256	1.79	0.07
13 to 19 years	272	0.35	0.04	416	0.34	0.04	1,085	0.98	0.05	40	0.19	0.06	3,447	0.99	0.04
20 to 49 years	278	0.63	0.05	780	0.26	0.02	1,362	0.81	0.04	95	0.20	0.04	4,278	0.90	0.03
Female 13 to 49 years	323	0.56	0.07	675	0.27	0.02	1,352	0.87	0.05	87	0.22	0.04	4,097	0.87	0.02
50 years and older	404	0.72	0.06	955	0.29	0.01	1,652	0.84	0.04	100	0.17	0.02	3,886	0.92	0.03
Race															
Mexican American	518	1.25	0.14	644	0.37	0.04	1,851	1.81	0.09	160	0.28	0.06	4,316	1.18	0.04
Non-Hispanic Black	489	0.61	0.07	812	0.42	0.04	1,512	1.15	0.05	10	0.71	0.33	4,218	1.10	0.03
Non-Hispanic White	807	0.84	0.05	1,364	0.38	0.02	2,821	1.23	0.03	91	0.17	0.02	6,667	1.15	0.03
Other Hispanic	54	0.90	0.12	116	0.39	0.08	223	1.55	0.21	11	0.28	0.12	544	1.26	0.09
Other Race—Including Multiple	97	1.51	0.32	197	0.49	0.07	292	1.78	0.16	13	0.23	0.14	733	1.36	0.08

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Stalk/Stem Vegetables			Stone Fruit			Strawberries			Tomatoes			Tropical Fruits		
Whole Population	2,409	0.24	0.01	8,966	0.30	0.02	6,168	0.24	0.02	14,240	0.83	0.02	11,299	0.70	0.02
Age Group															
Birth to 1 year	15	0.26	0.07	235	2.98	0.33	88	0.60	0.28	246	1.11	0.12	423	4.12	0.30
1 to 2 years	101	0.58	0.10	721	0.92	0.10	480	0.70	0.12	895	1.68	0.09	862	3.19	0.33
3 to 5 years	81	0.50	0.10	691	0.56	0.08	460	0.51	0.09	840	1.72	0.09	800	1.47	0.11
6 to 12 years	212	0.24	0.04	1,545	0.31	0.04	1,019	0.28	0.06	2,071	1.09	0.05	1,733	0.69	0.05
13 to 19 years	387	0.15	0.01	1,719	0.16	0.02	1,076	0.20	0.03	3,093	0.77	0.03	2,151	0.37	0.03
20 to 49 years	941	0.22	0.01	1,961	0.17	0.02	1,466	0.17	0.02	3,894	0.74	0.02	2,692	0.44	0.02
Female 13 to 49 years	719	0.20	0.01	2,101	0.18	0.02	1,492	0.19	0.03	3,679	0.71	0.02	2,720	0.44	0.03
50 years and older	672	0.26	0.03	2,094	0.30	0.03	1,579	0.23	0.03	3,201	0.70	0.03	2,638	0.58	0.02
Race															
Mexican American	411	0.18	0.02	2,043	0.38	0.05	1,438	0.22	0.02	3,897	1.09	0.03	3,031	1.03	0.07
Non-Hispanic Black	409	0.15	0.01	2,497	0.24	0.02	1,276	0.15	0.02	3,547	0.68	0.02	2,865	0.51	0.05
Non-Hispanic White	1,336	0.26	0.02	3,753	0.31	0.02	2,979	0.25	0.03	5,714	0.82	0.02	4,498	0.64	0.02
Other Hispanic	71	0.17	0.03	270	0.31	0.08	198	0.29	0.06	470	1.05	0.06	399	1.21	0.12
Other Race—Including Multiple	182	0.22	0.02	403	0.27	0.04	277	0.27	0.05	612	0.81	0.04	506	0.86	0.06

Table 9-6. Consumer-Only Intake of Individual Fruits and Vegetables Based on the 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	White Potatoes														
Whole Population	14,944	0.72	0.02												
Age Group															
Birth to 1 year	389	1.14	0.15												
1 to 2 years	982	1.86	0.10												
3 to 5 years	915	1.46	0.15												
6 to 12 years	2,111	1.03	0.07												
13 to 19 years	3,163	0.67	0.03												
20 to 49 years	3,861	0.59	0.02												
Female 13 to 49 years	3,691	0.56	0.02												
50 years and older	3,523	0.58	0.03												
Race															
Mexican American	3,773	0.75	0.03												
Non-Hispanic Black	3,881	0.70	0.03												
Non-Hispanic White	6,180	0.71	0.03												
Other Hispanic	466	0.77	0.08												
Other Race—Including Multiple	644	0.79	0.06												

N = Sample size.
SE = Standard error.
Source: U.S. EPA analysis of the 2003−2006 NHANES.

Table 9-7. Mean Total Fruit and Total Vegetable Intake (as-consumed) in a Day by Sex and Age (1977−1978)[a]			
Age (years)	Per Capita Intake (g/day)	Percent of Population Consuming in a Day	Consumer-Only Intake (g/day)[b]
		Fruits	
Male and Female			
≤1	169	86.8	196
1 to 2	146	62.9	231
3 to 5	134	56.1	239
6 to 8	152	60.1	253
Male			
9 to 11	133	50.5	263
12 to 14	120	51.2	236
15 to 18	147	47.0	313
19 to 22	107	39.4	271
23 to 34	141	46.4	305
35 to 50	115	44.0	262
51 to 64	171	62.4	275
65 to 74	174	62.2	281
≥75	186	62.6	197
Female			
9 to 11	148	59.7	247
12 to 14	120	48.7	247
15 to 18	126	49.9	251
19 to 22	133	48.0	278
23 to 34	122	47.7	255
35 to 50	133	52.8	252
51 to 64	171	66.7	256
65 to 74	179	69.3	259
≥75	189	64.7	292
Male and Female			
All ages	142	54.2	263
		Vegetables	
Male and Female			
≤1	76	62.7	121
1 to 2	91	78.0	116
3 to 5	100	79.3	126
6 to 8	136	84.3	161
Male			
9 to 11	138	83.5	165
12 to 14	184	84.5	217
15 to 18	216	85.9	251
19 to 22	226	84.7	267
23 to 34	248	88.5	280
35 to 50	261	86.8	300
51 to 64	285	90.3	316
65 to 74	265	88.5	300
≥75	264	93.6	281
Female			
9 to 11	139	83.7	166
12 to 14	154	84.6	183
15 to 18	178	83.8	212
19 to 22	184	81.1	227
23 to 34	187	84.7	221
35 to 50	187	84.6	221
51 to 64	229	89.8	255
65 to 74	221	87.2	253
≥75	198	88.1	226
Male and Female			
All ages	201	85.6	235

[a] Based on USDA Nationwide Food Consumption Survey (1977−1978) data for one day.

[b] Intake for users only was calculated by dividing the per capita intake rate by the fraction of the population consuming fruit in a day.

Source: USDA, 1980.

Table 9-8. Mean Total Fruit and Total Vegetable Intake (as-consumed) in a Day by Sex and Age (1987−1988, 1994, and 1995)[a]

Age (years)	Per Capita Intake (g/day)			Percent of Population Consuming in 1 Day			Consumer-Only Intake (g/day)[b]		
	1987−1988	1994	1995	1987−1988	1994	1995	1987−1988	1994	1995
	Fruits								
Male and Female									
5 and under	157	230	221	59.2	70.6	72.6	265	326	304
Male									
6 to 11	182	176	219	63.8	59.8	62.2	285	294	352
12 to 19	158	169	210	49.4	44.0	47.1	320	384	446
≥20	133	175	170	46.5	50.2	49.6	286	349	342
Female									
6 to 11	154	174	172	58.3	59.3	63.6	264	293	270
12 to 19	131	148	167	47.1	47.1	44.4	278	314	376
≥20	140	157	155	52.7	55.1	54.4	266	285	285
Male and Female									
All Ages	142	171	173	51.4	54.1	54.2	276	316	319
	Vegetables								
Male and Female									
5 and under	81	80	83	74.0	75.2	75.0	109	106	111
Male									
6 to 11	129	118	111	86.8	82.4	80.6	149	143	138
12 to 19	173	154	202	85.2	74.9	79.0	203	206	256
≥20	232	242	241	85.0	85.9	86.4	273	282	278
Female									
6 to 11	129	115	108	80.6	82.9	79.1	160	139	137
12 to 19	129	132	144	75.8	78.5	76.0	170	168	189
≥20	183	190	189	82.9	84.7	83.2	221	224	227
Male and Female									
All Ages	182	186	188	82.6	83.2	82.6	220	223	228

[a] Based on USDA NFCS (1987−1988) and CSFII (1994 and 1995) data for one day.

[b] Intake for users only was calculated by dividing the per capita intake rate by the fraction of the population consuming fruits in a day.

Source: USDA, 1996a, b.

Table 9-9. Per Capita Consumption of Fresh Fruits and Vegetables in 1997[a]

Fresh Fruits		Fresh Vegetables	
Food Item	Per Capita Consumption (g/day)[b]	Food Item	Per Capita Consumption (g/day)[b]
Citrus		Artichokes	0.6
Oranges (includes Temple oranges)	16.9	Asparagus	0.7
Tangerines and Tangelos	3.0	Bell Peppers	8.3
Lemons	3.4	Broccoli	6.0
Limes	1.4	Brussel Sprouts	0.4
Grapefruit	7.6	Cabbage	11.8
Total Fresh Citrus	32.2	Carrots	15.1
		Cauliflower	1.9
Non-citrus		Celery	7.0
Apples	22.0	Sweet Corn	9.2
Apricots	0.1	Cucumber	7.2
Avocados	1.6	Eggplant	0.5
Bananas	34.5	Escarole/Endive	0.2
Cherries	0.6	Garlic	2.1
Cranberries	0.1	Head Lettuce	28.1
Grapes	9.1	Romaine Lettuce	7.0
Kiwi Fruit	0.5	Onions	20.9
Mangoes	1.7	Radishes	0.5
Peaches and Nectarines	6.7	Snap Beans	1.6
Pears	4.1	Spinach	0.6
Pineapple	2.9	Tomatoes	20.0
Papayas	0.6	Total Fresh Vegetables	149.8
Plums and Prunes	1.9		
Strawberries	4.9		
Melons	34.5		
Total Fresh Non-citrus	125.6		
Total Fresh Fruits	157.8		

[a] Based on retail-weight equivalent. Includes imports; excludes exports and foods grown in home gardens. Data for 1997 were used.

[b] Original data were presented in lbs/year; data were converted to g/day by multiplying by a factor of 454 g/lb and dividing by 365 day/year.

Source: USDA, 1999a.

Table 9-10. Mean Quantities of Vegetables Consumed Daily by Sex and Age, for Children, Per Capita (g/day, as-consumed)[a]

Age Group (years)	Sample Size	Total	White Potatoes Total	White Potatoes Fried	Dark Green Vegetables	Deep Yellow Vegetables	Tomatoes	Lettuce, Lettuce-based Salads	Green Beans	Corn, Green Peas, Lima Beans	Other Vegetables
Male and Female											
Under 1	1,126	57	9	1	2	19	1[b]	[b,c]	6	5	16
1	1,016	79	26	11	5	9	7	1	8	9	16
2	1,102	87	32	17	4	5	11	2	7	10	17
1 to 2	2,118	83	29	14	5	7	9	1	7	9	17
3	1,831	91	34	17	5	5	13	2	5	11	16
4	1,859	97	37	19	6	5	11	3	5	12	18
5	884	103	44	22	4	6	12	3	6	12	17
3 to 5	4,574	97	38	20	5	5	12	3	5	11	17
≤5	7,818	88	31	16	4	7	10	2	6	10	17
Male											
6 to 9	787	110	47	26	4	5	16	5	5	11	16
6 to 11	1,031	115	50	27	5	5	16	5	5	11	18
12 to 19	737	176	85	44	6	6	28	12	3[b]	10	
Female											
6 to 9	704	110	42	22	5	4	14	6	5	13	21
6 to 11	969	116	46	25	5	4	15	7	5	12	22
12 to 19	732	145	61	31	9	4	18	12	4	8	28
Male and Female										25	
≤9	9,309	97	37	19	4	6	12	3	6	11	18
≤19	11,287	125	53	27	6	6	17	7	5	10	22

[a] Based on data from 1994−1996, 1998 CSFII.

[b] Estimate is not statistically reliable due to small samples size reporting intake.

[c] Value less than 0.5, but greater than 0.

Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 9-11. Percentage of Individuals Consuming Vegetables, by Sex and Age, for Children (%)[a]

Age Group (years)	Sample Size	Total	White Potatoes		Dark Green Vegetables	Deep Yellow Vegetables	Tomatoes	Lettuce, Lettuce-based Salads	Green Beans	Corn, Green Peas, Lima Beans	Other Vegetables
			Total	**Fried**							
Male and Female											
Under 1	1,126	47.2	12.3	4.3	2.3	20.5	1.8	0.2[b]	7.8	8.5	14.8
1	1,016	73.3	40.4	25.2	6.4	13.3	18.0	3.9	13.7	17.6	19.4
2	1,102	78.4	46.7	34.5	7.6	10.5	30.8	7.5	11.5	15.0	22.3
1 to 2	2,118	75.9	43.6	29.9	7.0	11.8	24.6	5.7	12.6	16.2	20.9
3	1,831	80.5	46.7	34.7	7.0	10.7	34.1	8.3	10.1	14.6	24.7
4	1,859	80.7	47.3	34.8	7.2	12.0	33.0	10.0	9.0	16.4	26.5
5	884	83.0	50.7	38.3	4.6	13.3	36.5	13.4	10.4	16.1	28.8
3 to 5	4,574	81.4	48.2	35.9	6.3	12.0	34.5	10.6	9.9	15.7	26.7
≤5	7,818	75.4	42.3	30.1	6.1	13.0	27.2	7.6	10.5	15.0	23.3
Male											
6 to 9	787	78.8	47.9	38.0	6.3	12.5	38.2	13.1	7.8	15.0	29.7
6 to 11	1,031	79.3	48.7	38.4	6.1	12.4	38.7	13.9	6.7	13.8	30.8
12 to 19	737	78.2	49.5	38.6	3.6	8.0	43.0	23.8	3.5	7.4	33.2
Female											
6 to 9	704	80.5	48.2	36.3	5.9	11.9	33.8	15.8	8.4	15.9	26.6
6 to 11	969	81.7	50.8	38.9	5.4	11.4	33.5	17.1	7.8	15.1	29.2
12 to 19	732	79.5	46.4	34.6	7.0	10.6	35.3	25.1	4.4	7.4	34.5
Male and Female											
≤9	9,309	77.1	44.6	32.9	6.1	12.7	30.7	10.3	9.6	15.2	25.2
≤19	11,287	78.3	46.8	35.3	5.6	11.2	34.6	16.6	7.0	11.9	29.4

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small samples size reporting intake.
Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 9-12. Mean Quantities of Fruits Consumed Daily by Sex and Age, for Children, Per Capita (g/day, as-consumed)[a]

Age Group (years)	Sample Size	Total	Citrus Fruits and Juices		Dried fruits	Other Fruits, Mixtures, and Juices					
			Total	Juices		Total	Apples	Bananas	Melons and berries	Other fruits and mixtures (mainly fruit)	Non-Citrus juices and nectars
Male and Female											
Under 1	1,126	131	4	4	-[b,c]	126	14	10	1[b]	39	61
1	1,016	267	47	42	2	216	22	23	8	29	134
2	1,102	276	65	56	2	207	27	20	10	20	130
1 to 2	2,118	271	56	49	2	212	24	22	9	24	132
3	1,831	256	61	51	1	191	27	18	13	24	110
4	1,859	243	62	52	1	177	31	17	14	22	92
5	884	218	55	44	-[b,c]	160	31	14	13	24	78
3 to 5	4,574	239	59	49	1	176	30	16	13	23	93
≤5	7,818	237	52	44	1	182	26	17	10	26	103
Male											
6 to 9	787	194	58	51	-[b,c]	133	32	11	21	20	50
6 to 11	1,031	183	67	60	-[b,c]	113	28	11	16	19	40
12 to 19	737	174	102	94	1[b]	70	13	8	11[b]	10	29
Female											
6 to 9	704	180	63	54	1[b]	113	23	10	10	25	46
6 to 11	969	169	64	54	-[b,c]	103	21	8	8	23	42
12 to 19	732	157	72	67	-[b,c]	83	13	5	15	14	35
Male and Female											
≤9	9,309	217	55	47	1	159	27	15	12	24	81
≤19	11,287	191	70	62	1	118	21	11	12	19	56

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small samples size reporting intake.
[c] Value less than 0.5, but greater than 0.
- Indicates value as not statistically significant or less than 0.5, but greater than 0.
Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 9-13. Percentage of Individuals Consuming, Fruits by Sex and Age, for Children (%)[a]

Age Group (years)	Sample Size	Total	Citrus Fruits and Juices		Dried fruits	Other Fruits, Mixtures, and Juices					
			Total	Juices		Total	Apples	Bananas	Melons and berries	Other fruits and mixtures (mainly fruit)	Non-Citrus juices and nectars
Male and Female											
Under 1	1,126	59.7	3.6	2.7	0.4[b]	59.0	15.7	13.3	1.8	29.9	33.0
1	1,016	81.0	23.6	19.0	5.9	73.0	23.4	25.1	6.9	26.5	43.2
2	1,102	76.6	30.6	23.4	5.3	64.7	24.0	20.2	8.5	19.4	37.0
1 to 2	2,118	78.8	27.2	21.3	5.6	68.8	23.7	22.6	7.7	22.9	40.0
3	1,831	74.5	27.9	21.4	4.1	64.2	22.4	17.5	7.8	20.1	33.3
4	1,859	72.6	28.0	21.8	3.0	62.1	23.7	15.7	7.6	20.0	30.8
5	884	67.6	26.9	19.5	1.3[b]	56.9	21.9	12.6	7.4	19.0	24.5
3 to 5	4,574	71.6	27.6	20.9	2.8	61.0	22.7	15.3	7.6	19.7	29.5
≤5	7,818	72.6	24.6	18.8	3.5	63.5	22.2	17.6	6.9	22.0	33.5
Male											
6 to 9	787	59.0	24.8	20.5	0.8[b]	49.1	20.3	8.7	7.3	16.8	15.5
6 to 11	1,031	56.5	25.2	21.6	1.1[b]	44.2	18.2	8.0	6.6	15.4	12.7
12 to 19	737	44.5	24.7	21.7	1.0[b]	27.1	8.2	6.0	4.1	7.1	8.2
Female											
6 to 9	704	64.9	27.9	22.3	1.5[b]	50.4	17.3	8.8	7.4	20.4	17.3
6 to 11	969	62.1	27.7	21.5	1.1[b]	47.2	16.2	7.3	7.4	19.0	14.9
12 to 19	732	45.6	22.4	18.1	1.1[b]	30.2	8.2	4.4	6.0	11.3	9.7
Male and Female											
≤9	9,309	68.3	25.2	19.8	2.5	58.0	20.9	14.0	7.1	20.6	26.7
≤19	11,287	57.8	24.8	20.1	1.8	44.4	15.2	9.7	6.2	15.5	17.9

a Based on data from 1994−1996, 1998 CSFII.
b Estimate is not statistically reliable due to small sample size reporting intake.
Note: Percentages shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 9-14. Per Capita Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Fruits														
Whole Population	20,607	80.0	1.6	0.0	0.0	0.0	0.0	0.0	0.5	2.0	4.2	6.5	14.0	73.8
Age Group														
Birth to 1 year	1,486	56.4	5.7	0.3	0.0	0.0	0.0	0.0	1.5	9.6	17.1	21.3	32.2	73.8
1 to 2 years	2,096	89.5	6.2	0.2	0.0	0.0	0.0	0.5	4.7	9.4	14.6	18.5	26.4	44.0
3 to 5 years	4,391	90.0	4.6	0.1	0.0	0.0	0.0	0.2	3.2	7.0	11.4	14.4	22.3	45.5
6 to 12 years	2,089	88.3	2.4	0.1	0.0	0.0	0.0	0.1	1.3	3.3	6.4	8.8	14.3	25.0
13 to 19 years	1,222	73.2	0.8	0.1	0.0	0.0	0.0	0.0	0.1	1.1	2.4	3.5	6.9	12.8
20 to 49 years	4,677	75.3	0.9	0.0	0.0	0.0	0.0	0.0	0.2	1.3	2.7	3.9	6.2	16.7
≥50 years	4,646	85.8	1.4	0.0	0.0	0.0	0.0	0.1	0.9	2.1	3.6	4.8	7.6	18.4
Season														
Fall	4,687	79.6	1.5	0.1	0.0	0.0	0.0	0.0	0.5	2.0	4.2	6.4	13.3	43.8
Spring	5,308	80.2	1.6	0.1	0.0	0.0	0.0	0.0	0.5	1.9	4.2	6.7	14.7	73.8
Summer	5,890	78.3	1.5	0.1	0.0	0.0	0.0	0.0	0.4	1.9	4.0	6.2	12.8	53.2
Winter	4,722	81.7	1.7	0.0	0.0	0.0	0.0	0.0	0.7	2.1	4.4	6.6	14.3	37.5
Race														
Asian, Pacific Islander	557	78.8	2.1	0.2	0.0	0.0	0.0	0.0	1.1	3.2	6.0	7.4	14.7	43.5
American Indian, Alaskan Native	177	77.8	1.9	0.3	0.0	0.0	0.0	0.0	0.9	1.9	5.3	9.6	16.4	20.9
Black	2,740	71.3	1.2	0.1	0.0	0.0	0.0	0.0	0.1	1.2	3.6	5.6	13.3	40.0
Other/NA	1,638	78.5	2.2	0.2	0.0	0.0	0.0	0.0	0.9	2.9	6.1	10.0	18.5	45.5
White	15,495	81.5	1.6	0.0	0.0	0.0	0.0	0.0	0.6	2.0	4.1	6.3	13.4	73.8
Region														
Midwest	4,822	82.3	1.6	0.0	0.0	0.0	0.0	0.0	0.6	2.0	4.1	6.2	13.1	43.5
Northeast	3,692	83.4	1.7	0.1	0.0	0.0	0.0	0.0	0.8	2.2	4.2	6.3	14.1	40.0
South	7,208	74.7	1.3	0.1	0.0	0.0	0.0	0.0	0.2	1.5	3.5	5.7	13.0	73.8
West	4,885	82.7	2.0	0.1	0.0	0.0	0.0	0.0	0.9	2.6	5.2	8.0	15.3	45.5
Urbanization														
City Center	6,164	79.0	1.6	0.0	0.0	0.0	0.0	0.0	0.5	2.0	4.4	6.3	14.1	45.5
Suburban	9,598	82.5	1.7	0.0	0.0	0.0	0.0	0.0	0.7	2.1	4.5	6.9	14.5	43.8
Non-metropolitan	4,845	75.9	1.3	0.1	0.0	0.0	0.0	0.0	0.3	1.6	3.6	5.4	12.8	73.8

Table 9-14. Per Capita Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles									
					1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Vegetables														
Whole Population	20,607	99.5	3.4	0.0	0.0 5	0.4	0.8	1.6	2.7	4.3	6.4	8.3	14.8	58.2
Age Group														
Birth to 1 year	1,486	72.1	4.5	0.2	0.0	0.0	0.0	0.0	2.7	7.4	12.2	14.8	25.3	56.8
1 to 2 years	2,096	99.7	6.9	0.2	0.0	0.7	1.5	3.2	5.6	9.3	13.9	17.1	26.5	58.2
3 to 5 years	4,391	100.0	5.9	0.1	0.0	0.8	1.4	2.8	4.7	7.7	11.7	14.7	23.4	50.9
6 to 12 years	2,089	99.9	4.1	0.1	0.1	0.6	1.0	1.8	3.2	5.3	7.8	9.9	17.4	53.7
13 to 19 years	1,222	100.0	2.9	0.1	0.0	0.4	0.7	1.4	2.4	3.8	5.5	6.9	11.4	29.5
20 to 49 years	4,677	99.9	2.9	0.0	0.1	0.5	0.8	1.5	2.5	3.8	5.4	6.8	10.0	42.7
≥50 years	4,646	99.9	3.1	0.0	0.0	0.5	0.9	1.6	2.6	4.0	5.7	7.0	10.6	38.7
Season														
Fall	4,687	99.6	3.3	0.1	0.0	0.5	0.8	1.6	2.7	4.3	6.2	7.6	13.0	58.2
Spring	5,308	99.5	3.4	0.1	0.0	0.4	0.8	1.5	2.6	4.2	6.6	8.8	16.0	53.7
Summer	5,890	99.5	3.6	0.1	0.0	0.4	0.8	1.6	2.9	4.6	7.2	9.5	15.8	50.9
Winter	4,722	99.5	3.2	0.1	0.0	0.5	0.9	1.6	2.6	4.2	5.8	7.5	12.8	56.8
Race														
Asian, Pacific Islander	557	99.0	4.4	0.3	0.0	0.8	1.3	2.3	3.9	5.6	8.2	10.2	15.9	32.3
American Indian, Alaskan Native	177	99.7	3.9	0.3	0.0	0.5	0.8	1.6	2.8	5.2	8.1	9.8	18.4	34.5
Black	2,740	99.5	3.0	0.1	0.0	0.2	0.5	1.2	2.1	3.9	6.2	8.4	16.1	56.8
Other/NA	1,638	98.8	4.1	0.2	0.0	0.5	0.9	1.7	3.0	5.1	8.2	11.6	21.1	58.2
White	15,495	99.6	3.3	0.0	0.0	0.5	0.8	1.6	2.7	4.3	6.2	8.0	13.5	50.9
Region														
Midwest	4,822	99.6	3.4	0.1	0.0	0.5	0.8	1.6	2.7	4.3	6.5	8.6	14.1	53.7
Northeast	3,692	99.7	3.3	0.1	0.0	0.4	0.7	1.5	2.6	4.3	6.2	8.2	14.4	42.7
South	7,208	99.5	3.2	0.1	0.0	0.4	0.8	1.6	2.6	4.1	6.2	7.9	14.2	58.2
West	4,885	99.3	3.6	0.1	0.0	0.5	0.9	1.7	2.9	4.6	7.0	8.8	15.5	50.9
Urbanization														
City Center	6,164	99.5	3.3	0.1	0.0	0.4	0.7	1.5	2.7	4.3	6.4	8.5	15.3	58.2
Suburban	9,598	99.5	3.4	0.0	0.0	0.5	0.9	1.6	2.7	4.3	6.5	8.3	14.0	53.7
Non-metropolitan	4,845	99.6	3.3	0.1	0.0	0.5	0.8	1.6	2.6	4.2	6.4	8.1	14.9	49.4

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-15. Consumer-Only Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	Percentiles									
				1st	th	10th	25th	50th	75th	90th	95th	99th	Max
				Fruits									
Whole Population	16,762	2.0	0.0	0.0[5]	0.0	0.0	0.1	1.0	2.5	4.9	7.3	15.0	73.8
Age Group													
Birth to 1 year	830	10.1	0.4	0.0	0.4	1.2	3.7	8.5	14.4	20.4	26.4	34.7	73.8
1 to 2 years	1,878	6.9	0.2	0.0	0.0	0.1	2.2	5.4	10.1	15.3	19.0	27.1	44.0
3 to 5 years	3,957	5.1	0.1	0.0	0.0	0.0	1.0	3.8	7.5	11.9	15.0	22.8	45.5
6 to 12 years	1,846	2.7	0.1	0.0	0.0	0.0	0.3	1.7	3.7	6.7	9.3	14.8	25.0
13 to 19 years	898	1.1	0.1	0.0	0.0	0.0	0.0	0.5	1.5	2.9	3.7	7.6	12.8
20 to 49 years	3,458	1.2	0.0	0.0	0.0	0.0	0.1	0.7	1.7	3.2	4.4	6.6	16.7
≥50 years	3,895	1.6	0.0	0.0	0.0	0.0	0.3	1.1	2.3	3.8	5.0	8.0	18.4
Season													
Fall	3,796	1.9	0.1	0.0	0.0	0.0	0.1	0.9	2.4	4.9	7.1	14.4	43.8
Spring	4,289	2.0	0.1	0.0	0.0	0.0	0.2	1.0	2.4	4.9	7.5	16.1	73.8
Summer	4,744	1.9	0.1	0.0	0.0	0.0	0.1	0.9	2.4	4.7	7.1	14.5	53.2
Winter	3,933	2.0	0.1	0.0	0.0	0.0	0.2	1.1	2.6	4.9	7.6	15.3	37.5
Race													
Asian, Pacific Islander	427	2.7	0.2	0.0	0.0	0.0	0.5	1.7	3.8	6.6	7.8	14.7	43.5
American Indian, Alaskan Native	146	2.4	0.4	0.0	0.0	0.0	0.4	1.1	2.9	5.8	10.0	17.6	20.9
Black	2,065	1.7	0.1	0.0	0.0	0.0	0.0	0.6	2.0	4.6	6.7	15.7	40.0
Other/NA	1,323	2.9	0.2	0.0	0.0	0.0	0.3	1.5	3.6	7.7	11.2	19.3	45.5
White	12,801	1.9	0.0	0.0	0.0	0.0	0.2	1.0	2.4	4.7	7.0	14.5	73.8
Region													
Midwest	4,023	1.9	0.1	0.0	0.0	0.0	0.1	1.0	2.3	4.7	6.7	14.4	43.5
Northeast	3,145	2.0	0.1	0.0	0.0	0.0	0.2	1.1	2.6	4.6	6.9	14.8	40.0
South	5,531	1.7	0.1	0.0	0.0	0.0	0.1	0.7	2.1	4.5	6.9	14.4	73.8
West	4,063	2.4	0.1	0.0	0.0	0.0	0.3	1.3	3.0	5.8	8.9	16.4	45.5
Urbanization													
City Center	4,985	2.0	0.1	0.0	0.0	0.0	0.1	1.0	2.7	4.9	7.1	14.8	45.5
Suburban	8,046	2.1	0.1	0.0	0.0	0.0	0.2	1.1	2.5	5.1	7.7	15.6	43.8
Non-metropolitan	3,731	1.7	0.1	0.0	0.0	0.0	0.1	0.8	2.1	4.1	6.3	13.9	73.8

Table 9-15. Consumer-Only Intake of Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	Percentiles									
				1st	th	10th	25th	50th	75th	90th	95th	99th	Max
						Vegetables							
Whole Population	20,163	3.4	0.0	0.0 5	0.5	0.8	1.6	2.7	4.3	6.4	8.4	14.8	58.2
Age Group													
Birth to 1 year	1,062	6.2	0.3	0.0	0.1	0.1	2.0	4.9	9.4	13.4	16.1	26.4	56.8
1 to 2 years	2,090	6.9	0.2	0.0	0.7	1.5	3.2	5.6	9.3	13.9	17.1	26.5	58.2
3 to 5 years	4,389	5.9	0.1	0.0	0.8	1.4	2.8	4.7	7.7	11.7	14.7	23.4	50.9
6 to 12 years	2,087	4.1	0.1	0.1	0.6	1.0	1.8	3.2	5.3	7.8	9.9	17.4	53.7
13 to 19 years	1,222	2.9	0.1	0.0	0.4	0.7	1.4	2.4	3.8	5.5	6.9	11.4	29.5
20 to 49 years	4,673	2.9	0.0	0.1	0.5	0.8	1.5	2.5	3.8	5.4	6.8	10.0	42.7
≥50 years	4,640	3.1	0.0	0.0	0.5	0.9	1.6	2.6	4.0	5.7	7.0	10.6	38.7
Season													
Fall	4,606	3.3	0.1	0.1	0.5	0.8	1.6	2.8	4.3	6.2	7.7	13.0	58.2
Spring	5,185	3.4	0.1	0.0	0.5	0.8	1.5	2.6	4.2	6.7	8.8	16.0	53.7
Summer	5,740	3.6	0.1	0.1	0.4	0.8	1.7	2.9	4.6	7.2	9.5	15.8	50.9
Winter	4,632	3.2	0.1	0.0	0.6	0.9	1.6	2.7	4.2	5.9	7.5	12.8	56.8
Race													
Asian, Pacific Islander	530	4.4	0.3	0.1	1.0	1.4	2.4	3.9	5.6	8.2	10.2	15.9	32.3
American Indian, Alaskan Native	174	3.9	0.3	0.0	0.5	0.9	1.7	2.9	5.2	8.1	9.8	18.4	34.5
Black	2,683	3.1	0.1	0.0	0.2	0.5	1.2	2.1	3.9	6.2	8.4	16.1	56.8
Other/NA	1,577	4.2	0.2	0.1	0.6	0.9	1.8	3.0	5.2	8.3	11.7	21.3	58.2
White	15,199	3.3	0.0	0.1	0.5	0.9	1.6	2.7	4.3	6.2	8.0	13.6	50.9
Region													
Midwest	4,721	3.4	0.1	0.1	0.5	0.8	1.6	2.7	4.3	6.5	8.6	14.2	53.7
Northeast	3,634	3.3	0.1	0.0	0.4	0.8	1.5	2.6	4.3	6.2	8.2	14.4	42.7
South	7,078	3.3	0.1	0.0	0.5	0.8	1.6	2.6	4.1	6.2	7.9	14.2	58.2
West	4,730	3.6	0.1	0.1	0.5	0.9	1.7	2.9	4.6	7.1	8.9	15.6	50.9
Urbanization													
City Center	6,029	3.4	0.1	0.0	0.4	0.8	1.5	2.7	4.3	6.4	8.6	15.4	58.2
Suburban	9,381	3.4	0.0	0.1	0.5	0.9	1.7	2.8	4.4	6.5	8.4	14.0	53.7
Non-metropolitan	4,753	3.3	0.1	0.0	0.5	0.9	1.6	2.7	4.2	6.4	8.1	14.9	49.4

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Apples			Asparagus			Bananas			Beans		
Whole Population	20,607	30.5	0.45	0.01	1.4	0.01	0.00	48.1	0.35	0.01	44.9	0.27	0.01
Age Group													
Birth to 1 year	1,486	34.6	2.32	0.13	0.2	0.01	0.00	40.7	1.24	0.06	21.6	0.43	0.04
1 to 2 years	2,096	44.8	1.79	0.09	0.8	0.02	0.01	62.8	1.77	0.09	46.8	0.76	0.04
3 to 5 years	4,391	44.6	1.64	0.05	0.5	0.01	0.00	60.7	0.93	0.04	43.0	0.52	0.02
6 to 12 years	2,089	38.2	0.83	0.05	0.7	0.01	0.00	57.7	0.38	0.03	38.8	0.32	0.02
13 to 19 years	1,222	22.5	0.20	0.02	0.6	0.00	0.00	42.1	0.13	0.02	36.0	0.18	0.02
20 to 49 years	4,677	25.7	0.21	0.01	1.3	0.01	0.00	41.7	0.21	0.01	45.5	0.22	0.01
≥50 years	4,646	34.5	0.32	0.02	2.5	0.02	0.00	54.1	0.35	0.01	51.4	0.26	0.01
Season													
Fall	4,687	35.0	0.55	0.03	1.2	0.01	0.00	45.6	0.36	0.02	47.3	0.29	0.01
Spring	5,308	29.6	0.45	0.02	1.9	0.02	0.00	49.8	0.35	0.02	43.3	0.25	0.01
Summer	5,890	25.5	0.34	0.02	0.9	0.01	0.00	49.6	0.33	0.02	43.6	0.28	0.01
Winter	4,722	32.2	0.46	0.02	1.6	0.02	0.00	47.3	0.38	0.01	45.5	0.26	0.01
Race													
Asian, Pacific Islander	557	33.5	0.53	0.06	1.0	0.01	0.00	45.4	0.43	0.04	52.0	0.25	0.02
American Indian, Alaskan Native	177	31.0	0.60	0.12	2.5	0.02	0.01	44.1	0.39	0.05	37.8	0.26	0.06
Black	2,740	22.0	0.36	0.02	0.4	0.00	0.00	45.4	0.43	0.04	45.2	0.32	0.02
Other/NA	1,638	27.7	0.55	0.05	0.2	0.00	0.00	44.1	0.26	0.02	60.6	0.43	0.03
White	15,495	32.0	0.45	0.01	1.7	0.01	0.00	47.5	0.58	0.07	43.6	0.25	0.01
Region													
Midwest	4,822	34.5	0.47	0.02	1.5	0.01	0.00	51.1	0.35	0.02	43.6	0.26	0.01
Northeast	3,692	32.7	0.48	0.03	1.3	0.01	0.00	52.9	0.36	0.01	36.7	0.21	0.01
South	7,208	25.3	0.36	0.01	1.1	0.01	0.00	42.4	0.30	0.02	48.8	0.33	0.01
West	4,885	32.7	0.55	0.02	1.9	0.01	0.00	49.6	0.44	0.03	47.5	0.25	0.02
Urbanization													
City Center	6,164	28.9	0.42	0.02	1.7	0.01	0.00	48.4	0.36	0.02	46.2	0.29	0.01
Suburban	9,598	33.2	0.49	0.02	1.1	0.01	0.00	50.5	0.38	0.01	42.4	0.25	0.01
Non-metropolitan	4,845	27.0	0.39	0.02	1.5	0.01	0.00	42.3	0.28	0.03	48.7	0.30	0.02

Population Group	*N*	Beets: Percent Consuming	Beets: Mean	Beets: SE	Berries and Small Fruit: Percent Consuming	Berries and Small Fruit: Mean	Berries and Small Fruit: SE	Broccoli: Percent Consuming	Broccoli: Mean	Broccoli: SE	Bulb Vegetables: Percent Consuming	Bulb Vegetables: Mean	Bulb Vegetables: SE
Whole Population	20,607	2.2	0.01	0.00	58.7	0.23	0.01	13.9	0.11	0.01	95.3	0.20	0.00
Age Group													
Birth to 1 year	1,486	0.4	0.01	0.01	16.5	0.13	0.02	3.5	0.07	0.02	33.4	0.07	0.01
1 to 2 years	2,096	0.7	0.01	0.00	66.2	0.91	0.05	12.0	0.25	0.03	93.3	0.30	0.01
3 to 5 years	4,391	0.8	0.01	0.00	72.7	0.72	0.03	10.7	0.18	0.01	95.8	0.27	0.01
6 to 12 years	2,089	0.8	0.01	0.00	73.4	0.40	0.03	11.0	0.14	0.02	97.3	0.21	0.01
13 to 19 years	1,222	0.7	0.00	0.00	55.4	0.15	0.02	8.3	0.06	0.01	97.7	0.19	0.01
20 to 49 years	4,677	1.9	0.00	0.00	53.1	0.14	0.01	14.7	0.10	0.01	97.4	0.21	0.01
≥50 years	4,646	4.6	0.02	0.00	63.0	0.19	0.01	17.3	0.11	0.01	93.4	0.17	0.00
Season													
Fall	4,687	2.0	0.01	0.00	57.4	0.18	0.01	14.6	0.12	0.01	95.8	0.21	0.01
Spring	5,308	2.3	0.01	0.00	60.6	0.27	0.02	13.5	0.11	0.02	95.4	0.20	0.01
Summer	5,890	2.3	0.01	0.00	60.4	0.29	0.02	13.7	0.11	0.01	94.3	0.19	0.01
Winter	4,722	2.3	0.01	0.00	56.6	0.20	0.01	13.7	0.10	0.01	95.5	0.21	0.01
Race													
Asian, Pacific Islander	557	2.7	0.00	0.00	41.7	0.28	0.06	25.7	0.23	0.06	95.0	0.38	0.03
American Indian, Alaskan Native	177	0.3	0.00	0.00	49.6	0.13	0.02	9.1	0.11	0.07	99.3	0.25	0.04
Black	2,740	0.9	0.00	0.00	50.6	0.14	0.01	13.2	0.14	0.02	92.9	0.16	0.01
Other/NA	1,638	1.3	0.01	0.00	47.5	0.21	0.03	8.2	0.09	0.02	95.0	0.31	0.02
White	15,495	2.5	0.01	0.00	61.6	0.25	0.01	14.0	0.10	0.01	95.6	0.19	0.00
Region													
Midwest	4,822	2.3	0.01	0.00	63.1	0.25	0.02	13.0	0.09	0.01	96.2	0.19	0.01
Northeast	3,692	2.4	0.01	0.00	63.2	0.24	0.02	15.3	0.13	0.01	94.5	0.19	0.01
South	7,208	1.7	0.01	0.00	53.3	0.19	0.01	13.1	0.11	0.01	94.4	0.18	0.01
West	4,885	2.8	0.01	0.00	58.7	0.28	0.03	14.6	0.12	0.02	96.3	0.25	0.01
Urbanization													
City Center	6,164	2.3	0.01	0.00	57.3	0.22	0.01	15.1	0.13	0.01	95.0	0.21	0.01
Suburban	9,598	2.2	0.01	0.00	62.0	0.27	0.02	14.9	0.12	0.01	95.7	0.20	0.01
Non-metropolitan	4,845	2.4	0.01	0.00	53.6	0.17	0.02	9.7	0.06	0.01	94.7	0.19	0.01

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994–1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cabbage			Carrots			Citrus Fruits			Corn		
Whole Population	20,607	15.5	0.08	0.01	49.8	0.17	0.00	19.3	0.19	0.01	94.6	0.44	0.01
Age Group													
Birth to 1 year	1,486	1.0	0.01	0.00	12.3	0.17	0.03	2.5	0.07	0.02	46.0	0.48	0.03
1 to 2 years	2,096	8.0	0.06	0.01	46.8	0.41	0.02	15.5	0.47	0.05	96.5	1.13	0.05
3 to 5 years	4,391	8.9	0.07	0.01	46.2	0.34	0.02	18.2	0.50	0.03	98.7	1.24	0.03
6 to 12 years	2,089	9.5	0.06	0.01	44.4	0.22	0.01	16.0	0.26	0.02	98.9	0.87	0.03
13 to 19 years	1,222	9.0	0.04	0.01	40.3	0.11	0.01	12.3	0.11	0.02	95.7	0.43	0.02
20 to 49 years	4,677	16.0	0.07	0.01	50.2	0.14	0.01	18.1	0.12	0.01	94.7	0.32	0.01
≥50 years	4,646	22.8	0.12	0.01	58.1	0.17	0.01	27.1	0.23	0.01	94.2	0.26	0.01
Season													
Fall	4,687	16.2	0.07	0.01	53.9	0.19	0.01	16.6	0.16	0.01	94.2	0.42	0.01
Spring	5,308	15.1	0.08	0.01	46.5	0.17	0.01	20.3	0.20	0.01	94.5	0.44	0.02
Summer	5,890	14.5	0.08	0.01	44.3	0.14	0.01	15.8	0.08	0.01	95.1	0.50	0.02
Winter	4,722	16.3	0.08	0.01	54.5	0.18	0.01	24.6	0.33	0.02	94.8	0.41	0.02
Race													
Asian, Pacific Islander	557	33.9	0.24	0.04	59.4	0.28	0.04	23.4	0.35	0.07	85.6	0.32	0.04
American Indian, Alaskan Native	177	15.8	0.05	0.04	47.3	0.12	0.02	20.4	0.33	0.13	93.6	0.51	0.06
Black	2,740	15.9	0.14	0.03	36.6	0.10	0.01	13.0	0.15	0.02	93.7	0.49	0.02
Other/NA	1,638	9.5	0.02	0.01	46.2	0.21	0.02	22.4	0.37	0.06	92.6	0.70	0.05
White	15,495	15.2	0.07	0.00	51.9	0.18	0.01	20.0	0.18	0.01	95.3	0.42	0.01
Region													
Midwest	4,822	15.5	0.08	0.01	50.9	0.17	0.01	18.9	0.16	0.01	96.6	0.46	0.02
Northeast	3,692	13.4	0.08	0.01	53.8	0.18	0.01	22.4	0.21	0.02	93.3	0.40	0.01
South	7,208	16.8	0.09	0.01	44.9	0.14	0.01	15.1	0.14	0.01	94.4	0.44	0.01
West	4,885	15.5	0.06	0.01	52.8	0.21	0.01	23.7	0.28	0.02	94.1	0.47	0.02
Urbanization													
City Center	6,164	16.4	0.09	0.01	48.8	0.16	0.01	19.8	0.20	0.01	93.8	0.44	0.01
Suburban	9,598	16.0	0.07	0.00	52.3	0.19	0.01	20.0	0.19	0.01	94.8	0.45	0.01
Non-metropolitan	4,845	13.4	0.06	0.01	45.7	0.15	0.01	17.0	0.17	0.01	95.5	0.43	0.02

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Cucumbers			Cucurbits			Fruiting Vegetables			Leafy Vegetables		
Whole Population	20,607	40.1	0.10	0.01	48.9	0.40	0.02	93.8	0.82	0.01	90.1	0.59	0.01
Age Group													
Birth to 1 year	1,486	1.7	0.00	0.00	14.0	0.45	0.04	25.5	0.32	0.04	44.2	0.29	0.05
1 to 2 years	2,096	20.5	0.11	0.01	31.3	0.72	0.06	92.1	1.56	0.06	82.1	0.71	0.04
3 to 5 years	4,391	29.3	0.16	0.02	38.7	0.83	0.07	95.4	1.46	0.03	86.9	0.67	0.02
6 to 12 years	2,089	32.6	0.14	0.02	39.9	0.54	0.06	95.9	1.05	0.03	89.5	0.55	0.03
13 to 19 years	1,222	41.3	0.11	0.03	46.7	0.32	0.08	96.1	0.79	0.03	90.3	0.43	0.02
20 to 49 years	4,677	44.8	0.09	0.01	52.8	0.29	0.01	96.0	0.75	0.02	92.2	0.58	0.02
≥50 years	4,646	41.0	0.08	0.01	52.8	0.43	0.03	92.0	0.66	0.02	90.7	0.66	0.02
Season													
Fall	4,687	36.7	0.08	0.01	45.4	0.21	0.01	92.6	0.81	0.03	89.7	0.59	0.02
Spring	5,308	43.3	0.10	0.01	51.8	0.48	0.04	94.3	0.77	0.02	90.9	0.60	0.02
Summer	5,890	43.2	0.14	0.02	55.6	0.73	0.06	94.5	0.88	0.02	90.1	0.56	0.02
Winter	4,722	37.2	0.07	0.01	43.0	0.16	0.01	93.7	0.80	0.02	89.6	0.59	0.02
Race													
Asian, Pacific Islander	557	34.9	0.24	0.16	46.9	0.90	0.39	88.4	0.86	0.06	92.8	1.13	0.12
American Indian, Alaskan Native	177	41.0	0.09	0.03	51.3	0.53	0.13	98.2	0.91	0.08	89.3	0.52	0.17
Black	2,740	39.1	0.06	0.01	43.4	0.27	0.04	91.9	0.69	0.04	89.5	0.65	0.04
Other/NA	1,638	33.4	0.10	0.01	46.1	0.53	0.09	93.6	1.25	0.05	85.3	0.50	0.03
White	15,495	40.9	0.10	0.01	50.1	0.39	0.02	94.3	0.80	0.01	90.4	0.56	0.01
Region													
Midwest	4,822	42.1	0.10	0.01	49.6	0.37	0.03	94.8	0.81	0.02	92.1	0.55	0.03
Northeast	3,692	39.4	0.10	0.01	50.7	0.43	0.05	92.3	0.82	0.02	87.4	0.62	0.03
South	7,208	39.7	0.09	0.01	46.7	0.33	0.03	93.3	0.76	0.03	90.1	0.55	0.02
West	4,885	39.3	0.11	0.03	50.1	0.50	0.06	94.9	0.91	0.03	90.3	0.64	0.03
Urbanization													
City Center	6,164	39.7	0.09	0.00	48.3	0.34	0.02	93.9	0.84	0.03	89.2	0.64	0.02
Suburban	9,598	40.6	0.11	0.01	49.9	0.44	0.04	93.5	0.81	0.01	90.5	0.60	0.02
Non-metropolitan	4,845	39.7	0.10	0.01	47.8	0.37	0.03	94.3	0.80	0.04	90.5	0.46	0.03

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Legumes			Lettuce			Okra			Onions		
Whole Population	20,607	95.5	0.43	0.01	52.2	0.24	0.01	1.4	0.01	0.00	94.9	0.19	0.00
Age Group													
Birth to 1 year	1,486	51.7	1.21	0.06	1.1	0.00	0.00	0.2	0.00	0.00	32.8	0.07	0.01
1 to 2 years	2,096	96.9	1.30	0.08	23.3	0.14	0.01	1.3	0.01	0.00	93.0	0.29	0.01
3 to 5 years	4,391	98.3	0.85	0.06	33.4	0.21	0.01	0.8	0.01	0.00	95.6	0.26	0.01
6 to 12 years	2,089	98.1	0.48	0.03	41.7	0.22	0.01	1.3	0.01	0.00	96.8	0.20	0.01
13 to 19 years	1,222	94.9	0.27	0.02	55.2	0.22	0.02	0.8	0.00	0.00	97.3	0.18	0.01
20 to 49 years	4,677	95.7	0.34	0.01	60.1	0.27	0.01	1.3	0.01	0.00	97.1	0.20	0.01
≥50 years	4,646	96.2	0.40	0.01	51.4	0.23	0.01	2.1	0.01	0.00	93.2	0.16	0.00
Season													
Fall	4,687	96.0	0.44	0.02	50.6	0.23	0.01	1.7	0.01	0.00	95.5	0.20	0.01
Spring	5,308	95.3	0.40	0.02	54.5	0.25	0.01	1.1	0.01	0.00	95.0	0.19	0.01
Summer	5,890	95.2	0.43	0.02	51.7	0.23	0.01	1.7	0.01	0.00	94.0	0.18	0.00
Winter	4,722	95.5	0.44	0.02	52.1	0.24	0.01	1.0	0.01	0.00	95.3	0.20	0.01
Race													
Asian, Pacific Islander	557	96.1	0.76	0.09	48.1	0.28	0.05	4.8	0.01	0.01	94.9	0.37	0.03
American Indian, Alaskan Native	177	97.5	0.42	0.07	61.3	0.21	0.04	0.6	0.00	0.00	99.3	0.25	0.04
Black	2,740	95.6	0.50	0.04	42.7	0.15	0.01	2.4	0.01	0.00	92.6	0.16	0.01
Other/NA	1,638	93.5	0.55	0.04	52.1	0.25	0.02	0.6	0.00	0.00	95.0	0.30	0.02
White	15,495	95.6	0.40	0.01	53.8	0.25	0.01	1.2	0.01	0.00	95.3	0.18	0.00
Region													
Midwest	4,822	96.9	0.40	0.02	53.3	0.25	0.02	0.4	0.00	0.00	96.0	0.18	0.01
Northeast	3,692	93.4	0.38	0.02	49.3	0.24	0.01	0.8	0.00	0.00	94.0	0.18	0.01
South	7,208	96.1	0.47	0.02	50.7	0.21	0.01	2.6	0.01	0.00	94.1	0.18	0.01
West	4,885	95.0	0.44	0.02	56.0	0.27	0.01	1.2	0.00	0.00	96.1	0.24	0.01
Urbanization													
City Center	6,164	95.1	0.47	0.02	51.3	0.24	0.01	1.8	0.01	0.00	94.8	0.20	0.01
Suburban	9,598	95.4	0.41	0.01	53.0	0.26	0.01	1.0	0.01	0.00	95.3	0.19	0.01
Non-metropolitan	4,845	96.2	0.41	0.02	51.6	0.20	0.01	1.7	0.01	0.00	94.3	0.19	0.01

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Peaches			Pears			Peas			Peppers		
Whole Population	20,607	40.8	0.11	0.00	8.2	0.09	0.00	22.3	0.11	0.01	83.0	0.06	0.00
Age Group													
Birth to 1 year	1,486	24.4	0.85	0.08	15.9	0.73	0.07	29.5	0.47	0.04	15.6	0.01	0.00
1 to 2 years	2,096	50.7	0.47	0.04	17.2	0.40	0.04	28.3	0.34	0.03	77.5	0.05	0.01
3 to 5 years	4,391	55.4	0.26	0.02	16.6	0.26	0.03	20.5	0.21	0.02	84.6	0.05	0.00
6 to 12 years	2,089	54.7	0.14	0.02	17.5	0.14	0.01	17.2	0.12	0.01	85.1	0.05	0.00
13 to 19 years	1,222	39.1	0.06	0.01	5.9	0.03	0.01	14.0	0.07	0.01	84.8	0.04	0.00
20 to 49 years	4,677	34.5	0.05	0.00	4.4	0.04	0.00	21.3	0.08	0.01	86.9	0.08	0.01
≥50 years	4,646	44.1	0.10	0.01	9.0	0.07	0.01	28.4	0.10	0.01	78.9	0.06	0.01
Season													
Fall	4,687	35.9	0.07	0.01	9.6	0.11	0.01	24.1	0.10	0.01	81.3	0.07	0.01
Spring	5,308	42.9	0.10	0.01	7.7	0.07	0.00	20.2	0.10	0.01	84.8	0.06	0.00
Summer	5,890	46.6	0.17	0.01	6.8	0.07	0.01	19.8	0.10	0.01	83.1	0.06	0.00
Winter	4,722	37.9	0.09	0.01	8.7	0.10	0.01	24.9	0.13	0.01	83.0	0.06	0.00
Race													
Asian, Pacific Islander	557	32.2	0.07	0.02	9.2	0.13	0.03	41.0	0.15	0.02	70.9	0.08	0.01
American Indian, Alaskan Native	177	38.0	0.20	0.06	11.2	0.15	0.06	22.5	0.13	0.03	89.3	0.08	0.02
Black	2,740	39.4	0.10	0.01	5.6	0.06	0.01	20.9	0.13	0.02	82.8	0.04	0.01
Other/NA	1,638	35.2	0.13	0.02	8.3	0.11	0.02	19.8	0.07	0.01	81.7	0.12	0.01
White	15,495	41.8	0.11	0.01	8.6	0.09	0.00	21.9	0.10	0.01	83.6	0.06	0.00
Region													
Midwest	4,822	45.3	0.11	0.01	9.1	0.09	0.01	22.1	0.10	0.01	85.6	0.06	0.01
Northeast	3,692	44.0	0.10	0.01	9.4	0.10	0.01	24.7	0.13	0.02	79.0	0.07	0.01
South	7,208	35.8	0.11	0.01	6.5	0.07	0.01	19.9	0.10	0.01	82.1	0.05	0.00
West	4,885	41.1	0.11	0.01	8.9	0.10	0.01	24.0	0.10	0.01	85.4	0.08	0.01
Urbanization													
City Center	6,164	39.9	0.11	0.01	8.1	0.09	0.01	24.0	0.12	0.01	83.4	0.07	0.01
Suburban	9,598	43.1	0.11	0.01	8.8	0.10	0.01	22.3	0.11	0.01	82.2	0.06	0.00
Non-metropolitan	4,845	37.1	0.10	0.00	7.2	0.06	0.01	19.6	0.09	0.01	84.4	0.06	0.01

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Pome Fruit			Pumpkins			Root Tuber Vegetables			Stalk, Stem Vegetables		
Whole Population	20,607	34.7	0.54	0.01	1.8	0.01	0.00	99.2	1.42	0.02	19.4	0.05	0.00
Age Group													
Birth to 1 year	1,486	40.0	3.04	0.17	0.3	0.00	0.00	61.7	2.60	0.15	1.9	0.01	0.00
1 to 2 years	2,096	52.0	2.19	0.10	0.7	0.01	0.00	99.6	3.38	0.09	13.2	0.06	0.01
3 to 5 years	4,391	51.7	1.90	0.06	0.9	0.01	0.00	100.0	2.96	0.07	10.9	0.04	0.00
6 to 12 years	2,089	47.9	0.97	0.06	1.8	0.01	0.00	100.0	2.09	0.07	10.7	0.03	0.01
13 to 19 years	1,222	26.5	0.23	0.02	1.3	0.01	0.00	99.9	1.36	0.06	16.6	0.03	0.01
20 to 49 years	4,677	27.9	0.25	0.01	1.7	0.00	0.00	99.7	1.12	0.02	24.5	0.05	0.00
≥50 years	4,646	39.0	0.39	0.02	2.3	0.01	0.00	99.7	1.13	0.02	18.3	0.05	0.00
Season													
Fall	4,687	39.5	0.66	0.04	4.9	0.01	0.00	99.4	1.49	0.04	18.5	0.04	0.00
Spring	5,308	33.6	0.52	0.03	0.4	0.00	0.00	99.3	1.41	0.03	20.1	0.05	0.00
Summer	5,890	29.1	0.41	0.02	0.7	0.00	0.00	99.2	1.34	0.03	17.0	0.03	0.00
Winter	4,722	36.7	0.56	0.03	1.0	0.00	0.00	99.0	1.45	0.04	21.8	0.06	0.01
Race													
Asian, Pacific Islander	557	36.5	0.66	0.08	1.0	0.00	0.00	97.3	1.31	0.10	36.5	0.11	0.01
American Indian, Alaskan Native	177	39.5	0.75	0.14	1.2	0.00	0.00	99.7	1.71	0.30	21.6	0.05	0.02
Black	2,740	24.8	0.42	0.03	0.5	0.00	0.00	99.0	1.31	0.09	8.1	0.01	0.00
Other/NA	1,638	32.7	0.67	0.06	3.5	0.01	0.00	98.0	1.47	0.05	14.5	0.03	0.00
White	15,495	36.4	0.54	0.01	1.9	0.01	0.00	99.4	1.44	0.02	20.9	0.05	0.00
Region													
Midwest	4,822	38.9	0.55	0.03	2.4	0.01	0.00	99.5	1.57	0.05	22.1	0.05	0.00
Northeast	3,692	37.3	0.57	0.02	2.0	0.01	0.00	99.4	1.33	0.05	17.2	0.05	0.01
South	7,208	28.9	0.43	0.02	1.1	0.00	0.00	99.2	1.40	0.04	16.4	0.04	0.00
West	4,885	37.2	0.65	0.03	1.9	0.01	0.00	98.8	1.38	0.05	23.1	0.06	0.00
Urbanization													
City Center	6,164	33.2	0.51	0.02	1.5	0.00	0.00	99.0	1.34	0.04	19.6	0.05	0.00
Suburban	9,598	37.6	0.59	0.02	1.8	0.00	0.00	99.3	1.44	0.03	20.0	0.05	0.00
Non-metropolitan	4,845	30.7	0.45	0.03	2.0	0.01	0.00	99.4	1.52	0.06	17.8	0.04	0.00

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
		Strawberries			Stone Fruit			Tomatoes			Tropical Fruits		
Whole Population	20,607	32.4	0.06	0.00	44.5	0.17	0.01	84.4	0.74	0.01	58.3	0.43	0.01
Age Group													
Birth to 1 year	1,486	6.8	0.02	0.00	29.2	1.15	0.10	21.5	0.30	0.03	42.2	1.31	0.07
1 to 2 years	2,096	33.5	0.19	0.03	53.6	0.60	0.04	80.7	1.50	0.05	70.1	1.97	0.10
3 to 5 years	4,391	37.1	0.14	0.01	57.5	0.38	0.02	85.7	1.40	0.03	69.7	1.10	0.04
6 to 12 years	2,089	37.3	0.10	0.01	56.8	0.23	0.02	86.9	1.00	0.03	67.0	0.50	0.04
13 to 19 years	1,222	26.8	0.05	0.01	41.1	0.09	0.01	90.2	0.74	0.03	54.5	0.19	0.02
20 to 49 years	4,677	29.8	0.05	0.00	38.1	0.09	0.01	87.1	0.66	0.01	52.8	0.27	0.01
≥50 years	4,646	37.7	0.06	0.00	49.4	0.17	0.01	80.1	0.57	0.01	63.1	0.41	0.01
Season													
Fall	4,687	26.8	0.03	0.00	39.3	0.11	0.01	83.5	0.73	0.03	56.5	0.42	0.02
Spring	5,308	36.8	0.11	0.01	46.8	0.17	0.01	84.3	0.69	0.02	59.4	0.43	0.02
Summer	5,890	36.1	0.06	0.01	50.3	0.28	0.02	85.1	0.80	0.02	58.2	0.41	0.02
Winter	4,722	29.9	0.05	0.01	41.6	0.12	0.01	84.5	0.72	0.02	58.9	0.45	0.02
Race													
Asian, Pacific Islander	557	23.9	0.07	0.03	36.5	0.16	0.04	74.1	0.73	0.06	55.4	0.61	0.07
American Indian, Alaskan Native	177	28.2	0.03	0.02	39.2	0.24	0.07	89.2	0.82	0.07	54.1	0.43	0.05
Black	2,740	21.1	0.02	0.00	40.7	0.14	0.02	78.1	0.63	0.03	53.6	0.36	0.03
Other/NA	1,638	22.3	0.05	0.01	38.2	0.19	0.03	89.6	1.11	0.05	60.9	0.77	0.09
White	15,495	35.3	0.07	0.00	45.9	0.17	0.01	85.4	0.73	0.01	59.0	0.41	0.01
Region													
Midwest	4,822	34.9	0.07	0.01	49.9	0.18	0.01	85.5	0.74	0.02	60.1	0.40	0.03
Northeast	3,692	37.1	0.06	0.01	47.5	0.15	0.01	83.4	0.73	0.02	62.4	0.47	0.02
South	7,208	27.2	0.05	0.00	38.9	0.15	0.01	82.7	0.69	0.02	53.1	0.36	0.02
West	4,885	33.9	0.08	0.01	44.8	0.20	0.01	86.6	0.81	0.02	60.8	0.53	0.03
Urbanization													
City Center	6,164	29.7	0.05	0.01	43.5	0.17	0.01	84.1	0.75	0.02	58.8	0.46	0.02
Suburban	9,598	36.2	0.08	0.00	46.9	0.18	0.01	84.5	0.73	0.01	60.2	0.44	0.01
Non-metropolitan	4,845	28.1	0.05	0.01	40.6	0.15	0.01	84.4	0.73	0.03	53.0	0.34	0.03

Table 9-16. Per Capita Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE
		White Potatoes		
Whole Population	20,607	91.3	0.89	0.02
Age Group				
Birth to 1 year	1,486	39.9	0.64	0.07
1 to 2 years	2,096	91.2	1.95	0.08
3 to 5 years	4,391	95.1	1.75	0.06
6 to 12 years	2,089	93.9	1.21	0.06
13 to 19 years	1,222	92.6	0.93	0.05
20 to 49 years	4,677	91.5	0.74	0.02
≥50 years	4,646	91.7	0.72	0.02
Season				
Fall	4,687	91.5	0.91	0.04
Spring	5,308	91.3	0.87	0.03
Summer	5,890	91.3	0.86	0.03
Winter	4,722	91.1	0.90	0.03
Race				
Asian, Pacific Islander	557	82.3	0.72	0.09
American Indian, Alaskan Native	177	92.7	1.29	0.32
Black	2,740	88.5	0.81	0.07
Other/NA	1,638	86.5	0.86	0.07
White	15,495	92.4	0.90	0.02
Region				
Midwest	4,822	94.5	1.00	0.03
Northeast	3,692	88.6	0.79	0.04
South	7,208	91.8	0.90	0.04
West	4,885	89.6	0.82	0.06
Urbanization				
City Center	6,164	89.5	0.81	0.04
Suburban	9,598	91.2	0.87	0.02
Non-metropolitan	4,845	94.2	1.02	0.06

N = Sample size.
SE = Standard error.
Note: Data for fruits and vegetables for which only small percentages of the population reported consumption may be less reliable than data for fruits and vegetables with higher percentages consuming.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Apples			Asparagus			Bananas			Beans			Beets		
Whole Population	7,193	1.47	0.03	233	0.85	0.04	10,734	0.73	0.02	9,086	0.60	0.01	374	0.35	0
Age Group															
Birth to 1 year	496	6.71	0.31	3	2.59	1.16	605	3.04	0.12	313	2.00	0.16	6	1.42	0.9
1 to 2 years	947	4.00	0.15	19	1.99	0.54	1,328	2.82	0.12	996	1.63	0.08	13	0.98	0.3
3 to 5 years	1,978	3.68	0.08	23	1.37	0.32	2,746	1.54	0.06	1,909	1.22	0.04	36	0.9	0.2
6 to 12 years	792	2.17	0.12	13	1.77	0.43	1,214	0.66	0.05	833	0.82	0.05	16	0.66	0.3
13 to 19 years	271	0.90	0.06	4	0.56	0.08	511	0.30	0.04	472	0.49	0.03	9	0.2	0.1
20 to 49 years	1,171	0.82	0.03	58	0.79	0.08	1,887	0.50	0.01	2,153	0.48	0.01	93	0.23	0
≥ 50 years	1,538	0.92	0.04	113	0.77	0.07	2,443	0.65	0.02	2,410	0.52	0.02	201	0.38	0
Season															
Fall	1,841	1.57	0.06	44	0.80	0.13	2,292	0.79	0.04	2,122	0.60	0.02	90	0.25	0
Spring	1,818	1.52	0.07	91	0.90	0.07	2,856	0.70	0.03	2,311	0.59	0.02	92	0.45	0.1
Summer	1,801	1.32	0.06	36	0.66	0.12	3,124	0.66	0.03	2,539	0.65	0.02	104	0.34	0.1
Winter	1,733	1.44	0.05	62	0.94	0.10	2,462	0.80	0.03	2,114	0.57	0.02	88	0.33	0.1
Race															
Asian, Pacific Islander	182	1.59	0.12	5	0.62	0.15	265	0.95	0.10	265	0.48	0.05	16	0.04	0
American Indian, Alaskan Native	58	1.93	0.27	2	0.81	-	88	0.87	0.15	74	0.70	0.12	1	0.02	-
Black	762	1.62	0.12	8	1.01	0.64	1,288	0.59	0.05	1,205	0.71	0.04	18	0.29	0.1
Other/NA	536	2.00	0.13	5	0.31	0.09	865	1.21	0.11	911	0.71	0.04	16	0.39	0.2
White	5,655	1.42	0.03	213	0.86	0.05	8,228	0.71	0.02	6,631	0.58	0.01	323	0.36	0
Region															
Midwest	1,792	1.35	0.06	63	0.91	0.08	2,589	0.68	0.04	2,071	0.59	0.02	90	0.35	0.1
Northeast	1,385	1.46	0.05	43	0.72	0.10	2,122	0.68	0.02	1,342	0.56	0.02	78	0.42	0.1
South	2,201	1.44	0.05	64	1.07	0.09	3,356	0.70	0.04	3,465	0.68	0.02	99	0.29	0
West	1,815	1.67	0.06	63	0.69	0.04	2,667	0.89	0.03	2,208	0.52	0.03	107	0.33	0.1
Urbanization															
City Center	2,091	1.46	0.05	81	0.85	0.07	3,182	0.75	0.03	2,840	0.62	0.02	110	0.28	0
Suburban	3,647	1.49	0.05	97	0.78	0.07	5,303	0.75	0.02	3,957	0.58	0.01	171	0.39	0.1
Non-metropolitan	1,455	1.45	0.03	55	0.98	0.11	2,249	0.67	0.04	2,289	0.61	0.01	93	0.35	0

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Berries and Small Fruits			Broccoli			Bulb Vegetables			Cabbage			Carrots		
Whole Population	12,206	0.40	0.01	2,474	0.80	0.03	18,738	0.21	0.00	2,633	0.50	0.03	9,513	0.34	0.01
Age Group															
Birth to 1 year	229	0.81	0.07	49	2.09	0.33	489	0.22	0.02	15	0.61	0.41	179	1.39	0.20
1 to 2 years	1,396	1.38	0.06	242	2.11	0.16	1,957	0.32	0.01	160	0.73	0.11	999	0.87	0.05
3 to 5 years	3,166	0.99	0.04	475	1.67	0.09	4,207	0.28	0.01	369	0.78	0.07	2,048	0.74	0.03
6 to 12 years	1,523	0.54	0.04	213	1.29	0.16	2,040	0.22	0.01	190	0.63	0.11	904	0.50	0.03
13 to 19 years	679	0.27	0.03	102	0.69	0.07	1,194	0.20	0.01	106	0.40	0.06	482	0.27	0.02
20 to 49 years	2,393	0.27	0.02	640	0.68	0.04	4,546	0.22	0.01	746	0.45	0.03	2,289	0.28	0.01
≥ 50 years	2,820	0.31	0.01	753	0.63	0.03	4,305	0.18	0.00	1,047	0.52	0.02	2,612	0.29	0.01
Season															
Fall	2,706	0.31	0.02	582	0.81	0.05	4,310	0.22	0.01	623	0.44	0.03	2,338	0.35	0.02
Spring	3,202	0.45	0.03	651	0.82	0.07	4,835	0.21	0.01	684	0.52	0.03	2,345	0.36	0.02
Summer	3,558	0.48	0.02	660	0.79	0.05	5,280	0.20	0.01	676	0.56	0.07	2,440	0.33	0.01
Winter	2,740	0.35	0.02	581	0.76	0.07	4,313	0.22	0.01	650	0.48	0.04	2,390	0.34	0.01
Race															
Asian, Pacific Islander	252	0.66	0.13	118	0.89	0.12	481	0.40	0.03	152	0.69	0.09	329	0.47	0.05
American Indian, Alaskan Native	85	0.26	0.04	16	1.18	0.43	169	0.25	0.04	18	0.34	0.13	82	0.26	0.03
Black	1,430	0.27	0.02	286	1.06	0.12	2,438	0.18	0.01	359	0.87	0.11	958	0.28	0.02
Other/NA	782	0.45	0.06	131	1.09	0.10	1,484	0.33	0.02	144	0.24	0.05	749	0.45	0.03
White	9,657	0.41	0.01	1,923	0.73	0.03	14,166	0.20	0.00	1,960	0.43	0.02	7,395	0.34	0.01
Region															
Midwest	3,042	0.40	0.03	533	0.66	0.03	4,457	0.20	0.01	629	0.49	0.04	2,313	0.34	0.02
Northeast	2,383	0.37	0.03	511	0.84	0.07	3,324	0.20	0.01	413	0.56	0.06	1,843	0.34	0.01
South	3,896	0.35	0.02	810	0.83	0.04	6,497	0.19	0.01	978	0.52	0.06	2,981	0.31	0.01
West	2,885	0.48	0.03	620	0.83	0.08	4,460	0.26	0.01	613	0.41	0.03	2,376	0.40	0.01
Urbanization															
City Center	3,525	0.38	0.02	741	0.83	0.06	5,547	0.22	0.01	794	0.58	0.07	2,759	0.34	0.01
Suburban	6,039	0.44	0.02	1,283	0.81	0.03	8,768	0.21	0.01	1,251	0.45	0.02	4,690	0.36	0.01
Non-metropolitan	2,642	0.31	0.03	450	0.64	0.05	4,423	0.20	0.01	588	0.48	0.04	2,064	0.32	0.01

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Citrus Fruits			Corn			Cucumbers			Cucurbits			Fruiting Vegetables		
Whole Population	3,656	0.99	0.03	19,059	0.47	0.01	6,779	0.24	0.02	8,763	0.81	0.04	18,407	0.87	0.01
Age Group															
Birth to 1 year	37	2.79	0.53	671	1.05	0.07	25	0.28	0.11	213	3.19	0.29	371	1.24	0.11
1 to 2 years	336	3.06	0.20	2,027	1.17	0.05	439	0.52	0.05	682	2.29	0.17	1,927	1.70	0.06
3 to 5 years	751	2.75	0.15	4,334	1.26	0.03	1,266	0.56	0.05	1,694	2.15	0.17	4,180	1.53	0.03
6 to 12 years	324	1.60	0.12	2,064	0.88	0.03	667	0.43	0.06	833	1.34	0.15	2,014	1.10	0.03
13 to 19 years	157	0.90	0.15	1,176	0.45	0.01	500	0.26	0.06	563	0.69	0.16	1,176	0.82	0.03
20 to 49 years	841	0.68	0.04	4,415	0.34	0.01	2,033	0.20	0.01	2,400	0.55	0.03	4,489	0.78	0.02
≥ 50 years	1,210	0.84	0.03	4,372	0.28	0.01	1,849	0.21	0.01	2,378	0.81	0.05	4,250	0.71	0.02
Season															
Fall	761	0.93	0.06	4,342	0.44	0.01	1,374	0.22	0.02	1,778	0.46	0.03	4,186	0.87	0.03
Spring	1,002	0.97	0.05	4,909	0.47	0.02	1,906	0.23	0.01	2,408	0.94	0.07	4,755	0.82	0.02
Summer	815	0.53	0.04	5,423	0.52	0.02	2,070	0.32	0.05	2,855	1.32	0.10	5,262	0.93	0.02
Winter	1,078	1.32	0.06	4,385	0.44	0.02	1,429	0.20	0.02	1,722	0.36	0.03	4,204	0.85	0.03
Race															
Asian, Pacific Islander	117	1.50	0.19	454	0.37	0.05	134	0.68	0.43	217	1.92	0.79	439	0.98	0.06
American Indian, Alaskan Native	41	1.61	0.17	165	0.55	0.06	60	0.23	0.06	75	1.04	0.32	162	0.93	0.08
Black	369	1.15	0.08	2,502	0.52	0.02	858	0.17	0.01	987	0.62	0.08	2,398	0.75	0.04
Other/NA	347	1.66	0.16	1,475	0.76	0.05	413	0.30	0.03	633	1.14	0.19	1,447	1.34	0.05
White	2,782	0.89	0.03	14,463	0.44	0.01	5,314	0.24	0.01	6,851	0.77	0.03	13,961	0.85	0.01
Region															
Midwest	842	0.84	0.06	4,562	0.48	0.02	1,693	0.23	0.02	2,091	0.75	0.05	4,379	0.85	0.02
Northeast	754	0.94	0.06	3,377	0.43	0.01	1,191	0.25	0.02	1,614	0.85	0.08	3,254	0.88	0.02
South	998	0.94	0.04	6,648	0.46	0.01	2,356	0.22	0.02	2,905	0.70	0.06	6,416	0.81	0.03
West	1,062	1.20	0.07	4,472	0.49	0.02	1,539	0.29	0.07	2,153	0.99	0.12	4,358	0.96	0.03
Urbanization															
City Center	1,146	1.01	0.04	5,641	0.47	0.01	1,965	0.22	0.01	2,570	0.71	0.05	5,477	0.89	0.03
Suburban	1,738	0.97	0.04	8,886	0.47	0.01	3,151	0.26	0.03	4,119	0.89	0.07	8,563	0.86	0.01
Non-metropolitan	772	0.99	0.07	4,532	0.45	0.02	1,663	0.25	0.03	2,074	0.78	0.06	4,367	0.85	0.04

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Leafy Vegetables			Legumes			Lettuce			Okra			Onions		
Whole Population	17,637	0.65	0.01	19,258	0.45	0.01	8,430	0.46	0.01	272	0.51	0.04	18,678	0.20	0.00
Age Group															
Birth to 1 year	639	0.65	0.11	754	2.34	0.11	15	0.17	0.02	4	1.50	0.54	481	0.22	0.02
1 to 2 years	1,729	0.87	0.05	2,037	1.34	0.08	481	0.58	0.04	29	0.64	0.19	1,948	0.31	0.01
3 to 5 years	3,815	0.77	0.03	4,308	0.86	0.06	1,415	0.62	0.03	34	1.16	0.32	4,200	0.27	0.01
6 to 12 years	1,860	0.62	0.03	2,045	0.49	0.03	858	0.53	0.02	21	0.62	0.15	2,030	0.21	0.01
13 to 19 years	1,101	0.47	0.02	1,168	0.29	0.02	669	0.40	0.03	12	0.43	0.13	1,190	0.19	0.01
20 to 49 years	4,308	0.63	0.02	4,477	0.36	0.01	2,693	0.45	0.01	62	0.44	0.06	4,533	0.21	0.01
≥ 50 years	4,185	0.72	0.02	4,469	0.41	0.01	2,299	0.45	0.01	110	0.50	0.05	4,296	0.17	0.00
Season															
Fall	4,046	0.66	0.03	4,412	0.46	0.02	1,894	0.46	0.02	58	0.39	0.04	4,300	0.21	0.01
Spring	4,579	0.66	0.02	4,952	0.42	0.02	2,279	0.46	0.02	66	0.47	0.09	4,815	0.20	0.01
Summer	4,964	0.62	0.02	5,476	0.45	0.02	2,325	0.45	0.01	106	0.65	0.08	5,265	0.19	0.01
Winter	4,048	0.66	0.02	4,418	0.46	0.02	1,932	0.46	0.02	42	0.53	0.13	4,298	0.21	0.01
Race															
Asian, Pacific Islander	469	1.22	0.12	503	0.79	0.09	191	0.58	0.09	15	0.20	0.06	480	0.39	0.03
American Indian, Alaskan Native	151	0.59	0.19	170	0.44	0.08	88	0.34	0.04	2	0.40	-	169	0.25	0.04
Black	2,367	0.73	0.04	2,563	0.52	0.04	884	0.35	0.02	67	0.63	0.08	2,431	0.17	0.01
Other/NA	1,329	0.59	0.04	1,478	0.58	0.05	643	0.49	0.04	15	0.70	0.25	1,484	0.32	0.02
White	13,321	0.62	0.01	14,544	0.42	0.01	6,624	0.47	0.01	173	0.51	0.05	14,114	0.19	0.00
Region															
Midwest	4,226	0.60	0.03	4,577	0.41	0.02	2,035	0.47	0.03	24	0.42	0.20	4,448	0.19	0.01
Northeast	3,081	0.71	0.03	3,421	0.40	0.02	1,396	0.49	0.02	22	0.50	0.18	3,308	0.19	0.01
South	6,174	0.61	0.02	6,771	0.49	0.02	2,830	0.41	0.02	178	0.58	0.05	6,479	0.19	0.01
West	4,156	0.71	0.04	4,489	0.47	0.03	2,169	0.49	0.03	48	0.30	0.07	4,443	0.25	0.01
Urbanization															
City Center	5,232	0.72	0.03	5,735	0.50	0.02	2,414	0.46	0.02	96	0.49	0.07	5,531	0.21	0.01
Suburban	8,220	0.67	0.02	8,950	0.43	0.02	3,999	0.49	0.01	102	0.59	0.07	8,739	0.20	0.01
Non-metropolitan	4,185	0.51	0.03	4,573	0.43	0.02	2,017	0.39	0.02	74	0.42	0.04	4,408	0.20	0.01

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Peaches			Pears			Peas			Peppers			Pome Fruit		
Whole Population	9,069	0.26	0.01	2,355	1.06	0.04	4,661	0.48	0.02	16,093	0.08	0.00	8,316	1.55	0.03
Age Group															
Birth to 1 year	344	3.47	0.28	217	4.55	0.28	417	1.60	0.09	224	0.05	0.01	572	7.60	0.34
1 to 2 years	1,067	0.93	0.08	354	2.33	0.16	609	1.21	0.06	1,627	0.06	0.01	1,097	4.21	0.13
3 to 5 years	2,461	0.48	0.03	711	1.59	0.12	888	1.02	0.07	3,706	0.06	0.00	2,291	3.68	0.08
6 to 12 years	1,150	0.26	0.03	382	0.81	0.07	346	0.68	0.06	1,784	0.05	0.01	1,012	2.03	0.10
13 to 19 years	480	0.15	0.03	72	0.45	0.09	168	0.48	0.06	1,041	0.05	0.00	320	0.87	0.06
20 to 49 years	1,544	0.14	0.01	205	0.80	0.05	959	0.37	0.02	4,068	0.09	0.01	1,274	0.88	0.03
≥ 50 years	2,023	0.22	0.01	414	0.81	0.04	1,274	0.37	0.02	3,643	0.08	0.01	1,750	1.00	0.03
Season															
Fall	1,841	0.20	0.02	596	1.15	0.08	1,172	0.43	0.02	3,643	0.08	0.01	2,102	1.67	0.07
Spring	2,439	0.23	0.02	590	0.86	0.05	1,120	0.51	0.03	4,212	0.07	0.01	2,102	1.54	0.06
Summer	2,815	0.37	0.02	585	1.05	0.06	1,213	0.48	0.02	4,568	0.08	0.01	2,092	1.40	0.06
Winter	1,974	0.22	0.02	584	1.14	0.09	1,156	0.52	0.04	3,670	0.07	0.01	2,020	1.53	0.06
Race															
Asian, Pacific Islander	200	0.23	0.04	56	1.43	0.21	192	0.35	0.04	344	0.11	0.01	209	1.82	0.14
American Indian, Alaskan Native	68	0.54	0.17	23	1.31	0.60	51	0.59	0.10	144	0.09	0.03	73	1.89	0.29
Black	1,146	0.25	0.03	244	1.09	0.15	612	0.64	0.05	2,150	0.05	0.01	878	1.68	0.12
Other/NA	590	0.38	0.07	171	1.39	0.22	323	0.38	0.04	1,233	0.15	0.01	624	2.05	0.14
White	7,065	0.26	0.01	1,861	1.02	0.04	3,483	0.48	0.02	12,222	0.07	0.00	6,532	1.48	0.03
Region															
Midwest	2,283	0.25	0.02	625	0.96	0.06	1,108	0.46	0.02	3,920	0.07	0.01	2,094	1.42	0.07
Northeast	1,778	0.22	0.02	470	1.04	0.06	923	0.52	0.05	2,711	0.08	0.01	1,598	1.54	0.05
South	2,849	0.30	0.02	648	1.08	0.10	1,526	0.51	0.03	5,579	0.06	0.01	2,535	1.50	0.05
West	2,159	0.26	0.02	612	1.17	0.08	1,104	0.43	0.04	3,883	0.10	0.01	2,089	1.74	0.07
Urbanization															
City Center	2,640	0.27	0.02	686	1.06	0.06	1,480	0.50	0.03	4,780	0.09	0.01	2,408	1.54	0.05
Suburban	4,457	0.26	0.01	1,205	1.12	0.06	2,179	0.48	0.03	7,436	0.07	0.00	4,224	1.58	0.06
Non-metropolitan	1,972	0.27	0.01	464	0.89	0.05	1,002	0.45	0.04	3,877	0.07	0.01	1,684	1.48	0.03

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Pumpkins			Root Tuber Vegetables			Stalk, Stem Vegetables			Strawberries			Stone Fruit		
Whole Population	299	0.30	0.02	19,997	1.44	0.02	3,095	0.24	0.01	6,675	0.20	0.01	9,786	0.38	0.01
Age Group															
Birth to 1 year	3	1.06	0.71	916	4.21	0.19	24	0.56	0.22	96	0.26	0.06	418	3.95	0.25
1 to 2 years	15	1.08	0.51	2,087	3.40	0.09	272	0.48	0.05	729	0.57	0.08	1,130	1.13	0.08
3 to 5 years	36	0.56	0.10	4,388	2.96	0.07	502	0.38	0.03	1,710	0.38	0.03	2,556	0.66	0.03
6 to 12 years	37	0.52	0.11	2,089	2.09	0.07	218	0.32	0.04	783	0.28	0.02	1,194	0.41	0.03
13 to 19 years	14	0.42	0.16	1,221	1.36	0.06	190	0.20	0.03	326	0.18	0.03	508	0.21	0.03
20 to 49 years	89	0.24	0.02	4,664	1.12	0.02	1,079	0.20	0.01	1,330	0.15	0.02	1,715	0.23	0.01
≥ 50 years	105	0.22	0.01	4,632	1.14	0.02	810	0.27	0.02	1,701	0.15	0.01	2,265	0.34	0.02
Season															
Fall	193	0.29	0.02	4,565	1.50	0.04	720	0.22	0.02	1,250	0.13	0.01	1,987	0.27	0.02
Spring	22	0.65	0.18	5,151	1.43	0.03	825	0.25	0.01	1,911	0.30	0.03	2,627	0.35	0.02
Summer	40	0.22	0.06	5,690	1.35	0.03	796	0.20	0.01	2,060	0.17	0.02	3,029	0.56	0.03
Winter	44	0.25	0.04	4,591	1.46	0.03	754	0.26	0.02	1,454	0.16	0.02	2,143	0.29	0.02
Race															
Asian, Pacific Islander	4	0.33	0.07	518	1.35	0.10	158	0.29	0.03	149	0.29	0.11	218	0.44	0.08
American Indian, Alaskan Native	3	0.11	0.01	174	1.71	0.30	32	0.25	0.05	50	0.11	0.04	73	0.60	0.18
Black	12	0.34	0.05	2,642	1.32	0.09	188	0.18	0.03	550	0.11	0.02	1,184	0.34	0.04
Other/NA	43	0.21	0.08	1,561	1.50	0.05	172	0.21	0.02	367	0.22	0.06	649	0.50	0.08
White	237	0.31	0.02	15,102	1.45	0.02	2,545	0.24	0.01	5,559	0.20	0.01	7,662	0.38	0.01
Region															
Midwest	87	0.31	0.01	4,709	1.58	0.05	883	0.22	0.02	1,668	0.20	0.01	2,469	0.36	0.02
Northeast	62	0.30	0.09	3,598	1.34	0.05	467	0.26	0.03	1,381	0.16	0.02	1,912	0.32	0.02
South	70	0.28	0.03	6,998	1.41	0.04	908	0.24	0.02	1,952	0.18	0.02	3,060	0.39	0.02
West	80	0.30	0.05	4,692	1.40	0.05	837	0.24	0.02	1,674	0.23	0.03	2,345	0.45	0.03
Urbanization															
City Center	76	0.31	0.05	5,961	1.36	0.04	891	0.25	0.02	1,772	0.18	0.02	2,845	0.38	0.02
Suburban	137	0.26	0.02	9,315	1.45	0.03	1,492	0.23	0.01	3,517	0.22	0.01	4,808	0.38	0.02
Non-metropolitan	86	0.36	0.04	4,721	1.53	0.07	712	0.24	0.02	1,386	0.17	0.03	2,133	0.36	0.01

Table 9-17. Consumer-Only Intake of Individual Fruits and Vegetables Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Tomatoes			Tropical Fruits			White Potatoes		
Whole Population	16,403	0.87	0.01	12,539	0.73	0.02	18,261	0.97	0.02
Age Group									
Birth to 1 year	315	1.42	0.13	630	3.09	0.12	577	1.60	0.15
1 to 2 years	1,684	1.86	0.06	1,476	2.81	0.12	1,918	2.14	0.09
3 to 5 years	3,764	1.63	0.03	3,106	1.57	0.05	4,147	1.84	0.06
6 to 12 years	1,832	1.15	0.03	1,407	0.75	0.05	1,963	1.29	0.06
13 to 19 years	1,098	0.82	0.03	652	0.35	0.04	4,271	0.81	0.02
20 to 49 years	4,053	0.75	0.02	2,428	0.51	0.02	2,664	0.75	0.02
≥ 50 years	3,657	0.72	0.01	2,840	0.64	0.02	4,254	0.78	0.02
Season									
Fall	3,732	0.87	0.03	2,748	0.75	0.03	4,205	1.00	0.04
Spring	4,173	0.82	0.02	3,291	0.72	0.03	4,703	0.96	0.03
Summer	4,731	0.94	0.02	3,595	0.70	0.02	5,190	0.94	0.03
Winter	3,767	0.86	0.03	2,905	0.77	0.03	4,163	0.99	0.03
Race									
Asian, Pacific Islander	373	0.99	0.08	314	1.10	0.13	428	0.88	0.09
American Indian, Alaskan Native	146	0.92	0.08	103	0.79	0.12	162	1.40	0.33
Black	2,017	0.80	0.04	1,541	0.67	0.05	2,365	0.92	0.08
Other/NA	1,369	1.24	0.05	1,034	1.26	0.10	1,353	1.00	0.06
White	12,498	0.85	0.01	9,547	0.69	0.02	13,953	0.98	0.02
Region									
Midwest	3,915	0.87	0.02	2,989	0.67	0.04	4,436	1.06	0.04
Northeast	2,906	0.88	0.02	2,412	0.75	0.02	3,199	0.90	0.03
South	5,629	0.83	0.02	4,016	0.67	0.03	6,415	0.98	0.04
West	3,953	0.93	0.02	3,122	0.87	0.03	4,211	0.92	0.06
Urbanization									
City Center	4,867	0.89	0.02	3,750	0.79	0.03	5,337	0.91	0.04
Suburban	7,647	0.87	0.01	6,092	0.73	0.02	8,488	0.96	0.02
Non-metropolitan	3,889	0.86	0.03	2,697	0.64	0.05	4,436	1.08	0.06

N = Sample size.
SE = Standard error.
Note: Data for fruits and vegetables for which only small percentages of the population reported consumption may be less reliable than data for fruits and vegetables with higher percentages consuming.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 9-18. Per Capita Intake of Exposed Fruits Based on 1994−1996 CSFII (g/kg-day, as-consumed)													
Population Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	39.9	1.5	0.06	0	0	0	0	0	1.3	3.8	7.0	22.6	101.3
Age Group													
0 to 5 months	32.8	6.4	1.6	0	0	0	0	0	6.9	23.7	40.2	48.5	63.4
6 to 12 months	79.9	14.1	1.2	0	0	0	4.5	11.8	19.3	32.7	37.1	63.7	69.6
<1 years	54.9	10.0	1.0	0	0	0	0	4.5	16.5	30.1	38.8	58.5	69.6
1 to 2 years	69.2	10.9	0.47	0	0	0	0	5.7	15.7	29.4	39.0	65.8	101.3
3 to 5 years	59.8	5.6	0.28	0	0	0	0	2.7	8.1	15.8	22.2	35.0	77.1
6 to 11 years	50	2.2	0.14	0	0	0	0	0	3.1	6.3	8.8	17.6	32.2
12 to 19 years	32.7	0.87	0.09	0	0	0	0	0	1.1	2.9	4.9	8.8	14.9
20 to 39 years	29.6	0.58	0.05	0	0	0	0	0	0.60	2.0	3.1	6.2	16.0
40 to 69 years	40	0.69	0.03	0	0	0	0	0	0.94	2.2	3.3	6.3	18.6
≥70 years	51.6	0.97	0.06	0	0	0	0	0.11	1.3	2.8	4.1	7.5	18.6
Season													
Fall	40.7	1.6	0.11	0	0	0	0	0	1.4	4.0	7.0	22.5	101.3
Spring	40.4	1.5	0.10	0	0	0	0	0	1.3	3.8	7.1	20.9	77.1
Summer	39.7	1.5	0.11	0	0	0	0	0	1.3	3.7	6.9	23.7	81.1
Winter	38.6	1.5	0.12	0	0	0	0	0	1.2	3.4	7.1	21.2	83.6
Urbanization													
Central City	39.6	1.6	0.11	0	0	0	0	0	1.4	4.3	7.3	23.6	83.6
Non-	33.6	1.1	0.10	0	0	0	0	0	0.8	2.8	5.4	16.5	65.8
Suburban	42.9	1.6	0.08	0	0	0	0	0	1.4	3.9	7.5	23.7	101.3
Race													
Asian	41.6	1.7	0.35	0	0	0	0	0	1.8	5.0	6.4	22.1	61.9
Black	29	1.3	0.17	0	0	0	0	0	0.67	3.3	6.3	22.4	101.3
Native American	33.2	1.2	0.57	0	0	0	0	0	0.99	3.8	6.4	14.0	40.8
Other/NA	38.2	1.9	0.29	0	0	0	0	0	1.4	4.3	8.8	28.4	69.6
White	41.7	1.5	0.06	0	0	0	0	0	1.3	3.7	7.1	21.6	83.6
Region													
Midwest	42.2	1.5	0.11	0	0	0	0	0	1.4	3.7	6.7	21.0	101.3
Northeast	45.3	1.8	0.13	0	0	0	0	0	1.5	4.5	7.5	24.6	81.1
South	33.3	1.3	0.10	0	0	0	0	0	0.86	3.2	6.4	20.4	81.3
West	42.9	1.6	0.12	0	0	0	0	0	1.6	4.2	7.5	22.1	83.6

SE = Standard error.

Source: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-19. Per Capita Intake of Protected Fruits Based on 1994−1996 CSFII (g/kg-day, as-consumed)

Population Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	53	1.9	0.04	0	0	0	0	0.38	2.6	5.4	8.1	16.3	113.4
Age Group													
0 to 5 months	10.8	0.5	0.34	0	0	0	0	0	0	1.3	4.3	7.7	12.5
6 to 12 months	49	3.1	0.58	0	0	0	0	0	4.4	8.3	11.2	26.8	30.3
<1 years	28.7	1.7	0.39	0	0	0	0	0	2.0	6.0	8.3	16.6	30.3
1 to 2 years	61.8	6.5	0.31	0	0	0	0	3.6	9.2	17.8	24.2	39.0	113.4
3 to 5 years	56.2	4.4	0.22	0	0	0	0	2.1	6.7	12.1	17.2	27.9	66.5
6 to 11 years	50.7	2.7	0.17	0	0	0	0	0.17	3.8	8.1	11.4	19.8	31.7
12 to 19 years	47.3	1.8	0.12	0	0	0	0	0	2.6	5.4	8.4	15.4	27.0
20 to 39 years	48	1.4	0.07	0	0	0	0	0	1.9	4.3	6.3	11.8	39.3
40 to 69 years	56.5	1.4	0.04	0	0	0	0	0.61	2.2	4.1	5.5	9.7	45.8
≥70 years	68.7	1.8	0.07	0	0	0	0	1.3	2.8	4.7	5.9	9.2	27.6
Season													
Fall	50.8	1.8	0.08	0	0	0	0	0.06	2.3	5.0	7.3	16.1	75.7
Spring	53.5	2.0	0.08	0	0	0	0	0.46	2.6	5.4	8.8	18.7	47.4
Summer	52.4	2.0	0.08	0	0	0	0	0.29	2.7	5.5	8.4	15.9	113.4
Winter	55.4	1.9	0.07	0	0	0	0	0.61	2.6	5.5	8.0	15.1	52.0
Urbanization													
Central City	55.5	2.1	0.07	0	0	0	0	0.67	2.8	5.8	8.5	17.2	66.5
Non-metropolitan	45.6	1.5	0.08	0	0	0	0	0	1.9	4.4	7.0	14.9	61.9
Suburban	54.6	2.0	0.06	0	0	0	0	0.59	2.7	5.5	8.3	16.6	113.4
Race													
Asian	62.3	3.0	0.30	0	0	0	0	1.5	4.1	8.1	11.7	18.7	64.0
Black	48.1	1.8	0.11	0	0	0	0	0	2.2	5.4	8.1	16.6	50.1
Native American	44.1	2.0	0.65	0	0	0	0	0	2.5	6.8	7.9	17.0	61.9
Other/NA	60.3	2.8	0.21	0	0	0	0	0.98	3.9	7.5	10.8	22.4	113.4
White	53	1.8	0.04	0	0	0	0	0.37	2.5	5.1	7.7	15.7	75.7
Region													
Midwest	51	1.8	0.08	0	0	0	0	0.08	2.4	5.3	7.8	16.5	75.7
Northeast	62.5	2.4	0.09	0	0	0	0	1.1	3.2	6.2	9.5	19.5	66.5
South	47.6	1.6	0.06	0	0	0	0	0	2.1	4.7	7.1	14.9	65.7
West	55.3	2.0	0.09	0	0	0	0	0.61	2.8	5.8	8.4	15.3	113.4

SE = Standard error.

Source: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-20. Per Capita Intake of Exposed Vegetables (g/kg-day, as-consumed)

Population Group	Percent consuming	Mean	SE	Percentile 1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	79.2	1.3	0.02	0	0	0	0.11	0.80	1.9	3.4	4.4	7.6	45.0
Age Group					5								
0 to 5 months	6	0.48	0.62	0	0	0	0	0	0	0	4.6	11.8	12.5
6 to 12 months	40.8	2.0	0.49	0	0	0	0	0	3.1	5.8	10.3	14.7	19.0
<1 years	22.3	1.2	0.37	0	0	0	0	0	0	5.0	7.4	14.7	19.0
1 to 2 years	63.3	2.0	0.11	0	0	0	0	0.59	2.7	5.8	8.6	14.9	45.0
3 to 5 years	67.8	1.6	0.08	0	0	0	0	0.67	2.2	4.4	6.4	12.8	25.1
6 to 11 years	70.8	1.2	0.06	0	0	0	0	0.60	1.6	3.4	4.8	8.1	19.6
12 to 19 years	77.4	0.97	0.04	0	0	0	0.06	0.53	1.3	2.5	3.6	5.8	13.0
20 to 39 years	82.6	1.3	0.03	0	0	0	0.15	0.81	1.8	3.2	4.1	6.9	18.4
40 to 69 years	84	1.4	0.02	0	0	0	0.28	0.97	2.0	3.3	4.3	6.4	16.4
≥70 years	83.2	1.5	0.05	0	0	0	0.31	1.09	2.1	3.6	4.4	7.2	20.1
Season													
Fall	79.6	1.3	0.03	0	0	0	0.12	0.79	1.9	3.4	4.4	7.3	45.0
Spring	78.8	1.3	0.03	0	0	0	0.09	0.79	1.8	3.3	4.3	7.9	25.1
Summer	81.2	1.5	0.03	0	0	0	0.16	0.92	2.1	3.5	4.8	8.6	25.1
Winter	77.4	1.2	0.03	0	0	0	0.08	0.74	1.7	3.2	4.2	7.0	20.9
Urbanization													
Central City	79.5	1.4	0.03	0	0	0	0.12	0.83	2.0	3.5	4.5	8.1	25.1
Non-metropolitan	78	1.2	0.03	0	0	0	0.08	0.69	1.6	2.9	4.1	6.9	45.0
Suburban	79.6	1.4	0.02	0	0	0	0.12	0.85	1.9	3.4	4.5	7.8	25.1
Race													
Asian	82.2	2.1	0.15	0	0	0	0.34	1.39	3.0	4.9	7.1	13.0	20.1
Black	76.3	1.2	0.04	0	0	0	0.04	0.66	1.7	3.3	4.1	7.2	20.9
Native American	70.7	1.3	0.40	0	0	0	0	0.45	1.5	2.0	4.5	9.5	45.0
Other/NA	73.8	1.3	0.08	0	0	0	0	0.73	1.8	3.3	4.7	10.4	24.8
White	80.1	1.3	0.02	0	0	0	0.13	0.82	1.9	3.3	4.4	7.2	25.1
Region													
Midwest	80.2	1.3	0.03	0	0	0	0.12	0.81	1.8	3.3	4.4	7.1	24.8
Northeast	79.4	1.4	0.04	0	0	0	0.12	0.91	2.1	3.5	4.6	7.9	25.1
South	79.6	1.3	0.03	0	0	0	0.12	0.78	1.8	3.2	4.2	7.1	25.1
West	77.5	1.3	0.04	0	0	0	0.08	0.78	1.8	3.4	4.6	8.9	45.0

SE = Standard error.

Source: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-21. Per Capita Intake of Protected Vegetables Based on 1994−1996 CSFII (g/kg-day, as-consumed)													
Population Group	Percent consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	38.0	0.63	0.02	0	0	0	0	0	0.73	2.0	3.1	6.6	45.8
Age Group													
0 to 5 months	10.3	0.49	0.41	0	0	0	0	0	0	1.4	3.9	9.2	11.0
6 to 12 months	34.8	2.2	0.55	0	0	0	0	0	4.4	7.3	9.6	19.5	23.1
<1 years	21.8	1.3	0.37	0	0	0	0	0	0	5.4	7.8	11.9	23.1
1 to 2 years	40.8	1.5	0.13	0	0	0	0	0	1.9	4.4	7.0	14.2	27.8
3 to 5 years	38.2	1.1	0.09	0	0	0	0	0	1.4	3.5	5.4	10.3	18.0
6 to 11 years	38.8	0.78	0.07	0	0	0	0	0	1.0	2.6	3.9	7.5	26.5
12 to 19 years	30.4	0.46	0.06	0	0	0	0	0	0.44	1.5	2.4	5.8	21.6
20 to 39 years	36.7	0.53	0.04	0	0	0	0	0	0.61	1.7	2.7	5.5	23.6
40 to 69 years	41.2	0.56	0.03	0	0	0	0	0	0.73	1.7	2.6	4.8	45.8
≥70 years	42.2	0.65	0.05	0	0	0	0	0	0.86	2.0	3.1	5.7	21.5
Season													
Fall	37.9	0.62	0.04	0	0	0	0	0	0.71	2.1	3.2	5.9	21.6
Spring	37.8	0.62	0.04	0	0	0	0	0	0.67	1.8	2.9	7.6	23.6
Summer	39.3	0.67	0.04	0	0	0	0	0	0.85	1.9	3.1	6.3	45.8
Winter	37.1	0.61	0.04	0	0	0	0	0	0.71	1.9	3.0	6.9	27.8
Urbanization													
Central City	38.9	0.70	0.04	0	0	0	0	0	0.78	2.1	3.4	7.3	45.8
Non-metropolitan	39.7	0.62	0.04	0	0	0	0	0	0.75	1.9	3.1	6.0	25.8
Suburban	36.6	0.59	0.03	0	0	0	0	0	0.68	1.9	2.9	5.9	27.8
Race													
Asian	45.4	0.85	0.14	0	0	0	0	0	1.1	2.7	4.1	7.8	23.3
Black	36.2	0.72	0.07	0	0	0	0	0	0.77	2.2	3.5	7.9	45.8
Native American	32.0	0.34	0.13	0	0	0	0	0	0.13	1.6	2.0	3.5	5.3
Other/NA	50.4	1.1	0.10	0	0	0	0	0.04	1.5	3.4	5.2	10.0	26.5
White	37.2	0.57	0.02	0	0	0	0	0	0.68	1.8	2.8	5.9	27.8
Region													
Midwest	36.3	0.57	0.04	0	0	0	0	0	0.62	1.8	2.9	5.6	21.5
Northeast	37.5	0.61	0.05	0	0	0	0	0	0.75	1.8	2.9	6.3	27.8
South	38.5	0.66	0.03	0	0	0	0	0	0.78	2.1	3.1	6.3	45.8
West	39.5	0.67	0.04	0	0	0	0	0	0.75	2.1	3.3	7.8	23.1

SE = Standard error.

Source: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-22. Per Capita Intake of Root Vegetables Based on 1994−1996 CSFII (g/kg-day, as-consumed)

Population Group	Percent consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	75.4	1.2	0.02	0	0	0	0.03	0.75	1.7	3.0	4.1	7.6	83.3
Age Group													
0 to 5 months	12	0.96	0.61	0	0	0	0	0	0	3.9	8.3	11.9	21.9
6 to 12 months	56.9	2.8	0.45	0	0	0	0	0.80	4.6	8.0	10.4	16.6	32.9
<1 years	33	1.8	0.36	0	0	0	0	0	2.3	6.9	9.6	15.6	32.9
1 to 2 years	67.5	2.6	0.13	0	0	0	0	1.5	3.6	6.8	8.3	16.8	83.3
3 to 5 years	71.9	2.2	0.09	0	0	0	0	1.4	3.2	5.5	7.1	14.1	32.1
6 to 11 years	73.8	1.6	0.06	0	0	0	0	1.0	2.3	4.2	5.3	9.5	20.6
12 to 19 years	76.4	1.3	0.05	0	0	0	0.09	0.82	1.8	3.0	4.0	7.7	22.5
20 to 39 years	77.5	1.1	0.03	0	0	0	0.10	0.73	1.6	2.7	3.5	6.0	16.6
40 to 69 years	77.2	0.99	0.02	0	0	0	0.08	0.68	1.5	2.5	3.2	4.8	15.1
≥70 years	73.2	1.1	0.04	0	0	0	0	0.70	1.6	2.7	3.4	5.3	9.8
Season													
Fall	77.3	1.3	0.04	0	0	0	0.09	0.83	1.8	3.1	4.2	8.1	83.3
Spring	75.9	1.2	0.03	0	0	0	0.05	0.73	1.7	3.1	4.3	7.7	30.0
Summer	74	1.2	0.03	0	0	0	0	0.73	1.6	2.9	3.9	7.4	25.8
Winter	74.4	1.2	0.03	0	0	0	0	0.74	1.7	3.0	4.1	7.4	34.3
Urbanization													
Central City	71.9	1.2	0.03	0	0	0	0	0.66	1.6	2.9	4.2	7.3	83.3
Non-metropolitan	78.5	1.4	0.04	0	0	0	0.14	0.89	1.9	3.2	4.5	9.5	34.3
Suburban	76.4	1.2	0.02	0	0	0	0.07	0.77	1.7	3.0	4.0	7.2	26.1
Race													
Asian	64.2	0.97	0.10	0	0	0	0	0.37	1.3	2.8	4.0	7.1	17.3
Black	68.9	1.1	0.05	0	0	0	0	0.62	1.4	2.9	4.2	7.6	32.9
Native American	71.1	1.4	0.27	0	0	0	0	1.0	1.9	2.8	3.0	11.2	34.3
Other/NA	67	1.1	0.10	0	0	0	0	0.50	1.4	2.8	3.7	9.6	83.3
White	77.5	1.3	0.02	0	0	0	0.09	0.81	1.8	3.1	4.2	7.5	32.1
Region													
Midwest	79.4	1.4	0.04	0	0	0	0.16	0.90	2.0	3.4	4.6	8.6	26.1
Northeast	72.3	1.1	0.03	0	0	0	0	0.64	1.5	2.9	3.8	7.1	20.7
South	77	1.3	0.03	0	0	0	0.09	0.81	1.8	3.0	4.1	7.6	83.3
West	71.3	1.1	0.03	0	0	0	0	0.61	1.5	2.8	3.7	6.9	34.3

SE = Standard error.

Source: U.S. EPA analysis of the 1994−1996 CSFII.

Table 9-23. Quantity (as-consumed) of Fruits and Vegetables Consumed per Eating Occasion and the Percentage of Individuals Consuming These Foods in Two Days

Food category	Percent Consuming[a]	Quantity consumed per eating occasion (gram)		Consumers-only Quantity consumed per eating occasion at specified percentiles (gram)[a]						
		Average	SE	5	10	25	50	75	90	95
Raw vegetables										
Cucumbers	10.8	48	3	7	14	16	29	54	100	157
Lettuce	53.3	41	1	7	8	13	27	55	91	110
Mixed lettuce-based salad	2.2	97	6	11	18	55	74	123	167	229
Carrots	14.1	33	1	5	7	14	27	40	61	100
Tomatoes	32.0	53	1	15	20	27	40	61	93	123
Coleslaw	5.0	102	3	18	32	55	91	134	179	183
Onions	14.4	23	1	3	7	10	15	28	41	60
Cooked vegetables										
Broccoli	7.3	119	4	23	35	61	92	156	232	275
Carrots	5.8	72	2	13	19	36	65	78	146	156
Total tomato sauce	54.3	34	1	1	2	7	17	40	80	124
String beans	13.2	90	2	17	31	52	68	125	136	202
Peas	6.1	86	3	11	21	40	80	120	167	170
Corn	15.1	101	2	20	33	55	82	123	171	228
French-fried potatoes	25.5	83	1	28	35	57	70	112	125	140
Home-fried and hash-browned potatoes	8.9	135	3	36	47	70	105	192	284	308
Baked potatoes	12.4	120	2	48	61	92	106	143	184	217
Boiled potatoes	5.3	157	5	34	52	91	123	197	308	368
Mashed potatoes	15.0	188	3	46	61	105	156	207	397	413
Dried beans and peas	8.0	133	3	22	33	64	101	173	259	345
Baked beans	4.7	171	6	24	47	84	126	235	314	385
Fruits										
Raw oranges	7.9	132	2	42	64	95	127	131	183	253
Orange juice	27.2	268	4	124	124	187	249	311	447	498
Raw apples	15.6	135	2	46	68	105	134	137	209	211
Applesauce and cooked apples	4.6	134	4	31	59	85	121	142	249	254
Apple juice	7.0	271	7	117	120	182	242	307	481	525
Raw bananas	20.8	111	1	55	58	100	117	118	135	136

[a] = Percent consuming at least once in two days.
SE = Standard error of the mean.
Source: Smiciklas-Wright et al., 2002 (based on 1994−1996 CSFII data).

Table 9-24. Quantity (as-consumed) of Fruits and Vegetables Consumed per Eating Occasion and Percentage of Individuals Consuming These Foods in Two Days, by Food

Food category	Quantity consumed per eating occasion (grams)											
	2 to 5 years			6 to 11 years			12 to 19 years					
	Male and Female (*N* = 2,109)			Male and Female (*N* = 1,432)			Male (*N* = 696)			Female (*N* = 702)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	**SE**
Raw Vegetables												
Carrots	10.4	27	2	17.8	32	2	9.2	35	6	11.9	32	4
Cucumbers	6.4	32	4	6.6	39	6	6.1	71[a]	22[a]	6.8	48	11
Lettuce	34.0	17	1	40.8	26	1	56.0	32	3	52.3	34	2
Onions	3.9	9	2	4.5	17	2	11.1	28	4	7.9	23	4
Tomatoes	14.8	31	2	14.0	42	4	25.7	49	5	23.9	44	3
Cooked Vegetables												
Beans (string)	16.8	50	2	12.1	71	6	8.3	85	9	7.6	78	5
Broccoli	7.2	61	3	5.6	102	16	3.9	127[a]	17[a]	5.7	109[a]	14[a]
Carrots	6.0	48	4	3.8	46	5	2.8	81[a]	16[a]	2.1	75[a]	17[a]
Corn	18.9	68	3	22.2	79	4	12.8	125	9	12.3	100	6
Peas	8.4	48	3	6.8	72	9	3.6	115[a]	15[a]	2.4	93[a]	17[a]
Potatoes (French-fried)	32.7	52	1	33.7	67	2	41.7	97	3	38.1	81	4
Potatoes (home-fried and hash-browned)	9.3	85	5	10.1	93	6	10.1	145	13	6.1	138	13
Potatoes (baked)	7.6	70	4	8.2	95	6	8.6	152	15	8.8	115	10
Potatoes (boiled)	4.8	81	9	2.7	103[a]	17[a]	2.0	250[a]	40[a]	3.2	144[a]	16[a]
Potatoes (mashed)	14.8	118	6	13.3	162	12	14.6	245	16	11.9	170	17
Apples (raw)	26.8	106	2	21.9	123	3	11.7	149	9	12.4	129	5
Apples (cooked and applesauce)	10.1	118	5	9.0	130	7	2.3	153[a]	19[a]	2.6	200[a]	47[a]
Apple juice	26.3	207	5	12.2	223	10	7.8	346	22	8.5	360	44
Bananas (raw)	25.0	95	2	16.5	105	3	10.3	122	6	8.4	119	5
Oranges (raw)	11.1	103	5	10.5	114	5	4.3	187[a]	38[a]	5.4	109[a]	8[a]
Orange juice	34.4	190	4	30.9	224	6	30.8	354	16	29.5	305	11

Table 9-24. Quantity (as-consumed) of Fruits and Vegetables Consumed Per Eating Occasion and Percentage of Individuals Consuming These Foods in Two Days, by Food (continued)

Food category	Quantity consumed per eating occasion (grams)																	
	20 to <40 years						40 to <60 years						≥60 years					
	Male (*N* = 1,543)			Female (*N* = 1,449)			Male (*N* = 1,663)			Female (*N* = 1,694)			Male (*N* = 1,545)			Female (*N* = 1,429)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Raw Vegetables																		
Carrots	12.3	35	4	15.4	38	4	14.4	35	2	18.1	31	2	13.6	29	2	12.7	27	1
Cucumbers	10.5	62	12	10.4	45	4	12.5	47	4	15.7	41	3	14.2	51	4	13.2	45	3
Lettuce	63.4	40	2	57.6	44	2	55.5	48	2	59.1	48	1	48.1	47	2	46.1	42	2
Onions	17.9	27	2	14.7	22	1	19.6	26	1	18.3	19	1	19.0	19	1	15.6	19	1
Tomatoes	33.1	57	2	32.3	49	2	38.1	60	2	42.4	53	1	40.0	62	3	41.0	52	2
Cooked Vegetables																		
Beans (string)	10.6	111	5	12.5	89	6	13.7	114	6	13.4	93	4	18.3	99	4	19.7	78	3
Broccoli	7.6	152	13	6.7	129	13	7.8	127	7	7.6	114	7	8.5	117	7	10.9	107	6
Carrots	5.0	79	7	5.3	69	6	6.7	83	7	6.4	66	4	9.6	78	4	9.0	75	4
Corn	12.7	122	5	15.3	98	5	17.1	133	6	13.5	90	3	14.2	109	4	13.0	83	5
Peas	4.4	109	10	4.9	82	9	7.4	113	7	6.3	79	7	8.4	88	7	9.4	73	5
Potatoes (French-fried)	35.3	107	2	23.9	79	3	20.6	89	2	16.8	72	3	11.2	76	3	8.1	58	3
Potatoes (home-fried/hash-browned)	9.5	160	10	8.8	129	7	11.	174	10	6.4	119	7	10.4	152	8	7.1	110	9
Potatoes (baked)	11.4	154	7	11.1	126	5	13.0	133	3	16.5	112	3	17.9	115	3	18.1	100	4
Potatoes (boiled)	3.9	185	16	2.9	162	15	6.3	209	12	7.0	142	9	11.0	166	6	10.2	131	5
Potatoes (mashed)	14.7	269	12	13.5	167	5	16.0	225	11	14.3	156	7	19.7	173	6	18.1	140	5
Fruits																		
Apples (raw)	6.6	153	8	6.3	126	6	7.4	148	8	8.3	132	5	8.9	133	5	11.2	129	4
Apples (cooked and applesauce)	24.3	373	20	23.2	289	12	24.1	285	10	25.2	231	6	30.2	213	5	31.7	196	5
Apple juice	12.1	161	6	12.9	134	3	14.1	145	3	16.2	136	4	17.6	145	8	16.1	128	3
Bananas (raw)	1.3	153[a]	31[a]	2.4	155[a]	21[a]	3.1	142	12	3.9	125	10	8.1	135	10	9.2	121	7
Oranges (raw)	4.2	345	20	4.7	302	19	4.7	358	33	3.2	259	21	4.8	233	11	5.0	225	13
Orange juice	14.4	126	2	18.5	112	2	21.9	125	3	24.4	111	2	36.5	105	2	34.0	96	2

[a] Indicates a statistic that is potentially unreliable because of a small sample size and a large SE.
PC = Percent consuming at least once in two days.
SE = Standard error of the mean.
N = Sample size.

Source: Smiciklas-Wright et al., 2002 (based on 1994−1996 CSFII data).

Table 9-25. Consumption of Major Food Groups: Median Servings (and Ranges) by Demographic and Health Characteristics, for Older Adults

Subject Characteristic		*N*	Fruits and Vegetables (servings per day)
Sex			
	Female	80	5.7 (1.5−8.1)
	Male	50	4.5 (0.8−8.8)
Ethnicity[a]			
	African American	44	4.5 (0.8−8.0)
	European American	47	6.0 (1.5−8.0)
	Native American	39	4.5 (1.6−8.8)
Age			
	70 to 74 years	42	4.5 (1.6−8.1)
	75 to 79 years	36	5.6 (0.8−8.0)
	80 to 84 years	36	5.6 (1.5−8.8)
	≥ 85 years	16	5.4 (1.8−8.0)
Marital Status			
	Married	49	4.5 (1.6−8.0)
	Not Married	81	5.6 (0.8−8.8)
Education			
	8th grade or less	37	5.0 (1.5−8.1)
	9th to 12th grades	47	4.5 (0.8−8.0)
	> High School	46	6.0 (1.5−8.8)
Dentures			
	Yes	83	5.4 (1.5−8.8)
	No	47	4.7 (0.8−8.0)
Chronic Diseases			
	0	7	7.0 (5.2−8.8)
	1	31	5.4 (1.5−8.0)
	2	56	5.4 (1.6−8.1)
	3	26	4.5 (2.0−8.0)
	4+	10	5.5 (0.8−8.0)
Weight[b]			
	130 pounds	18	6.0 (1.8−8.0)
	131 to 150 pounds	32	5.5 (1.5−8.0)
	151 to 170 pounds	27	5.7 (1.7−8.1)
	171 to 190 pounds	22	5.6 (1.8−8.8)
	191 pounds	29	4.5 (0.8−8.0)

a $p < 0.05$.
b Two missing values.
N = Number of individuals.

Source: Vitolins et al., 2002.

Table 9-26. Characteristics of the Feeding Infants and Toddlers Study (FITS) Sample Population

	Sample Size	Percentage of Sample
Sex		
Male	1,549	51.3
Female	1,473	48.7
Age of Child		
4 to 6 months	862	28.5
7 to 8 months	483	16.0
9 to 11 months	679	22.5
12 to 14 months	374	12.4
15 to 18 months	308	10.2
19 to 24 months	316	10.4
Child's Ethnicity		
Hispanic or Latino	367	12.1
Non-Hispanic or Latino	2,641	87.4
Missing	14	0.5
Child's Race		
White	2,417	80.0
Black	225	7.4
Other	380	12.6
Urbanicity		
Urban	1,389	46.0
Suburban	1,014	33.6
Rural	577	19.1
Missing data	42	1.3
Household Income		
Under $10,000	48	1.6
$10,000 to $14,999	48	1.6
$15,000 to $24,999	221	7.3
$25,000 to $34,999	359	11.9
$35,000 to $49,999	723	23.9
$50,000 to $74,999	588	19.5
$75,000 to $99,999	311	10.3
$100,000 and Over	272	9.0
Missing	452	14.9
Receives WIC		
Yes	821	27.2
No	2,196	72.6
Missing	5	0.2
Sample Size (Unweighted)	3,022	100.0

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Devaney et al., 2004.

Table 9-27. Percentage of Infants and Toddlers Consuming Different Types of Vegetables

Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 months	7 to 8 months	9 to 11 months	12 to 14 months	15 to 18 months	19 to 24 months
Any Vegetable	39.9	66.5	72.6	76.5	79.2	81.6
Baby Food Vegetables	35.7	54.5	34.4	12.7	3.0	1.6
Cooked Vegetables	5.2	17.4	45.9	66.3	72.9	75.6
Raw Vegetables	0.5	1.6	5.5	7.9	14.3	18.6
Types of Vegetables[a]						
Dark Green Vegetables[b]	0.1	2.9	4.2	5.0	10.4	7.8
Deep Yellow Vegetables[c]	26.5	39.3	29.0	24.0	13.6	13.4
White Potatoes	3.6	12.4	24.1	33.2	42.0	40.6
French Fries and Other Fried Potatoes	0.7	2.9	8.6	12.9	19.8	25.5
Other Starchy Vegetables[d]	6.5	10.9	16.9	17.3	20.8	24.2
Other Vegetables	11.2	25.9	35.1	39.1	45.6	43.3

[a] Totals include commercial baby food, cooked vegetables, and raw vegetables.
[b] Reported dark green vegetables include broccoli, spinach and other greens, and romaine lettuce.
[c] Reported deep yellow vegetables include carrots, pumpkin, sweet potatoes, and winter squash.
[d] Reported starchy vegetables include corn, green peas, immature lima beans, black-eyed peas (not dried), cassava, and rutabaga.

Source: Fox et al., 2004.

Table 9-28. Top Five Vegetables Consumed by Infants and Toddlers	
Top Vegetables by Age Group[a]	Percentage Consuming at Least Once in a Day
4 to 6 months	
Baby Food Carrots	9.6
Baby Food Sweet Potatoes	9.1
Baby Food Squash	8.1
Baby Food Green Beans	7.2
Baby Food Peas	5.0
7 to 8 months	
Baby Food Carrots	14.2
Baby Food Sweet Potatoes	12.9
Baby Food Squash	12.9
Baby Food Green Beans	11.2
Baby Food Mixed/Garden Vegetables	10.1
9 to 11 months	
Cooked Green Beans	9.7
Mashed/Whipped Potatoes	9.0
French Fries/Other Fried Potatoes	8.6
Baby Food Mixed/Garden Vegetables	8.4
Cooked Carrots	8.0
12 to 14 months	
Cooked Green Beans	18.2
French Fries/Other Fried Potatoes	12.9
Cooked Carrots	11.5
Mashed/Whipped Potatoes	10.3
Cooked Peas	8.4
15 to 18 months	
French Fries/Other Fried Potatoes	19.8
Cooked Green Beans	16.7
Cooked Peas	13.9
Cooked Tomatoes/Tomato Sauce	13.7
Mashed/Whipped Potatoes	12.4
19 to 24 months	
French Fries/Other Fried Potatoes	25.5
Cooked Green Beans	16.8
Cooked Corn	15.2
Cooked Peas	11.4
Cooked Tomatoes/Tomato Sauce	9.4

[a] Baby food vegetables include single vegetables (majority of vegetables reported) as well as mixtures with the named vegetables the predominant vegetable, e.g., broccoli and cauliflower or broccoli and carrots.

Source: Fox et al., 2004.

Table 9-29. Percentage of Infants and Toddlers Consuming Different Types of Fruits

Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 months	7 to 8 months	9 to 11 months	12 to 14 months	15 to 18 months	19 to 24 months
Any Fruit	41.9	75.5	75.8	77.2	71.8	67.3
Baby Food Fruit	39.1	67.9	44.8	16.2	4.2	1.8
Non-Baby Food Fruit	5.3	14.3	44.2	67.1	69.4	66.8
Types of Non-Baby Food Fruit						
Canned Fruit	1.4	5.8	21.6	31.9	25.1	20.2
Packed in Syrup	0.7	0.7	8.1	14.9	12.7	8.1
Packed in Juice or Water	0.7	4.5	13.5	18.5	11.3	11.4
Unknown Pack	0.0	0.7	1.5	1.2	3.1	1.2
Fresh Fruit	4.4	9.5	29.5	52.1	55.0	54.6
Dried Fruit	0.0	0.4	2.1	3.5	7.1	9.4
Types of Fruit[a]						
Apples	18.6	33.1	31.6	27.5	19.8	22.4
Bananas	16.0	30.6	34.5	37.8	32.4	30.0
Berries	0.1	0.6	5.3	6.6	11.3	7.7
Citrus Fruits	0.2	0.4	1.6	4.9	7.3	5.1
Melons	0.6	1.0	4.4	7.3	7.2	9.6

[a] Totals include all baby food and non-baby food fruits.

Source: Fox et al., 2004.

Table 9-30. Top Five Fruits Consumed by Infants and Toddlers

Top Fruits by Age Group[a]	Percentage Consuming at Least Once in a Day
4 to 6 months	
Baby Food Applesauce	17.5
Baby Food Bananas	13.0
Baby Food Pears	7.5
Baby Food Peaches	7.4
Fresh Banana	0.3
7 to 8 months	
Baby Food Applesauce	29.0
Baby Food Bananas	25.2
Baby Food Pears	18.2
Baby Food Peaches	13.1
Fresh Banana	6.6
9 to 11 months	
Fresh Banana	19.0
Baby Food Applesauce	17.7
Baby Food Bananas	16.8
Baby Food Pears	12.4
Canned Applesauce	11.1
12 to 14 months	
Fresh Banana	33.0
Canned Applesauce	15.2
Fresh Grapes	9.0
Fresh Apple	8.8
Canned Peaches	7.2
Canned Fruit Cocktail	7.2
15 to 18 months	
Fresh Banana	30.5
Fresh Grapes	13.2
Fresh Apple	11.2
Fresh Strawberries	10.6
Canned Peaches	8.9
19 to 24 months	
Fresh Banana	29.6
Fresh Apple	15.0
Fresh Grapes	11.2
Raisins	9.0
Fresh Strawberries	7.6

[a] Baby food fruits include single fruits (majority of fruits reported) as well as mixtures with the named fruit as the predominant fruit, e.g., pears and raspberries or prunes with pears. Baby food fruits with tapioca and other baby food dessert fruits were counted as desserts.

Source: Fox et al., 2004.

Table 9-31. Characteristics of Women, Infants, and Children (WIC) Participants and Non-Participants[a] (Percentages)

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Sex						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		[b]		[b]		[b]
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		[b]		[b]		[b]
White	63	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child In Daycare				[b]		[c]
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother		[b]		[b]		[b]
14 to 19 years	18	1	13	1	9	1
20 to 24 years	33	13	38	11	33	14
25 to 29 years	29	29	23	30	29	26
30 to 34 years	9	33	15	36	18	34
>35 years	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		[b]		[b]		[b]
11th Grade or Less	23	2	15	2	17	3
Completed High School	35	19	42	20	42	19
Some Postsecondary	33	26	32	27	31	28
Completed College	7	53	9	51	9	48
Missing	2	1	2	0	1	2
Parent's Marital Status		[b]		[b]		[b]
Married	49	93	57	93	58	88
Not Married	50	7	42	7	41	11
Missing	1	1	1	0	1	1
Mother or Female Guardian Works				[b]		[c]
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1
Urbanicity		[b]		[b]		[b]
Urban	34	55	37	50	35	48
Suburban	36	31	31	34	35	35
Rural	28	13	30	15	28	16
Missing	2	1	2	1	2	2
Sample Size (Unweighted)	265	597	351	808	205	791

[a] X^2 tests were conducted to test for statistical significance in the differences between WIC participants and non-participants within each age group for each variable. The results of the χ^2 tests are listed next to the variable under the column labeled non-participants for each of the three age groups.

[b] $p < 0.01$ non-participants significantly different from WIC participants on the variable.

[c] $p < 0.05$ non-participants significantly different from WIC participants on the variable.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 9-32. Food Choices for Infants and Toddlers by Women, Infants, and Children (WIC) Participation Status

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Vegetables						
Any Vegetable	40.2	39.8	68.2	70.7	77.5	80.2
Baby Food Vegetables	32.9	37.0	38.2	45.0	4.8	4.7
Cooked Vegetables	8.0	3.9[a]	33.8	33.8	73.1	72.3
Raw Vegetables	1.4	0.1[b]	3.6	4.1	11.8	15.4
Dark Green Vegetables	0.4	0.0	2.9	4.0	6.3	8.4
Deep Yellow Vegetables	23.2	28.1	30.1	34.8	12.5	16.9
Other Starchy Vegetables	6.5	6.4	12.9	15.2	21.1	21.5
Potatoes	6.0	2.4[a]	20.7	18.2	43.1	38.3
Fruits						
Any Fruit	47.8	39.2[a]	64.7	81.0[b]	58.5	74.6[b]
Baby Food Fruits	43.8	36.9	48.4	57.4[a]	3.8	6.5
Non-Baby Food Fruit	8.1	4.0	22.9	35.9[b]	56.4	70.9[b]
Fresh Fruit	5.4	3.8	14.3	24.3[b]	43.6	57.0[b]
Canned Fruit	3.4	0.5[b]	10.3	17.3[b]	22.3	25.3
Sample Size (unweighted)	265	597	351	808	205	791

[a] = p <0.05 non-participants significantly different from WIC participants.
[b] = p <0.01 non-participants significantly different from WIC participants.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 9-33. Average Portion Sizes per Eating Occasion of Fruits and Vegetables Commonly Consumed by Infants from the 2002 Feeding Infants and Toddlers Study

Food group	Reference unit	4 to 5 months (*N* = 624)	6 to 8 months (*N* = 708)	9 to 11 months (*N* = 687)
			Mean ± SE	
Fruits and Juices				
All fruits	tablespoon	3.6 ± 0.19	4.7 ± 0.11	5.8 ± 0.17
Baby food fruit	tablespoon	3.3 ± 0.16	4.6 ± 0.11	5.6 ± 0.17
Baby food peaches	tablespoon	3.6 ± 0.37	4.4 ± 0.26	5.3 ± 0.36
Baby food pears	tablespoon	3.5 ± 0.46	4.5 ± 0.21	6.0 ± 0.40
Baby food bananas	tablespoon	3.4 ± 0.23	5.0 ± 0.21	5.9 ± 0.35
Baby food applesauce	tablespoon	3.7 ± 0.29	4.6 ± 0.17	5.6 ± 0.25
Canned fruit	tablespoon	-	4.5 ± 0.59	4.8 ± 0.25
Fresh fruit	tablespoon	-	5.3 ± 0.52	6.4 ± 0.37
100% juice	fluid ounce	2.5 ± 0.17	2.8 ± 0.11	3.1 ± 0.09
Apple/apple blends	fluid ounce	2.7 ± 0.22	2.9 ± 0.13	3.2 ± 0.11
Grape	fluid ounce	-	2.6 ± 0.19	3.1 ± 0.21
Pear	fluid ounce	-	2.6 ± 0.29	3.1 ± 0.28
Vegetables				
All vegetables	tablespoon	3.8 ± 0.20	5.8 ± 0.16	5.6 ± 0.20
Baby food vegetables	tablespoon	4.0 ± 0.20	5.9 ± 0.16	6.6 ± 0.21
Baby food green beans	tablespoon	3.5 ± 0.33	5.1 ± 0.28	6.1 ± 0.50
Baby food squash	tablespoon	4.3 ± 0.47	5.6 ± 0.30	6.9 ± 0.41
Baby food sweet	tablespoon	4.3 ± 0.31	6.1 ± 0.34	7.2 ± 0.69
Baby food carrots	tablespoon	3.5 ± 0.33	5.6 ± 0.27	6.7 ± 0.48
Cooked vegetables, excluding French fries	tablespoon	-	4.2 ± 0.47	3.8 ± 0.31
Deep yellow vegetables	tablespoon	-	3.2 ± 0.59	3.2 ± 0.39
Mashed potatoes	tablespoon	-	4.1 ± 0.67	2.8 ± 0.37
Green beans	tablespoon	-	3.2 ± 0.62	5.0 ± 0.61

\- = Cell size was too small to generate a reliable estimate.
N = Number of respondents.
SE = Standard error.

Source: Fox et al., 2006.

Table 9-34. Average Portion Sizes per Eating Occasion of Fruits and Vegetables Commonly Consumed by Toddlers from the 2002 Feeding Infants and Toddlers Study

Food group	Reference unit	12 to 14 months (N = 371)	15 to 18 months (N = 312)	19 to 24 months (N = 320)
			Mean ± SE	
Fruits and Juices				
All fruits	cup	0.4 ± 0.02	0.5 ± 0.03	0.6 ± 0.03
Canned fruit	cup	0.3 ± 0.02	0.4 ± 0.03	0.4 ± 0.04
Fresh fruit	cup	0.4 ± 0.02	0.5 ± 0.03	0.6 ± 0.03
Fresh apple	cup, slice	0.4 ± 0.05	0.6 ± 0.07	0.8 ± 0.14
	1 medium	0.3 ± 0.04	0.5 ± 0.06	0.6 ± 0.11
Fresh banana	cup, slice	0.4 ± 0.02	0.5 ± 0.03	0.5 ± 0.03
	1 medium	0.6 ± 0.03	0.7 ± 0.03	0.7 ± 0.04
Fresh grapes	cup	0.2 ± 0.01	0.3 ± 0.03	0.3 ± 0.02
100% juice	fluid ounce	3.7 ± 0.15	5.0 ± 0.20	5.1 ± 0.18
Orange/orange blends	fluid ounce	3.3 ± 0.38	4.5 ± 0.33	5.2 ± 0.35
Apple/apple blends	fluid ounce	3.6 ± 0.21	4.5 ± 0.29	4.9 ± 0.27
Grape	fluid ounce	3.6 ± 0.38	5.6 ± 0.43	4.7 ± 0.31
Vegetables				
All vegetables	cup	0.4 ± 0.02	0.4 ± 0.03	0.4 ± 0.02
Cooked vegetables, excluding French fries	cup	0.3 ± 0.03	0.3 ± 0.03	0.3 ± 0.02
Deep yellow vegetables	cup	0.2 ± 0.03	0.3 ± 0.05	0.3 ± 0.05
Corn	cup	0.2 ± 0.03	0.2 ± 0.03	0.2 ± 0.03
Peas	cup	0.2 ± 0.02	0.2 ± 0.02	0.2 ± 0.02
Green beans	cup	0.4 ± 0.05	0.4 ± 0.05	0.3 ± 0.03
Mashed potatoes	cup	0.3 ± 0.05	0.4 ± 0.05	0.3 ± 0.05
Baked/boiled potatoes	cup	0.3 ± 0.05	0.4 ± 0.06	-
French fries	cup	0.4 ± 0.05	0.6 ± 0.05	0.6 ± 0.05

- Cell size too small to generate reliable estimate.
N = Number of respondents.
SE = Standard error of the mean.

Source: Fox et al., 2006.

Table 9-35. Percentage of Hispanic and Non-Hispanic Infants and Toddlers Consuming Different Types of Fruits and Vegetables on a Given Day

	Age 4 to 5 months		Age 6 to 11 months		Age 12 to 24 months	
	Hispanic (N = 84)	Non-Hispanic (N = 538)	Hispanic (N = 163)	Non-Hispanic (N = 1,228)	Hispanic (N = 124)	Non-Hispanic (N = 871)
Fruits						
Any Fruit or 100% Fruit Juice	45.0	35.9	86.2	86.8	84.6	87.2
Any Fruit[a]	39.4	28.8	68.1	76.0	67.6	71.5
100% Fruit Juice	19.3	15.3	57.8	47.7	64.1	58.9
Fruit Preparation						
Baby Food Fruit	32.6	28.4	42.9[b]	58.1	5.6[c]	6.3
Non-Baby Food Fruit	9.1[c]	1.3[c]	35.8	27.4	64.2	68.0
Canned Fruit	2.3[c]	-	8.8	13.7	12.1[d]	26.2
Fresh Fruit	9.1[b,c]	-	30.0[d]	17.7	59.3	53.1
Vegetables						
Any Vegetable or 100% Vegetable Juice[e]	30.0	27.3	66.2	70.3	76.0	80.5
Type of Preparation						
Baby Food Vegetables	25.7	25.4	34.4[b]	47.6	4.1[c]	4.9
Cooked Vegetables	4.2[c]	2.4[c]	33.2	29.4	71.4	72.9
Raw Vegetables	2.3[c]	-	8.3[c]	2.6	25.0	13.1
Types of Vegetables[e]						
Dark Green Vegetables[f]	-	-	3.3[c]	3.1	11.4[c]	7.5
Deep Yellow Vegetables[g]	21.0	18.2	32.2	25.9	20.0	15.4
Starchy Vegetable:						
White Potatoes	1.4[c]	2.3[c]	20.7	17.4	43.5	39.0
French Fries/Fried Potatoes	-	-	5.7[c]	5.3	23.4	20.3
Baked/Mashed	-	-	14.4[c]	10.7	19.8	17.7
Other Starchy Vegetables[h]	5.0[c]	4.0	6.7[d]	15.1	16.6	22.2
Other Non-Starchy Vegetables[i]	8.1[c]	8.0	28.5	29.0	42.0	43.4

[a] Total includes all baby food and non-baby food fruits and excludes 100% fruit juices and juice drinks.
[b] = Significantly different from non-Hispanic at the $p < 0.05$.
[c] = Statistic is potentially unreliable because of a high coefficient of variation.
[d] = Significantly different from non-Hispanic at the $p < 0.01$.
[e] Total includes commercial baby food, cooked vegetables, raw vegetables, and 100% vegetable juices.
[f] Reported dark green vegetables include broccoli, spinach, romaine lettuce, and other greens such as kale.
[g] Reported yellow vegetables include carrots, pumpkin, sweet potatoes, and winter squash.
[h] Reported starchy vegetables include corn, green peas, immature lima beans, black-eyed peas (not dried), cassava, and rutabaga. Corn is also shown as a subcategory of other starchy vegetables.
[i] Reported non-starchy vegetables include asparagus, cauliflower, cabbage, onions, green beans, mixed vegetables, peppers, and tomatoes.

\- = Less than 1% of the group consumed this food on a given day.
N = Sample size.

Source: Mennella et al., 2006.

Table 9-36. Top Five Fruits and Vegetables Consumed by Hispanic and Non-Hispanic Infants and Toddlers Per Age Group[a]

Age (month)	*N*	Ethnicity	
		Hispanic	Non-Hispanic
		Top Fruits By Age Group	
4 to 5	84 Hispanic 538 non-Hispanic	Bananas (16.3%) Apples (14.7%) Peaches (10.9%) Melons (3.5%) Pears (2.5%)	Apples (12.5%) Bananas (10.0%) Pears (5.9%) Peaches (5.8%) Prunes (1.6%)
6 to 11	136 Hispanic 1,228 non-Hispanic	Bananas (35.9%) Apples (29.7%) Pears (15.2%) Peaches (11.7%) Melons (4.7%)	Apples (32.9%) Bananas (31.5%) Pears (17.5%) Peaches (13.9%) Apricots (3.7%)
12 to 24	124 Hispanic 871 non-Hispanic	Bananas (41.5%) Apples (25.7%) Berries (8.5%) Melons (7.6%) Pears (7.3%)	Bananas (30.9%) Apples (22.0%) Grapes (12.3%) Peaches (9.6%) Berries (8.7%)
		Top Vegetables By Age Group	
4 to 5	84 Hispanic 538 non-Hispanic	Carrots (9.9%) Sweet Potatoes (6.8%) Green Beans (5.8%) Peas (5.0%) Squash (4.3%)	Sweet Potatoes (7.5%) Carrots (6.6%) Green Beans (5.9%) Squash (5.4%) Peas (3.8%)
6 to 11	136 Hispanic 1,228 non-Hispanic	Potatoes (20.7%) Carrots (19.0%) Mixed Vegetables (11.1%) Green Beans (11.0%) Sweet Potatoes (8.7%)	Carrots (17.5%) Potatoes (16.4%) Green Beans (15.9%) Squash (11.8%) Sweet Potatoes (11.4%)
12 to 24	124 Hispanic 871 non-Hispanic	Potatoes (43.5%) Tomatoes (23.1%) Carrots (18.6%) Onions (11.8%) Corn (10.2%)	Potatoes (39.0%) Green Beans (19.6%) Peas (12.8%) Carrots (12.3%) Tomatoes (11.9%)

[a] Percentage consuming at least one in a day is in parentheses.
N = Sample size.

Source: Mennella et al., 2006.

Table 9-37. Mean Moisture Content of Selected Food Groups Expressed as Percentages of Edible Portions			
Food	Moisture Content		Comments
	Raw	Cooked	
Fruits			
Apples—dried	31.76	84.13*	sulfured; * without added sugar
Apples	85.56* 86.67**	- -	*with skin **without skin
Apples—juice	-	87.93	canned or bottled
Applesauce	-	88.35*	*unsweetened
Apricots	86.35	86.62*	*canned juice pack with skin
Apricots—dried	30.09	75.56*	sulfured; *without added sugar
Bananas	74.91	-	
Blackberries	88.15	-	
Blueberries	84.21	86.59*	*frozen unsweetened
Boysenberries	85.90	-	frozen unsweetened
Cantaloupes	90.15	-	
Casabas	91.85	-	
Cherries—sweet	82.25	84.95*	*canned, juice pack
Crabapples	78.94	-	
Cranberries	87.13	-	
Cranberries—juice cocktail	85.00	-	Bottled
Currants (red and white)	83.95	-	
Elderberries	79.80	-	
Grapefruit (pink, red and white)	90.89	-	
Grapefruit—juice	90.00	90.10*	*canned unsweetened
Grapefruit—unspecified	90.89	-	pink, red, white
Grapes—fresh	81.30	-	American type (slip skin)
Grapes—juice	84.12	-	canned or bottled
Grapes—raisins	15.43	-	Seedless
Honeydew melons	89.82	-	
Kiwi fruit	83.07	-	
Kumquats	80.85	-	
Lemons—juice	90.73	92.46*	*canned or bottled
Lemons—peel	81.60	-	
Lemons—pulp	88.98	-	
Limes	88.26	-	
Limes—juice	90.79	92.52*	*canned or bottled
Loganberries	84.61*	-	*frozen
Mulberries	87.68	-	
Nectarines	87.59	-	
Oranges—unspecified	86.75	-	all varieties
Peaches	88.87	87.49*	*canned juice pack
Pears—dried	26.69	64.44*	sulfured; *without added sugar
Pears—fresh	83.71	86.47*	*canned juice pack
Pineapple	86.00	83.51*	*canned juice pack
Pineapple—juice	-	86.37	Canned
Plums—dried (prunes)	30.92	-	
Plums	87.23	84.02*	*canned juice pack
Quinces	83.80	-	
Raspberries	85.75	-	
Strawberries	90.95	89.97*	*frozen unsweetened
Tangerine—juice	88.90	87.00*	*canned sweetened
Tangerines	85.17	89.51*	*canned juice pack
Watermelon	91.45	-	

Table 9-37. Mean Moisture Content of Selected Food Groups Expressed as Percentages of Edible Portions (continued)

Food	Moisture Content		Comments
	Raw	Cooked	
Vegetables			
Alfalfa seeds—sprouted	92.82		
Artichokes—globe and French	84.94	84.08	boiled, drained
Artichokes—Jerusalem	78.01	-	
Asparagus	93.22	92.63	boiled, drained
Bamboo shoots	91.00	95.92	boiled, drained
Beans—dry—blackeyed peas (cowpeas)	77.20	75.48	boiled, drained
Beans—dry—hyacinth (mature seeds)	87.87	86.90	boiled, drained
Beans—dry—navy (mature seeds)	79.15	76.02	boiled, drained
Beans—dry—pinto (mature seeds)	81.30	93.39	boiled, drained
Beans—lima	70.24	67.17	boiled, drained
Beans—snap—green—yellow	90.27	89.22	boiled, drained
Beets	87.58	87.06	boiled, drained
Beets—tops (greens)	91.02	89.13	boiled, drained
Broccoli	90.69	89.25	boiled, drained
Brussel sprouts	86.00	88.90	boiled, drained
Cabbage—Chinese (pak-choi)	95.32	95.55	boiled, drained
Cabbage—red	90.39	90.84	boiled, drained
Cabbage—savoy	91.00	92.00	boiled, drained
Carrots	88.29	90.17	boiled, drained
Cassava (yucca blanca)	59.68	-	
Cauliflower	91.91	93.00	boiled, drained
Celeriac	88.00	92.30	boiled, drained
Celery	95.43	94.11	boiled, drained
Chives	90.65	-	
Cole slaw	81.50	-	
Collards	90.55	91.86	boiled, drained
Corn—sweet	75.96	69.57	boiled, drained
Cress—garden	89.40	92.50	boiled, drained
Cucumbers—peeled	96.73	-	
Dandelion—greens	85.60	89.80	boiled, drained
Eggplant	92.41	89.67	boiled, drained
Endive	93.79	-	
Garlic	58.58	-	
Kale	84.46	91.20	boiled, drained
Kohlrabi	91.00	90.30	boiled, drained
Lambsquarter	84.30	88.90	boiled, drained
Leeks—bulb and lower leaf-portion	83.00	90.80	boiled, drained
Lentils—sprouted	67.34	68.70	stir-fried
Lettuce—iceberg	95.64	-	
Lettuce—cos or romaine	94.61	-	
Mung beans—mature seeds (sprouted)	90.40	93.39	boiled, drained
Mushrooms—unspecified	-	91.08	boiled, drained
Mushrooms—oyster	88.80	-	
Mushrooms—Maitake	90.53	-	
Mushrooms—portabella	91.20	-	
Mustard greens	90.80	94.46	boiled, drained
Okra	90.17	92.57	boiled, drained
Onions	89.11	87.86	boiled, drained
Onions—dehydrated or dried	3.93	-	
Parsley	87.71	-	
Parsnips	79.53	80.24	boiled, drained
Peas—edible-podded	88.89	88.91	boiled, drained
Peppers—sweet—green	93.89	91.87	boiled, drained
Peppers—hot chili-green	87.74	92.50*	*canned solids and liquid

Table 9-37. Mean Moisture Content of Selected Food Groups Expressed as Percentages of Edible Portions (continued)

Food	Moisture Content		Comments
	Raw	Cooked	
Potatoes (white)	81.58	75.43	Baked
Pumpkin	91.60	93.69	boiled, drained
Radishes	95.27	-	
Rutabagas—unspecified	89.66	88.88	boiled, drained
Salsify (vegetable oyster)	77.00	81.00	boiled, drained
Shallots	79.80	-	
Soybeans—mature seeds—sprouted	69.05	79.45	Steamed
Spinach	91.40	91.21	boiled, drained
Squash—summer	94.64	93.70	all varieties; boiled, drained
Squash—winter	89.76	89.02	all varieties; baked
Sweet potatoes	77.28	75.78	baked in skin
Swiss chard	92.66	92.65	boiled, drained
Taro—leaves	85.66	92.15	Steamed
Taro	70.64	63.80	
Tomatoes—juice	-	93.90	Canned
Tomatoes—paste	-	73.50	Canned
Tomatoes—puree	-	87.88	Canned
Tomatoes	93.95	-	
Towel gourd	93.85	84.29	boiled, drained
Turnips	91.87	93.60	boiled, drained
Turnips—greens	89.67	93.20	boiled, drained
Water chestnuts—Chinese	73.46	86.42*	*canned solids and liquids
Yambean—tuber	90.07	90.07	boiled, drained

- Indicates data are not available for the fruit or vegetable under those conditions.

* Number without added sugar.

Source: USDA, 2007.

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10. INTAKE OF FISH AND SHELLFISH

10.1. INTRODUCTION

Contaminated finfish and shellfish are potential sources of human exposure to toxic chemicals. Pollutants are carried in the surface waters but also may be stored and accumulated in the sediments as a result of complex physical and chemical processes. Finfish and shellfish are exposed to these pollutants and may become sources of contaminated food if the contaminants bioconcentrate in fish tissue or bioaccumulate through the food chain. Some chemicals (e.g., polychlorinated biphenyls and dioxins) are stored in fatty tissues, while others (e.g., mercury and arsenic) are typically found in the non-lipid components.

Accurately estimating exposure to toxic chemicals in fish requires information about the nature of the exposed population (i.e., general population, recreational fishermen, subsistence fishers) and their intake rates. For example, general population intake rates may be appropriate for assessing contaminants that are widely distributed in commercially caught fish. However, these data may not be suitable to estimate exposure to contaminants in a particular water source among recreational or subsistence fishers. Because the catch of recreational and subsistence fishermen is not "diluted" by fish from other water bodies, these individuals and their families represent the population that is most vulnerable to exposure by intake of contaminated fish from a specific location. Subsistence fishermen are those individuals who consume fresh caught fish as a major source of food. Their intake rates are generally higher than those of the general population. It should be noted that, depending on the study, the data presented in this chapter for Native American populations may or may not reflect subsistence fishing. Harper and Harris (2007), and Donatuto and Harper (2008) describe some difficulties associated with evaluating fish intake rates among Native American subsistence populations. For example, Donatuto and Harper (2008) suggest that contemporary Native American subsistence intake rates may be lower (i.e., suppressed) compared to heritage rates. Also, the intake rates among certain subsets of the Native American populations may be higher than the rate for the average Native American (Harper and Harris, 2007; Donatuto and Harper, 2008).

This chapter focuses on intake rates of fish. Note that in this section the term fish refers to both finfish and shellfish, unless otherwise noted. Intake rates for the general population, and recreational and Native American fishing populations are addressed, and data are presented for intake rates for both marine and freshwater fish, when available. The general population studies in this chapter use the term consumer-only intake when referring to the quantity of fish and shellfish consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who consumed fish and shellfish. Per capita intake rates are generated by averaging consumer-only intakes over the entire survey population (including those individuals that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessments for which average dose estimates are of interest because they represent both individuals who ate the foods during the survey period and individuals who may eat fish at some time but did not consume it during the survey period. Per capita intake, therefore, represents an average across the entire population of interest but does so at the expense of underestimating consumption for the population of fish consumers. Similarly, the discussions regarding recreationally caught fish consumption use the terms “all respondents” and “consuming anglers.” “All respondents” represents both survey individuals/anglers who ate recreationally caught fish during the survey period and those that did not but may eat recreationally caught fish during other periods. “Consuming anglers” refers only to the individuals who ate fish during the survey period.

The determination to use consumers-only or per capita estimates of fish consumption in exposure assessments depends on the purpose of the assessment and on the source of the data. Both approaches can be a source of valuable insights on analyses of exposure and risk related to consumption of fish. This is because in the overall population, fish is not a frequently consumed item, and quantities may be relatively small, while in some populations, fish is consumed frequently and in large quantities. Nationwide surveys of food intake such as the Continuing Survey of Food Intake by Individuals (CSFII) or the National Health and Nutrition Examination Survey (NHANES) provide objective measures of food consumption that by design include overall, population-based estimates of fish consumption. The data from the CSFII or NHANES can be analyzed in terms of overall per-capita consumption or consumers only. Although the CSFII and NHANES data are collected over short time periods, the large scale nature and design of such studies offer substantial advantages. In exposure analysis and risk assessment applications where fish intake is a concern, usually consumers-only data are of greater interest because of the relative infrequency of fish consumption. Both approaches are a source of valuable insights and help to provide context for the results from specialized surveys that typically focus on fish consumption. Specialized surveys are done for a variety of reasons using different methodologies that typically focus on relatively small, high-fish consuming groups. It may be important to know how results based on small, high consuming groups compare to overall estimates of consumption based on per capita data and consumers-only data. The data presented in this chapter come from a variety of sources and were collected using various methodologies. Some data come from creel surveys where fishermen are usually asked, among other things, how much they have caught and the number of family members with which they will share their catch. These data will not represent usual behavior because one cannot assume that the angler will have the same luck over time. In all likelihood, there will be variation in the amounts caught and consumed by anglers that should be considered. Other data come from mail surveys or personal or phone interviews where participants are asked to recall how much fish each family member eats over a certain period of time. In some cases, data are recorded by survey participants in a food diary. Some surveys may ask about frequency of consumption, but not the amount. Frequency of consumption data can be combined with information on amount consumed per eating occasion to estimate consumption. The recall period determines if the survey characterizes long-term (i.e., usual intake) or short-term consumption. Exposure assessors are generally interested in estimates of long-term behaviors, but longer recall periods are associated with generally higher reporting error that should be considered. If the data come from a survey where long-term or usual intake is characterized (i.e., how often does someone eat fish in a year?), then consumers-only estimates may capture day-to-day variability in consumption. On the other hand, if the survey instrument used to collect the data characterizes short-term consumption (e.g., how much was eaten in a week, how much was consumed on a particular day), then a per capita estimate may account for the fact that individuals who are not consumers during the survey period may consume fish at some point over a longer time period. Using consumers-only data from short-term surveys may tend to overestimate consumption over the long term, especially at the high end, because it would not include days where respondents do not consume fish. Overestimates of consumption could, however, be considered conservative with regard to intake of contaminants and, thus, provide the basis for measures protective of human health.

The U.S. Environmental Protection Agency (EPA) has prepared a review of and an evaluation of five different survey methods used for obtaining fish consumption data. They are

- Recall-Telephone Survey,
- Recall-Mail Survey,
- Recall-Personal Interview,
- Diary, and
- Creel Census.

Refer to U.S. EPA (1998) *Guidance for Conducting Fish and Wildlife Consumption Surveys* for more detail on these survey methods and their advantages and limitations. The type of survey used, its design, and any weighting factors used in estimating consumption should be considered when interpreting survey data for exposure assessment purposes. For surveys used in this handbook, respondents are typically adults who have reported on fish intake for themselves and for children living in their households.

Generally, surveys are either "creel" studies in which fishermen are interviewed while fishing, or broader population surveys using either mailed questionnaires or phone interviews. Both types of data can be useful for exposure assessment purposes, but somewhat different applications and interpretations are needed. In fact, results from creel studies have often been misinterpreted, due to inadequate knowledge of survey principles. Below, some basic facts about survey design are presented, followed by an analysis of the differences between creel and population-based studies.

Typical surveys seek to draw inferences about a larger population from a smaller sample of that population. This larger population, from which the survey sample is taken and to which the results of the survey are generalized, is denoted the target population of the survey. In order to generalize from the sample to the target population, the probability of being sampled must be known for each member of the target population. This probability is reflected in weights assigned to survey respondents, with weights being inversely proportional to sampling probability. When all members of the target population have the same probability of being sampled, all weights can be set to one and essentially ignored. For example, in a mail or phone study of licensed anglers, the target population is generally all licensed anglers in a particular area, and in the studies presented, the sampling probability is essentially equal for all target population members.

In a creel study (i.e., a study in which fishermen are interviewed while fishing), the target population is anyone who fishes at the locations being studied. Generally, in a creel study, the probability of being sampled is not the same for all members of the target population. For instance, if the survey is conducted for 1 day at a site, then it will include all persons who fish there daily, but only about 1/7 of the people who fish there weekly, 1/30 of the people who fish there monthly, etc. In this example, the probability of being sampled (or inverse weight) is seen to be proportional to the frequency of fishing. However, if the survey involves interviewers revisiting the same site on multiple days, and persons are only interviewed once for the survey, then the probability of being in the survey is not proportional to frequency; in fact, it increases less than proportionally with frequency. At the extreme of surveying the same site every day over the survey period with no re-interviewing, all members of the target population would have the same probability of being sampled regardless of fishing frequency, implying that the survey weights should all equal one. On the other hand, if the survey protocol calls for individuals to be interviewed each time an interviewer encounters them (i.e., without regard to whether they were previously interviewed), then the inverse weights will again be proportional to fishing frequency, no matter how many times interviewers revisit the same site. Note that when individuals can be interviewed multiple times, the results of each interview are included as separate records in the database and the survey weights should be inversely proportional to the expected number of times that an individual's interviews are included in the database.

In the published analyses of most creel studies, there is no mention of sampling weights; by default, all weights are set to one, implying equal probability of sampling. However, because the sampling probabilities in a creel study, even with repeated interviewing at a site, are highly dependent on fishing frequency, the fish intake distributions reported for these surveys are not reflective of the corresponding target populations. Instead, those individuals with high fishing frequencies are given too big a weight, and the distribution is skewed to the right, i.e., it overestimates the target population distribution.

Price et al. (1994) explained this problem and set out to rectify it by adding weights to creel survey data; the authors used data from two creel studies (Puffer et al., 1981; Pierce et al., 1981) as examples. Price et al. (1994) used inverse fishing frequency as survey weights and produced revised estimates of median and 95th percentile intake for the above two studies. These revised estimates were dramatically lower than the original estimates. The approach of Price et al. (1994) is discussed in more detail in Section 10.4 where the Puffer et al. (1981) and Pierce et al. (1981) studies are summarized.

When the correct weights are applied to survey data, the resulting percentiles reflect, on average, the distribution in the target population; thus, for example, an estimated 90% of the target population will have intake levels below the 90th percentile of the survey fish intake distribution. There is another way, however, of characterizing distributions in addition to the standard percentile approach; this approach is reflected in statements of the form "50% of the income is received by, for example, the top 10% of the population, which consists of individuals making more than $100,000." Note that the 50th percentile (median) of the income distribution is well below $100,000. Here the $100,000 level can be thought of as, not the 50th percentile of the population income distribution, but as the 50th percentile of the "resource utilization distribution" (see Appendix 10A for technical discussion of this distribution). Other percentiles of the resource utilization distribution have similar interpretations; e.g., the 90th percentile of the resource utilization distribution (for income) would be that level of income such that 90% of total income is received by individuals with incomes below this level and 10% by individuals with income above this level. This alternative approach to characterizing distributions is of particular interest when a relatively small fraction of individuals consumes a relatively large fraction of a resource, which is the case with regards to recreational fish consumption. In the studies of recreational anglers, this alternative approach, based on resource utilization, will be presented, where possible, in addition to the primary approach of presenting the standard percentiles of the fish intake distribution.

The recommendations for fish and shellfish ingestion rates are provided in the next section, along with summaries of the confidence ratings for these recommendations. The recommended values for the general population and for other subsets of the population are based on the key studies identified by U.S. EPA for this factor. Following the recommendations, the studies on fish ingestion among the general population (see Section 10.3), marine recreational angler populations (see Section 10.4), freshwater recreational populations (see Section 10.5), and Native American populations (see Section 10.6) are summarized. Information is provided on the key studies that form the basis for the fish and shellfish intake rate recommendations. Relevant data on ingestion of fish and shellfish are also provided. These studies are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of fish and shellfish among children and adults. Information on other population studies (see Section 10.7), serving size (see Section 10.8), and other factors to consider (see Section 10.9) are also presented.

10.2. RECOMMENDATIONS

Considerable variation exists in the mean and upper percentile fish consumption rates obtained from the studies presented in this chapter. This can be attributed largely to the type of water body (i.e., marine, estuarine, freshwater) and the characteristics of the survey population (i.e., general population, recreational, Native American), but other factors such as study design, method of data collection, and geographic location also play a role. Based on these study variations, fish consumption studies were classified into the following categories:

- General Population (finfish, shellfish, and total fish and shellfish combined);
- Recreational Marine Intake;
- Recreational Freshwater Intake; and
- Native American Populations

For exposure assessment purposes, the selection of intake rates for the appropriate category (or categories) will depend on the exposure scenario being evaluated.

10.2.1. Recommendations—General Population

Fish consumption rates are recommended for the general population, based on the key study presented in Section 10.3.1. The key study for estimating mean fish intake among the general population is the U.S. EPA analysis of data from the Centers for Disease Control and Prevention (CDC) NHANES 2003–2006.

Table 10-1 presents a summary of the recommended values for per capita and consumer-only intake of finfish, shellfish, and total finfish and shellfish combined. Table 10-2 provides confidence ratings for the fish intake recommendations for the general population. The U.S. EPA analysis of 2003–2006 NHANES data was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations presented here, data were placed in the standardized age categories closest to those used in the analysis.

Note that the fish intake values presented in Table 10-1 are reported as uncooked fish weights. Recipe files were used to convert, for each fish-containing food, the as-eaten fish weight consumed into an uncooked equivalent weight of fish. This is important because the concentrations of the contaminants in fish are generally measured in the uncooked samples. Assuming that cooking results in some reductions in weight (e.g., loss of moisture), and the mass of the contaminant in the fish tissue remains constant, then the contaminant concentration in the cooked fish tissue will increase.

In terms of calculating the dose (i.e., concentration times weight), actual consumption may be overestimated when intake is expressed on an uncooked basis, but the actual concentration may be underestimated when it is based on the uncooked sample. The net effect on the dose would depend on the magnitude of the opposing effects on these two exposure factors. On the other hand, if the "as-prepared" (i.e., as-consumed) intake rate and the uncooked concentration are used in the dose equation, dose may be underestimated because the concentration in the cooked fish is likely to be higher, if the mass of the contaminant remains constant after cooking. Reported weights are also more likely to reflect uncooked weight, and interpretation of advisories are likely to be in terms of uncooked weights. Although it is generally more conservative and appropriate to use uncooked fish intake rates, one should also be sure to use like measures. That is to say, avoid using raw fish concentrations and cooked weights to estimate the dose. For more information on cooking losses and conversions necessary to account for such losses, refer to Chapter 13 of this handbook.

If concentration data can be adjusted to account for changes after cooking, then the "as-prepared" (i.e., as-consumed) intake rates are appropriate. However, data on the effects of cooking on contaminant concentrations are limited, and assessors generally make the conservative assumption that cooking has no effect on the contaminant mass. The key study on fish ingestion provides intake data based on uncooked fish weights. However, relevant data on both "as-prepared" (i.e., as-consumed) and uncooked general population fish intake are also presented in this handbook. The assessor should choose the intake data that best matches the concentration data that are being used.

The NHANES data on which the general population recommendations are based, are short-term survey data and could not be used to estimate the distribution over the long term. Also, it is important to note that a limitation associated with these data is that the total amount of fish reported by respondents included fish from all sources (e.g., fresh, frozen, canned, domestic, international origin). The analysis of NHANES survey data used to develop the recommended intake rates in this handbook did not consider the source of the fish consumed. This type of information may be relevant for some assessments.

Recommended values should be selected that are relevant to the assessment, choosing the appropriate age groups and type of fish (i.e., finfish, shellfish, or total finfish, and shellfish). In some cases, a different study or studies may be particularly relevant to the needs of an assessment, in which case, results from that specific study or studies may be used instead of the recommended values provided here. For example, it may be advantageous to use estimates that target a particular region or geographical area, if relevant data are available. In addition, seasonal, sex, and fish species variations should be considered when appropriate, if data are available. Also, relevant data on general population fish intake in this chapter may be used if appropriate to the scenarios being assessed. For example, older data from the U.S. EPA's analysis of data from the 1994–1996 and 1998 CSFII provide intake rates for freshwater/estuarine fish and shellfish, marine fish and shellfish, and total fish and shellfish that are not available from the more recent NHANES analysis.

10.2.2. Recommendations—Recreational Marine Anglers

Table 10-3 presents the recommended values for recreational marine anglers. These values are based on the surveys of the National Marine Fisheries Service (NMFS, 1993). The values from NMFS (1993) are assumed to represent intake of marine fish among adult recreational fishers. Values represent both individuals who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods. Age-specific values were not available from this source. However, recommendations for children were estimated based on the ratios of marine fish intake for general population children to that of adults using data from U.S. EPA's analysis of CSFII data from 1994–1996 and 1998 (U.S. EPA, 2002) (see Section 10.3.2.6), multiplied by the adult recreational marine fish intake rates for the Atlantic, Gulf, and Pacific regions, using data from NMFS (1993) (see Section 10.4.1.1). The ratios of each age group to adults >18 years were calculated separately for the means and 95th percentiles. Much of the other relevant data on recreational marine fish intake in this chapter are limited to certain geographic areas and cannot be generalized to the U.S. population as a whole. However, assessors may use the data from the relevant studies provided in this chapter if appropriate to the scenarios being assessed. Table 10-4 presents the confidence ratings for recommended recreational marine fish intake rates.

10.2.3. Recommendations—Recreational Freshwater Anglers

Recommended values are not provided for recreational freshwater fish intake because the available data are limited to certain geographic areas and cannot be readily generalized to the U.S. population of freshwater recreational anglers as a whole (see Figure 10-1). For example, factors associated with water body, climate, fishing regulations, availability of alternate fishable water bodies, and water body productivity may affect recreational fish intake rates. However, data from several relevant recreational freshwater studies are provided in this chapter. Table 10-5 summarizes data from these studies. Assessors may use these data, if appropriate to the scenarios and locations being assessed. Although recommendations are not provided, some general observations can be made. Most of the studies in Table 10-5 represent state-wide surveys of recreational anglers. These include Alabama, Connecticut, Indiana, Maine, Michigan, Minnesota, North Dakota, and Wisconsin. Consumption data from these states would include freshwater fish from rivers, lakes, and ponds. The average range of consumption for all respondents from these states varies from 5 g/day to 51 g/day. Another two studies represent consumption of fish from specific rivers. These included Savannah River in Georgia and The Clinch River in Tennessee. The consumption rates for all respondents from these two rivers ranged from 20 g/day to 70 g/day. One of the studies in Table 10-5 represents the consumption of fish from three lakes in Washington, and another represents consumption of fish from Lake Ontario. The average consumption rate for all responding adults was 10 g/day for the three Washington lakes. It can also be noted that a large percentage of recreational anglers consumed fish and shellfish during the survey period. Thus, values for all respondents and consuming anglers are fairly similar. For Lake Ontario, the average consumption rate for adults was 5 g/day.

10.2.4. Recommendations—Native American Populations

Recommended values are also not provided for Native American fish intake because the available data are limited to certain geographic areas and/or tribes and cannot be readily generalized to Native American tribes as a whole. However, data from several Native American studies are provided in this chapter and are summarized in Table 10-6. Assessors may use these data, if appropriate to the scenarios and populations being assessed. These studies were performed at various study locations among various tribes.

Table 10-1. Recommended Per Capita and Consumer-Only Values for Fish Intake (g/kg-day), Uncooked Fish Weight, by Age

	Per Capita				Consumer Only			
Age	*N*	% Consuming	Mean	95th percentile	*N*	Mean	95th percentile	Source
Finfish[a]								
All	16,783	23	0.16	1.1	3,204	0.73	2.2	U.S. EPA Analysis of NHANES 2003-2006 data
Birth to 1 year	865	2.6	0.03	0.0[b]	22	1.3	2.9[b]	
1 to <2 years	1,052	14	0.22	1.2[b]	143	1.6	4.9[b]	
2 to <3 years	1,052	14	0.22	1.2[b]	143	1.6	4.9[b]	
3 to <6 years	978	15	0.19	1.4	156	1.3	3.6[b]	
6 to <11 years	2,256	15	0.16	1.1	333	1.1	2.9[b]	
11 to <16 years	3,450	15	0.10	0.7	501	0.66	1.7	
16 to <21 years	3,450	15	0.10	0.7	501	0.66	1.7	
21 to <50 years	4,289	23	0.15	1.0	961	0.65	2.1	
Females 13 to 49 years	4,103	22	0.14	0.9	793	0.62	1.8	
50+ years	3,893	29	0.20	1.2	1,088	0.68	2.0	
Shellfish[a]								
All	16,783	11	0.06	0.4	1,563	0.57	1.9	U.S. EPA Analysis of NHANES 2003-2006 data
Birth to 1 year	865	0.66	0.00	0.0[b]	11	0.42	2.3[b]	
1 to <2 years	1,052	4.4	0.04	0.0[b]	53	0.94	3.5[b]	
2 to <3 years	1,052	4.4	0.04	0.0[b]	53	0.94	3.5[b]	
3 to <6 years	978	4.6	0.05	0.0	56	1.0	2.9[b]	
6 to <11 years	2,256	7.0	0.05	0.2	158	0.72	2.0[b]	
11 to <16 years	3,450	5.1	0.03	0.0	245	0.61	1.9	
16 to <21 years	3,450	5.1	0.03	0.0	245	0.61	1.9	
21 to <50 years	4,289	13	0.08	0.5	605	0.63	2.2	
Females 13 to 49 years	4,103	11	0.06	0.3	474	0.53	1.8	
50+ years	3,893	13	0.05	0.4	435	0.41	1.2	
Total Finfish and Shellfish[a]								
All	16,783	29	0.22	1.3	4,206	0.78	2.4	U.S. EPA Analysis of NHANES 2003-2006 data
Birth to 1 year	865	3.1	0.04	0.0[b]	30	1.2	2.9[b]	
1 to <2 years	1,052	17	0.26	1.6[b]	183	1.5	5.9[b]	
2 to <3 years	1,052	17	0.26	1.6[b]	183	1.5	5.9[b]	
3 to <6 years	978	18	0.24	1.6	196	1.3	3.6[b]	
6 to <11 years	2,256	22	0.21	1.4	461	0.99	2.7[b]	
11 to <16 years	3,450	18	0.13	1.0	685	0.69	1.8	
16 to <21 years	3,450	18	0.13	1.0	685	0.69	1.8	
21 to <50 years	4,289	31	0.23	1.3	1,332	0.76	2.5	
Females 13 to 49 years	4,103	28	0.19	1.2	1,109	0.68	1.9	
50+ years	3,893	36	0.25	1.4	1,319	0.71	2.1	

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Data were placed in the standardized age categories closest to those used in the analysis.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Table 10-2. Confidence in Recommendations for General Population Fish Intake

General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and the analysis of the survey data were adequate. Primary data were collected and used in a secondary analysis of the data. The sample size was large.	
Minimal (or Defined) Bias	The response rate was adequate. The survey data were based on recent recall. Data were collected over a short duration (i.e., 2 days).	
Applicability and Utility		High
Exposure Factor of Interest	The key study focused on the exposure factor of interest.	
Representativeness	The survey was conducted nationwide and was representative of the general U.S. population.	
Currency	Data were derived from 2003–2006 NHANES.	
Data Collection Period	Data were collected for 2 non-consecutive days.	
Clarity and Completeness		High
Accessibility	The primary data are accessible through CDC.	
Reproducibility	The methodology was clearly presented; enough information was available to allow for reproduction of the results.	
Quality Assurance	Quality assurance of NHANES data was good; quality control of secondary analysis was good.	
Variability and Uncertainty		Medium to high for averages; low for long-term upper percentiles
Variability in Population	Full distributions were provided by the key study.	
Uncertainty	The survey was not designed to capture long-term intake and was based on recall.	
Evaluation and Review		Medium
Peer Review	The National Center for Health Statistics (NCHS) NHANES survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency, but the methodology used has been peer reviewed in analysis of previous data.	
Number and Agreement of Studies	The number of studies is one.	
Overall Rating		**Medium to High** (mean) **Medium** (long-term upper percentiles)

Table 10-3. Recommended Values for Recreational Marine Fish Intake

Age Group	Intake Rate[a]	
	Mean g/day[b]	95th Percentile g/day[b]
Atlantic		
3 to <6 years	2.5	8.8
6 to <11 years	2.5	8.6
11 to <16 years	3.4	13
16 to <18 years	2.8	6.6
>18 years	5.6	18
Gulf		
3 to <6 years	3.2	13
6 to <11 years	3.3	12
11 to <16 years	4.4	18
16 to <18 years	3.5	9.5
>18 years	7.2	26
Pacific		
3 to <6 years	0.9	3.3
6 to <11 years	0.9	3.2
11 to <16 years	1.2	4.8
16 to <18 years	1.0	2.5
>18 years	2.0	6.8

[a] Represents intake for the recreational fishing population only. Data from U.S. EPA analysis of NMFS (1993) assumed to represent adults >18 years. Values represent both survey anglers who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods.

[b] Recommendations for children were estimated based on the ratios of marine fish intake for general population children to that of adults using data from U.S. EPA's analysis of CSFII data (see Table 10-31), multiplied by the adult recreational marine fish intake rates for the Atlantic, Gulf, and Pacific regions, using data from NMFS (1993) (see Table 10-50).The ratios of each age group to adults >18 years were calculated separately for the means and 95th percentiles.

Table 10-4. Confidence in Recommendations for Recreational Marine Fish Intake

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The survey methodology and the analysis of the survey data were adequate. Primary data were collected and used in a secondary analysis of the data. The sample size was large.	
Minimal (or Defined) Bias	The response rate was adequate. The survey data were based on recent recall.	
Applicability and Utility		Low to Medium
Exposure Factor of Interest	The key study was not designed to estimate individual consumption of fish. U.S. EPA obtained the raw data and estimated intake distributions by employing assumptions derived from other data sources.	
Representativeness	The survey was conducted in coastal states in the Atlantic, Pacific, and Gulf regions and was representative of fishing populations in these regions of the United States.	
Currency	The data are from a survey conducted in 1993.	
Data Collection Period	Data were collected in telephone interviews and direct interviews of fishermen in the field over a short time frame.	
Clarity and Completeness		Medium
Accessibility	The primary data are from NMFS.	
Reproducibility	The methodology was clearly presented; enough information was available to allow for reproduction of the results.	
Quality Assurance	Quality assurance of the primary data was not described. Quality assurance of the secondary analysis was good.	
Variability and Uncertainty		Low
Variability in Population	Mean and 95^{th} percentile values were provided.	
Uncertainty	The survey was specifically designed to estimate individual intake rates. U.S. EPA estimated intake based on an analysis of the raw data, using assumptions about the number of individuals consuming fish meals from the fish caught. Estimates for children are based on additional assumptions regarding the proportion of intake relative to the amount eaten by adults.	
Evaluation and Review		Medium
Peer Review	Data from NMFS (1993) were reviewed by NMFS and U.S. EPA. U.S. EPA's analysis was not peer reviewed outside of EPA.	
Number and Agreement of Studies	The number of studies is one.	
Overall Rating		**Low to Medium** (adults) **Low** (children)

Table 10-5. Summary of Relevant Studies on Freshwater Recreational Fish Intake

Location	Population Group	Mean g/day	95th Percentile g/day	Source
Alabama	All Respondents (Adults)	44[a]	-	ADEM, 1994
	Consuming Anglers	53[b]	-	
Connecticut	All Respondents	51[c]	-	Balcom et al., 1999
	Consuming Anglers	53[c,d]	-	
Georgia (Savannah River)	All Respondents (Adult Whites)	38[e]	-	Burger et al., 1999
	All Respondents (Adult Blacks)	70[e]	-	
Indiana	All Respondents	16	61	Williams et al., 1999
	Consuming Anglers	20	61	
Maine	All Respondents	5.0	21	Chemrisk, 1992; Ebert et al., 1993
	Consuming Anglers	6.4	26	
Michigan	Consuming Anglers			West et al., 1989, 1993
	1 to 5 years	5.6	-	
	6 to 10 years	7.9	-	
	11 to 20 years	7.3	-	
	21 to 80 years	16[f]	-	
	All ages	14	39	
Minnesota	All Respondents			Benson et al., 2001
	0 to 14 years	1.2 (50th percentile)	14	
	>14 years (male)	4.5 (50th percentile)	40	
	15 to 44 (female)	2.1 (50th percentile)	25	
	>44 (female)	3.6 (50th percentile)	37	
	Consuming Anglers	14	37	
New York (Lake Ontario)	All Respondents (Adults)	4.9[f]	18	Connelly et al., 1996
	Consuming Anglers	5.8[g]	-	
North Dakota	All Respondents			Benson et al., 2001
	0 to 14 years	1.7 (50th percentile)	22	
	>14 years (male)	2.3 (50th percentile)	25	
	15 to 44 (female)	4.3 (50th percentile)	30	
	>44 (female)	4.2 (50th percentile)	33	
	Consuming Anglers	12	43	
Tennessee (Clinch River)	All Respondents	20[e,h]	-	Campbell et al., 2002
	Consuming Anglers	38[e,h]	-	
Washington	All Respondents (Adults)	10	42	Mayfield et al., 2007
	Children of Respondents	7	29	
	Consuming Anglers (Adults)	15[i]	-	
Wisconsin	All Respondents (Adults)	11	37	Fiore et al., 1989
	Consuming Anglers	12	37	
Summary (mean ranges)	Statewide Surveys[j]	5–51 g/day		
	Rivers[k]	20–70 g/day		
	Lakes[l]	5–10 g/day		

Table 10-5. Summary of Relevant Studies on Freshwater Recreational Fish Intake (continued)

a	Based on the average of two methods.
b	Value represents anglers who consumed recreationally caught fish during the survey period, calculated by dividing all respondents by the percent consuming of 83%.
c	Values included consumption of both freshwater and saltwater fish.
d	Value calculated by dividing all respondents by the percent consuming of 97%.
e	Calculated as amount eaten per year divided by 365 days per year.
f	Based on average of multiple adult age groups.
g	Value calculated by dividing all respondents by the percent consuming of 84%.
h	Values included consumption of both self-caught and store-bought fish.
i	Value calculated by dividing all respondents by the percent consuming of 66%.
j	Represents the range from the following states: Alabama, Connecticut, Indiana, Maine, Michigan, Minnesota, North Dakota, and Wisconsin.
k	Represents the range from the following rivers: Savannah River in GA and The Clinch River in TN.
l	Represents the range from three lakes in Washington and Lake Ontario.
-	Estimate not available.
Note	All respondents represent both survey anglers who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods.

Figure 10-1. Locations of Freshwater Fish Consumption Surveys in the United States.

Table 10-6. Summary of Relevant Studies on Native American Fish Intake

Location/Tribe	Population Group	Mean [a]	95th Percentile[a]	Source
94 Alaska Communities	All Respondents			Wolfe and Walker, 1987
	Lowest of 94	16 g/day	-	
	Median of 94	81 g/day	-	
	Highest of 94	770 g/day	-	
Chippewa Indians (Wisconsin)	All Respondents			Peterson et al., 1994
	Adults	39 g/day[b]	-	
4 Columbia River Tribes (Oregon)	All Respondents			CRITFC, 1994
	Adults	59 g/day	170 g/day	
	Children ≤5 years	11 g/day (50th percentile)	98 g/day	
	Consumers			
	Adults	63 g/day[c]	183[c]	
Florida	All Respondents	0.8 g/kg-day	4.5 g/kg-day	Westat, 2006
	Consumers[d]	1.5 g/kg-day	5.7 g/kg-day	
Minnesota	All Respondents	2.8 g/kg-day	-	Westat, 2006
	Consumers[d]	2.8 g/kg-day	-	
Mohawk Tribe (New York and Canada)	All Respondents			Fitzgerald et al., 1995
	Women	13 g/day[e]	-	
	Consuming Women	16 g/day[e]	-	
Mohawk Tribe (New York and Canada)	All Respondents[f]			
	Adults	25 g/day	131 g/day	Forti et al., 1995
	Children 2 years[f]	10 g/day	54 g/day	
	Consumers			
	Adults[f]	29 g/day	135 g/day	
	Children 2 years[f]	13 g/day	58 g/day	
North Dakota	All Respondents	0.4 g/kg-day	0.9[g]	Westat, 2006
	Consumers[b]	0.4 g/kg-day	0.8 [g]	
Tulalip Tribe (Washington)	All Respondents			Toy et al., 1996
	Adult	0.9 g/kg-day	2.9 g/kg-day	
	Children birth ≤5 years	0.2 g/kg-day	0.7 g/kg-day[g]	
	All Respondents			
Squaxin Island Tribe (Washington)	Adults	0.9 g/kg-day	3.0 g/kg-day	
	Children	0.8 g/kg-day	2.1 g/kg-day[g]	
Tulalip Tribe (Washington)	Consumers			Polissar et al., 2006
	Adults	1.0 g/kg-day	2.6 g/kg-day	
	Children birth ≤5 years	0.4 g/kg-day	0.8 g/kg-day[g]	
	Consumers			
Squaxin Island Tribe (Washington)	Adults	1.0 g/kg-day	3.4 g/kg-day	
	Children birth ≤5 years	2.9 g/kg-day	7.7 g/kg-day	
Suquamish Tribe (Washington)	All Respondents			Duncan, 2000
	Adults	2.7 g/kg-day	10 g/kg-day	
	Children <6 years	1.5 g/kg-day	7.3 g/kg-day	
	Consumers			
	Adults	2.7 g/kg-day	10 g/kg-day	
	Children <6 years	1.5 g/kg-day	7.3 g/kg-day	

Table 10-6. Summary of Relevant Studies on Native American Fish Intake (continued)

a	Results are reported in g/day or g/kg-day, depending on which was provided in the source material.
b	All respondents consumed fish caught in Northern Wisconsin lakes.
c	Value calculated by dividing all respondents by the percent consuming of 93%.
d	Based on uncooked fish weight.
e	Value represents consumption by Mohawk women >1 year before pregnancy. Value estimated by multiplying number of fish meals/year by the 90th percentile meal size of 209 g/meal for general population females 20–39 years old from Smiciklas-Wright et al. (2002).
f	Based on 90th percentile general population meal size, based on Pao et al. (1982).
g	Value represents the 90th percentile.
-	Estimate not available.

10.3. GENERAL POPULATION STUDIES

10.3.1. Key General Population Study

10.3.1.1. *U.S. EPA Analysis of Consumption Data from 2003–2006 NHANES*

The key source of recent information on consumption rates of fish and shellfish is the U.S. CDC's NCHS' NHANES. Data from NHANES 2003–2006 have been used by the U.S. EPA, Office of Pesticide Programs (OPP) to generate per capita and consumer-only intake rates for finfish, shellfish, and total fish and shellfish combined.

NHANES is designed to assess the health and nutritional status of adults and children in the United States. In 1999, the survey became a continuous program that interviews a nationally representative sample of approximately 7,000 persons each year and examines a nationally representative sample of about 5,000 persons each year, located in counties across the country, 15 of which are visited each year. Data are released on a 2-year basis, thus, for example, the 2003 data are combined with the 2004 data to produce NHANES 2003–2004.

The dietary interview component of NHANES is called *What We Eat in America* and is conducted by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). DHHS' NCHS is responsible for the sample design and data collection, and USDA's Food Surveys Research Group is responsible for the dietary data collection methodology, maintenance of the databases used to code and process the data, and data review and processing. Beginning in 2003, 2 non-consecutive days of 24-hour intake data were collected. The first day is collected in-person, and the second day is collected by telephone 3 to 10 days later. These data are collected using USDA's dietary data collection instrument, the Automated Multiple Pass Method. This method provides an efficient and accurate means of collecting intakes for large-scale national surveys. It is fully computerized and uses a five-step interview. Details can be found at USDA's Agriculture Research Service (http://www.ars.usda.gov/ba/bhnrc/fsrg).

For NHANES 2003–2004, there were 12,761 persons selected; of these, 9,643 were considered respondents to the mobile examination center (MEC) for examination and data collection. However, only 9,034 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,354 provided complete dietary intakes for Day 2. For NHANES 2005–2006, there were 12,862 persons selected; of these, 9,950 were considered respondents to the MEC examination and data collection. However, only 9,349 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,429 provided complete dietary intakes for Day 2.

The 2003–2006 NHANES surveys are stratified, multistage probability samples of the civilian non-institutionalized U.S. population. The sampling frame was organized using 2000 U.S. population census estimates. NHANES oversamples low-income persons, adolescents 12–19 years, persons 60 years and older, African Americans, and Mexican Americans. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all 4 years of the surveys can be combined. Additional information on NHANES can be obtained at http://www.cdc.gov/nchs/nhanes.htm.

In 2010, U.S. EPA's OPP used NHANES 2003–2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the U.S. Department of Agriculture's (USDA's) CSFII (USDA, 2000; U.S. EPA, 2002). NHANES data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean plant (or animal) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, clam chowder may contain the commodities clams, vegetables, and spices. FCID contains approximately 553 unique commodity names and eight-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

Intake rates were generated for finfish, shellfish, and finfish and shellfish combined. These intake rates represent intake of all forms of the food (e.g., both self-caught and commercially caught) for individuals who provided data for 2 days of the survey. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. Note that if the person reported consuming fish on only one day of the survey, their 2-day average would be half the amount reported for the one day of consumption. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the 4-year, 2-day sample weights provided in NHANES 2003–2006 to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on a consumer-only and on a per capita basis. Summary statistics, including number of observations, percentage of the population consuming fish, mean intake rate, and standard error of the mean intake rate were calculated for finfish, shellfish, and finfish and shellfish combined, for both the entire population and consumers only (see Tables 10-7 to 10-12). Data were provided for the following age groups: birth to <1 year, 1 to 2 years, 3 to 5 years, 6 to 12 years, 13 to 19 years, 20 to 49 years, and ≥50 years. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

The results are presented in units of g/kg-day (same as the CSFII data). Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the average daily dose equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate because individual intake rates were indexed to the reported body weights of the survey respondents. Also, it should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) does not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution.

The advantages of using the U.S. EPA's analysis of NHANES data are that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The data set was designed to be representative of the U.S. population, and includes 4 years of intake data combined. Another advantage is the currency of the data. The NHANES data are from 2003–2006. However, short-term consumption data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given fish species. This is particularly true for the tails (extremes) of the distribution of food intake. Because these are 2-day averages, consumption estimates at the upper end of the intake distribution may be underestimated if these consumption values are used to assess acute (i.e., short-term) exposures. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest.

10.3.2. Relevant General Population Studies

10.3.2.1. *Javitz (1980)—Seafood Consumption Study*

Javitz (1980) utilized data that were originally collected in a study funded by the Tuna Research Foundation (TRF) to estimate fish intake rates. The TRF study of fish consumption was performed by the National Purchase Diary during the period of September, 1973 to August, 1974. The data tapes from this survey were obtained by the NMFS, which later, along with the Food and Drug Administration, USDA and TRF, conducted an intensive effort to identify and correct errors in the database. Javitz (1980) summarized the TRF survey methodology and used the corrected tape to generate fish intake distributions for various population groups.

The TRF survey sample included 9,590 families, of which 7,662 (25,162 individuals) completed the questionnaire, a response rate of 80%. The survey was weighted to represent the U.S. population.

The population of fish consumers represented 94% of the U.S. population. For this population of "fish consumers," Javitz (1980) calculated means and percentiles of fish consumption by demographic variables (age, sex, race, census region, and community type) and overall (see Table 10-13). The overall mean fish intake rate among fish consumers was calculated at 14.3 g/day and the 95th percentile at 41.7 g/day.

Table 10-14 presents the distribution of fish consumption for females and males, by age; this table give the percentages of females/males in a given age bracket with intake rates within various ranges. Table 10-15 presents mean total fish consumption by fish species.

The TRF survey data were also utilized by Rupp et al. (1980) to generate fish intake distributions for three age groups (1 to 11, 12 to 18, and 18 to

98 years) within each of the 9 census regions and for the entire United States. Separate distributions were derived for freshwater finfish, saltwater finfish, and shellfish. Ruffle et al. (1994) used the percentiles data of Rupp et al. (1980) to estimate the best-fitting lognormal parameters for each distribution. Table 10-16 presents the optimal lognormal parameters, the mean (μ) and standard deviation (σ). These parameters can be used to determine percentiles of the corresponding distribution of average daily fish consumption rates through the relation $(p) = \exp[\mu + z(p)\sigma]$ where DCR(p) is the p^{th} percentile of the distribution of average daily fish consumption rates and $z(p)$ is the z-score associated with the p^{th} percentile (e.g., $z(50) = 0$). The mean average daily fish consumption rate is given by $\exp[\mu + 0.5\sigma^2]$.

The advantages of the TRF data survey are that it was a large, nationally representative survey with a high response rate (80%) and was conducted over an entire year. In addition, consumption was recorded in a daily diary over a 1-month period; this format should be more reliable than one based on 1-month recall. The upper percentiles presented are derived from 1 month of data and are likely to overestimate the corresponding upper percentiles of the long-term (i.e., 1 year or more) average daily fish intake distribution. Similarly, the standard deviation of the fitted lognormal distribution probably overestimates the standard deviation of the long-term distribution. However, the period of this survey (1 month) is considerably longer than those of many other consumption studies, including the USDA National Food Consumption Surveys, CSFII, and NHANES, which report consumption over a 2-day to 1-week period. Another obvious limitation of this database is that it is now over 30 years out of date. Ruffle et al. (1994) considered this shortcoming and suggested that one may wish to shift the distribution upward to account for the recent increase in fish consumption, though CSFII has shown little change in g/day fish consumption from 1978 to 1996. Adding $\ln(1 + x/100)$ to the log mean μ will shift the distribution upward by x% (e.g., adding $0.22 = \ln(1.25)$ increases the distribution by 25%). Although the TRF survey distinguished between recreationally and commercially caught fish, Javitz (1980), Rupp et al. (1980), and Ruffle et al. (1994) (which was based on Rupp et al., 1980) did not present analyses by this variable.

10.3.2.2. *Pao et al. (1982)—Foods Commonly Eaten by Individuals: Amount per Day and per Eating Occasion*

The USDA 1977–1978 Nationwide Food Consumption Survey (NFCS) consisted of a household and individual component. For the individual component, all members of surveyed households were asked to provide three consecutive days of dietary data. For the first day's data, participants supplied dietary recall information to an in-home interviewer. Second and 3rd day dietary intakes were recorded by participants. A total of 15,000 households were included in the 1977–1978 NFCS, and about 38,000 individuals completed the 3-day diet records. Fish intake was estimated based on consumption of fish products identified in the NFCS database according to NFCS-defined food codes. These products included fresh, breaded, floured, canned, raw, and dried fish, but not fish mixtures or frozen plate meals.

Pao et al. (1982) used the data from this survey set to calculate per capita fish intake rates. However, because these data are now almost 30 years out of date, this analysis is not considered key with respect to assessing per capita intake (the average quantity of fish consumed per fish meal should be less subject to change over time than is per capita intake). In addition, fish mixtures and frozen plate meals were not included in the calculation of fish intake. The per capita fish intake rate reported by Pao et al. (1982) was 11.8 g/day. The 1977–1978 NFCS was a large and well-designed survey, and the data are representative of the U.S. population.

10.3.2.3. *USDA (1992a)—Food and Nutrient Intakes by Individuals in the United States, 1 Day, 1987–1988: Nationwide Food Consumption Survey 1987–1988*

The USDA 1987–1988 (NFCS) also consisted of a household and individual component. For the individual component, each member of a surveyed household was interviewed (in person) and asked to recall all foods eaten the previous day; the information from this interview made up the "1-day data" for the survey. In addition, members were instructed to fill out a detailed dietary record for the day of the interview and the following day. The data for this entire 3-day period made up the "3-day diet records." A statistical sampling design was used to ensure that all seasons, geographic regions of the United States, and demographic and socioeconomic groups were represented. Sampling weights were used to match the population distribution of

13 demographic characteristics related to food intake (USDA, 1992b).

Total fish intake was estimated based on consumption of fish products identified in the NFCS database according to NFCS-defined food codes. These products included fresh, breaded, floured, canned, raw, and dried fish but not fish mixtures or frozen plate meals.

A total of 4,500 households participated in the 1987–1988 survey; the household response rate was 38%. One-day data were obtained for 10,172 (81%) of the 12,522 individuals in participating households; 8,468 (68%) individuals completed 3-day diet records.

USDA (1992b) used the 1-day data to derive per capita fish intake rate and intake rates for consumers of total fish. Table 10-17 shows these rates, calculated by sex and age group. Intake rates for consumers only were calculated by dividing the per capita intake rates by the fractions of the population consuming fish in 1 day.

An advantage of analyses based on the 1987-1988 USDA NFCS is that the data set is a large, geographically and seasonally balanced survey of a representative sample of the U.S. population. The survey response rate, however, was low, and an expert panel concluded that it was not possible to establish the presence or absence of non-response bias (USDA, 1992b). In addition, the data from this survey have been superseded by more recent surveys.

10.3.2.4. *U.S. EPA (1996)—Descriptive Statistics from a Detailed Analysis of the National Human Activity Pattern Survey (NHAPS) Responses*

The U.S. EPA collected information for the general population on the duration and frequency of time spent in selected activities and time spent in selected microenvironments via 24-hour diaries (U.S. EPA, 1996). Over 9,000 individuals from 48 contiguous states participated in NHAPS. Approximately 4,700 participants also provided information on seafood consumption. The survey was conducted between October 1992 and September 1994. Data were collected on (1) the number of people that ate seafood in the last month, (2) the number of servings of seafood consumed, and (3) whether the seafood consumed was caught or purchased (U.S. EPA, 1996). The participant responses were weighted according to selected demographics such as age, sex, and race to ensure that results were representative of the U.S. population. Of those 4,700 respondents, 2,980 (59.6%) ate seafood (including shellfish, eels, or squid) in the last month (see Table 10-18). The number of servings per month was categorized in ranges of 1–2, 3–5, 6–10, 11–19, and 20+ servings per month (see Table 10-19). The highest percentage (35%) of the respondent population had an intake of 3–5 servings per month. Most (92%) of the respondents purchased the seafood they ate (see Table 10-20).

Intake data were not provided in the survey. However, intake of fish can be estimated using the information on the number of servings of fish eaten from this study and serving size data from other studies. Smiciklas-Wright et al. (2002) estimated that the mean value for fish serving size for all age groups combined is 114 g/serving based on the 1994–1996 CSFII survey (see Section 10.8). The CSFII serving size data are based on all finfish, except canned, dried, and raw, whether reported separately or as part of a sandwich or other mixed food. Using this mean value for serving size and assuming that the average individual eats 3–5 servings per month, the amount of seafood eaten per month would range from 340 to 570 g/month or 11.3 to 19.0 g/day for the highest percentage of the population. These values are within the range of per capita mean intake values for total fish (16.9 g/day, uncooked equivalent weight) calculated by U.S. EPA (2002) analysis of the USDA CSFII data. It should be noted that an all inclusive description for seafood was not presented in U.S. EPA (1996). It is not known if they included processed or canned seafood and seafood mixtures in the seafood category.

The advantages of NHAPS are that the data were collected for a large number of individuals and are representative of the U.S. general population. However, evaluation of seafood intake was not the primary purpose of the study, and the data do not reflect the actual amount of seafood that was eaten. However, using the assumption described above, the estimated seafood intake from this study is comparable to that observed in the U.S. EPA CSFII analysis.

10.3.2.5. *Stern et al. (1996)—Estimation of Fish Consumption and Methylmercury Intake in the New Jersey Population*

Stern et al. (1996) reported on a 7-day fish consumption recall survey that was conducted in 1993 as part of the New Jersey Household Fish Consumption Study. Households were contacted by telephone using the random-digit dialing technique, and the survey completion rate was 72% of households contacted. Respondents included 1 adult (i.e., ≥18 years) resident per household, for a total of

1,000 residents. The sample was "stratified to provide equal numbers of men and women and proportional representation by county" (Stern et al., 1996). Survey respondents provided data on consumption of all seafood consumed within the previous 7 days, including the number of fish meals, fish type, amount eaten at each meal, frequency of consumption, and whether the consumption patterns during the recall period were typical of their intake throughout the year.

Stern et al. (1996) reported that "of the 1,000 respondents, 933 reported that they normally consume fish at least a few times per year and 686 reported that they consumed fish during the recall period" (Stern et al., 1996). Table 10-21 presents the distribution of the number of meals for the 7-day recall period. The average portion size was 168 grams. Approximately "4–5% of all fish meals consisted of fish obtained non-commercially, and only about 13% of these consisted of freshwater fish" (Stern et al., 1996). Tuna was consumed most frequently, followed by shrimp and flounder/fluke (see Table 10-22).

Table 10-23 provides the average daily consumption rates (g/day) for all fish for all adults and for women of childbearing age (i.e., 18–40 years). The mean fish intake rate for all adult consumers was 50 g/day, and the 90th percentile was 107 g/day. For women of childbearing age, the mean fish intake rate was 41 g/day, and the 90th percentile was 88 g/day. Table 10-24 provides information on the frequency of fish consumption.

The advantages of this study are that it is based on a 7-day recall period and that data were collected for the frequency of eating fish. However, the data are based on fish consumers in New Jersey and may not be representative of the general population of the United States.

10.3.2.6. *U.S. EPA (2002)—Estimated Per Capita Fish Consumption in the United States*

U.S. EPA's Office of Water used data from the 1994–1996 CSFII and its 1998 Children's Supplement (referred to collectively as CSFII 1994–1996, 1998) to generate fish intake estimates (U.S. EPA, 2002). Participants in the CSFII 1994–1996, 1998 provided 2 non-consecutive days of dietary data. The Day 2 interview occurred 3 to 10 days after the Day 1 interview but not on the same day of the week. Data collection for the CSFII started in April of the given year and was completed in March of the following year. Respondents estimated the weight of each food that they consumed. Information on the consumption of food was classified using 11,345 different food codes and stored in a database in units of grams consumed per day. A total of 831 of these food codes related to fish or shellfish; survey respondents reported consumption across 665 of these codes. The fish component (by weight) of the various foods was calculated using data from the recipe file for release seven of USDA's Nutrient Data Base for Individual Food Intake Surveys.

The amount of fish consumed by each individual was then calculated by summing, over all fish containing foods, the product of the weight of food consumed and the fish component (i.e., the percentage fish by weight) of the food. The recipe file also contains cooking loss factors associated with each food. These were used to convert, for each fish-containing food, the as-eaten fish weight consumed into an uncooked equivalent weight of fish. Analyses of fish intake were performed on both an "as-prepared" (i.e., as-consumed) and uncooked basis.

Each fish-related food code was assigned, by U.S. EPA, to a habitat category. The habitat categories included freshwater/estuarine, or marine. Food codes were also designated as finfish or shellfish. Average daily individual consumption (g/day) was calculated, for a given fish type-by-habitat category (e.g., marine finfish), by summing the amount of fish consumed by the individual across the 2 reporting days for all fish-related food codes in the given fish-by-habitat category and then dividing by 2. Individual daily fish consumption (g/day) was calculated similarly except that total fish consumption was divided by the specific number of survey days the individual reported consuming fish; this was calculated for fish consumers only (i.e., those consuming fish on at least 1 of the 2 survey days). The reported body weight of the individual was used to convert consumption in g/day to consumption in g/kg-day.

There were a total of 20,607 respondents in the combined data set that had 2-day dietary intake data. Survey weights were assigned to this data set to make it representative of the U.S. population with respect to various demographic characteristics related to food intake. Survey weights were also adjusted for non-response.

U.S. EPA (2002) reported means, medians, and estimates of the 90th, 95th, and 99th percentiles of fish intake. The 90% interval estimates are non-parametric estimates from bootstrap techniques. The bootstrap estimates result from the percentile method, which calculates the lower and upper bounds for the interval estimate by the 100α percentile and 100 (1–α) percentile estimates from the non-parametric distribution of the given point estimate (U.S. EPA, 2002).

Analyses of fish intake were performed on an as-prepared as well as on an uncooked equivalent basis and on a g/day and mg/kg-day basis. Table 10-25 gives the mean and various percentiles of the distribution of per capita finfish and shellfish intake rates (g/day), as prepared, by habitat and fish type, for the general population. Table 10-26 provides a list of the fish species categorized within each habitat. Table 10-26 also shows per capita consumption estimates by species. Table 10-27 displays the mean and various percentiles of the distribution of per capita finfish and shellfish intake rates (g/day) by habitat and fish type, on an uncooked equivalent basis. Table 10-28 shows per capita consumption estimates by species on an uncooked equivalent basis.

Tables 10-29 through 10-36 present data for daily average fish consumption. These data are presented by selected age groupings (14 and under, 15–44, 45 and older, all ages, children ages 3 to 17, and ages 18 and older) and sex. It should be noted the analysis predated the age groups recommended by U.S. EPA *Guidelines on Selecting Age Groups for Monitoring and Assessing Childhood Exposure to Environmental Contaminants* (U.S. EPA, 2005). Tables 10-29 through 10-32 present fish intake data (g/day and mg/kg-day; as prepared and uncooked) on a per capita basis, and Tables 10-33 through 10-36 provide data for consumers only.

The advantages of this study are its large size and its representativeness. The survey was also designed and conducted to support unbiased estimation of food consumption across the population. In addition, through use of the USDA recipe files, the analysis identified all fish-related food codes and estimated the percent fish content of each of these codes. By contrast, some analyses of the USDA NFCSs, which reported per capita fish intake rates (e.g., Pao et al., 1982; USDA, 1992a), excluded certain fish-containing foods (e.g., fish mixtures, frozen plate meals) in their calculations.

10.3.2.7. *Westat (2006)—Fish Consumption in Connecticut, Florida, Minnesota, and North Dakota*

Westat (2006) analyzed the raw data from three fish consumption studies to derive fish consumption rates for various age, sex, and ethnic groups, and according to the source of fish consumed (i.e., bought or caught) and habitat (i.e., freshwater, estuarine, or marine). The studies represented data from four states: Connecticut, Florida, Minnesota, and North Dakota.

The Connecticut data were collected in 1996/1997 by the University of Connecticut to obtain estimates of fish consumption for the general population, sport fishing households, commercial fishing households, minority and limited income households, women of child-bearing years, and children. Data were obtained from 810 households, representing 2,080 individuals, using a combination of a mail questionnaire that included a 10-day diary, and personal interviews. The response rate for this survey was low (i.e., 6% for the general population and 10% for anglers) but was considered to be adequate by the study authors (Balcom et al., 1999).

The Florida data were collected by telephone and in-person interviews by the University of Florida and represented a random sample of 8,000 households (telephone interviews) and 500 food stamp recipients (in-person interviews). The purpose of the survey was to obtain information on the quantity of fish and shellfish eaten, as well as the cooking method used. Additional information of the Florida survey can be found in Degner et al. (1994).

The Minnesota and North Dakota data were collected by the University of North Dakota in 2000 and represented 1,572 households and 4,273 individuals. Data on purchased and caught fish were collected for the general population, anglers, new mothers, and Native American tribes. The survey also collected information on the species of fish eaten. Additional information on this study can be found in Benson et al. (2001).

The primary difference in survey procedures among the three studies was the manner in which the fish consumption data were collected. In Connecticut, the survey requested information on how often each type of seafood was eaten, without a recall period specified. In Minnesota and North Dakota, the survey requested information on the rate of fish or shellfish consumption during the previous 12 months. In Florida, the survey requested information on fish consumption during the last 7 days prior to the telephone interview. In addition, for the Florida survey, information on away-from-home fish consumption was collected from a randomly selected adult from each participating household. Because this information was not collected from all household members, the study may tend to underestimate away-from-home consumption. The study notes that estimates of fish consumption using a shorter recall period will decrease the proportion of respondents that report eating fish or shellfish. This trend was observed in the Florida study (in which approximately half of respondents reported eating fish/shellfish), compared with Connecticut, Minnesota, and North Dakota (in which approximately 90% of respondents reported eating fish or shellfish).

Tables 10-37 through 10-46 present key findings of the Westat (2006) consumption study. The tables show the fish and shellfish consumption rates for various groups classified by demographic characteristics and by the source of the fish and shellfish consumed (i.e., freshwater versus marine, and bought versus self-caught). Consumption rates are presented in grams per kilogram of body weight per day for the entire population (i.e., consumption per capita) and for just those that reported consuming fish and shellfish (consumption for consumers only).

An advantage of this study is that it focused on individuals within the general population that may consume more fish and shellfish and, thus, may be at higher risk from exposure to contaminants in fish than other members of the population. Also, it provides distributions of fish consumption for different age cohorts, ethnic groups, socioeconomic status, types of fish (i.e., freshwater, marine, estuarine), and sources of fish (i.e., store-bought versus self-caught). However, the data were collected in four states and may not be representative of the U.S. population as a whole.

10.3.2.8. *Moya et al. (2008)—Estimates of Fish Consumption Rates for Consumers of Bought and Self-Caught Fish in Connecticut, Florida, Minnesota, and North Dakota*

Moya et al. (2008) summarized the analysis conducted by Westat (2006) described in Section 10.3.2.7. Moya et al. (2008) utilized the data to generate intake rates for 3 age groups of children (i.e., 1 to <6 years, 6 to <11 years, and 11 to <16 years) and 3 age groups of adults (16 to <30 years, 30 to <50 years, and >50 years), which are also listed by sex. These data represented the general population and angler population in the four states. Recreational fish intake rates were not provided for children, and data were not provided for children according to the source of intake (i.e., bought or caught) or habitat (i.e., freshwater, estuarine, or marine). Table 10-47 presents the intake rates for the general population who consumed fish and shellfish in g/kg-day, as-consumed. Table 10-47 also provides information on the fish intake among the sample populations from the four states, based on the source of the fish (i.e., caught or bought) and provides estimated fish intake rates among the general populations and angler populations from Connecticut, Minnesota, and North Dakota.

This analysis is based on the data from Westat (2006). Therefore, the advantages and limitations are the same as those of the Westat (2006) study. Also, while data were provided for individuals who ate self-caught fish, it is not possible from this analysis to determine the proportion of self-caught fish represented by marine or freshwater habitats.

10.3.2.9. *Mahaffey et al. (2009)—Adult Women's Blood Mercury Concentrations Vary Regionally in the United States: Association with Patterns of Fish Consumption (NHANES 1999–2004)*

Mahaffey et al. (2009) used NHANES 1999–2004 data to evaluate relationships between fish intake and blood mercury levels. Mercury intake via fish ingestion was evaluated for four coastal populations (i.e., Atlantic, Pacific, Gulf of Mexico, and Great Lakes), and four non-coastal populations defined by U.S. census regions (i.e., Northeast, South, Midwest, and West) (Mahaffey et al., 2009). Serving size data, based on 24-hour dietary recall, were used with 30-day food frequency data to estimate mercury intake from consumption of fish over a 30-day period. The frequency data used in the study indicated that people living on the Atlantic coast consumed fish most frequently (averaging 6 meals/month), followed closely by those of the Gulf and Pacific coasts. People living in non-coastal areas or on the coasts of the Great Lakes consumed fish least often (averaging ≤4 meals/month). Figure 10-2 illustrates these regional differences.

The advantage of this study is that it is based on relatively recent NHANES data (i.e., 1999–2004), it uses data from the 30-day food frequency questionnaire, and it provides regional data that are not available elsewhere. However, because the study focused on mercury exposure, it did not provide non-chemical specific fish intake data (in g/day or g/kg-day) that can be used to support risk assessments for other chemicals (i.e., only frequency data were provided). It does, however, provide useful information on the relative differences in frequency of fish intake for regional populations.

10.4. MARINE RECREATIONAL STUDIES

10.4.1. Key Marine Recreational Study

10.4.1.1. *National Marine Fisheries Service (1986a, b, c, 1993)*

The NMFS conducts systematic surveys, on a continuing basis, of marine recreational fishing.

These surveys are designed to estimate the size of the recreational marine finfish catch by location, species, and fishing mode. In addition, the surveys provide estimates for the total number of participants in marine recreational finfishing and the total number of fishing trips.

The NMFS surveys involve two components: telephone surveys and direct interviewing of fishermen in the field. The telephone survey randomly samples residents of coastal regions, defined generally as counties within 25 miles of the nearest seacoast, and inquires about participation in marine recreational fishing in the resident's home state in the past year, and more specifically, in the past 2 months. This component of the survey is used to estimate, for each coastal state, the total number of coastal region residents who participate in marine recreational fishing (for finfish) within the state, as well as the total number of (within state) fishing trips these residents take. To estimate the total number of participants and fishing trips in the state, by coastal residents and others, a ratio approach, based on the field interview data, was used. Thus, if the field survey data found that there was a 4:1 ratio of fishing trips taken by coastal residents as compared to trips taken by non-coastal and out-of-state residents, then an additional 25% would be added to the number of trips taken by coastal residents to generate an estimate of the total number of within-state trips.

The surveys are not designed to estimate individual consumption of fish from marine recreational sources, primarily because they do not attempt to estimate the number of individuals consuming the recreational catch. Intake rates for marine recreational anglers can be estimated, however, by employing assumptions derived from other data sources about the number of consumers.

The field intercept survey is essentially a creel type survey. The survey utilizes a national site register that details marine fishing locations in each state. Sites for field interviews are chosen in proportion to fishing frequency at the site. Anglers fishing on shore, private boat, and charter/party boat modes who had completed their fishing were interviewed. The field survey included questions about frequency of fishing, area of fishing, age, and place of residence. The fish catch was classified by the interviewer as either type A, type B1, or type B2 catch. The type A catch denoted fish that were taken whole from the fishing site and were available for inspection. The type B1 and B2 catch were not available for inspection; the former consisted of fish used as bait, filleted, or discarded dead, while the latter was fish released alive. The type A catch was identified by species and weighed, with the weight reflecting total fish weight, including inedible parts. The type B1 catch was not weighed, but weights were estimated using the average weight derived from the type A catch for the given species, state, fishing mode, and season of the year. For both the type A and B1 catch, the intended disposition of the catch (e.g., plan to eat, plan to throw away, etc.) was ascertained.

U.S. EPA obtained the raw data tapes from NMFS in order to generate intake distributions and other specialized analyses. Fish intake distributions were generated using the field survey tapes. Weights proportional to the inverse of the angler's reported fishing frequency were employed to correct for the unequal probabilities of sampling; this was the same approach used by NMFS in deriving their estimates. Note that in the field survey, anglers were interviewed regardless of past interviewing experience; thus, the use of inverse fishing frequency as weights was justified (see Section 10.1).

For each angler interviewed in the field survey, the yearly amount of fish caught that was intended to be eaten by the angler and his/her family or friends was estimated by U.S. EPA as follows:

$$Y = [(wt\ of\ A\ catch) \times I_A + (wt\ of\ B1\ catch) \times I_B] \times [Fishing\ frequency] \quad \text{(Eqn. 10-1)}$$

where I_A (I_B) are indicator variables equal to one if the type A ($B1$) catch was intended to be eaten, and equal to 0 otherwise. To convert Y to a daily fish intake rate by the angler, it was necessary to convert amount of fish caught to edible amount of fish, divide by the number of intended consumers, and convert from yearly to daily rate.

Although theoretically possible, U.S. EPA chose not to use species-specific edible fractions to convert overall weight to edible fish weight because edible fraction estimates were not readily available for many marine species. Instead, an average value of 0.5 was employed. For the number of intended consumers, U.S. EPA used an average value of 2.5, which was an average derived from the results of several studies of recreational fish consumption (Chemrisk, 1992; Puffer et al., 1981; West et al., 1989). Thus, the average daily intake rate (ADI) for each angler was calculated as

$$ADI = Y \times (0.5)/[2.5 \times 365] \quad \text{(Eqn. 10-2)}$$

Note that *ADI* will be 0 for those anglers who either did not intend to eat their catch or who did not catch any fish. The distribution of ADI among anglers was calculated by region and coastal status (i.e., coastal versus non-coastal counties).

The results presented in Tables 10-48 and 10-49 are based on the results of the 1993 survey. Sample sizes were 200,000 for the telephone survey and 120,000 for the field surveys. All coastal states in the continental United States were included in the survey except Texas and Washington.

Table 10-48 presents the estimated number of coastal, non-coastal, and out-of-state fishing participants by state and region of fishing. Florida had the greatest number of both Atlantic and Gulf participants. The total number of coastal residents who participated in marine finfishing in their home state was eight million; an additional 750,000 non-coastal residents participated in marine finfishing in their home state.

Table 10-49 presents the estimated total weight of the type A and B1 catch by region and time of year. For each region, the greatest catches were during the 6-month period from May through October. This period accounted for about 90% of the North and Mid-Atlantic catch, about 80% of the Northern California and Oregon catch, about 70% of the Southern Atlantic and Southern California catch, and 62% of the Gulf catch. Note that in the North and Mid-Atlantic regions, field surveys were not done in January and February due to very low fishing activity. For all regions, over half the catch occurred within 3 miles of the shore or in inland waterways.

Table 10-50 presents the mean and 95th percentile of average daily intake (ADI) of recreationally caught marine finfish among anglers by region. The mean ADI values among all anglers were 5.6, 7.2, and 2.0 g/day for the Atlantic, Gulf, and Pacific regions, respectively. Table 10-51 gives the distribution of catch, by species, for the Atlantic, Gulf, and Pacific regions.

The NMFS surveys provide a large, geographically representative sample of marine angler activity in the United States. The major limitation of this database in terms of estimating fish intake is the lack of information regarding the intended number of consumers of each angler's catch. In this analysis, it was assumed that every angler's catch was consumed by the same number (2.5) of people; this number was derived from averaging the results of other studies. This assumption introduces a relatively low level of uncertainty in the estimated mean intake rates among anglers, but a somewhat higher level of uncertainty in the estimated intake distributions.

Under the above assumption, the distributions shown here pertain not only to the population of anglers, but also to the entire population of recreational fish consumers, which is 2.5 times the number of anglers. If the number of consumers was changed, to, for instance, 2.0, then the distribution would be increased by a factor of 1.25 (2.5/2.0), but the estimated population of recreational fish consumers to which the distribution would apply, would decrease by a factor of 0.8 (2.0/2.5).

Another uncertainty involves the use of 0.5 as an (average) edible fraction. This figure is assumed to be somewhat conservative (i.e., the true average edible fraction is probably lower); thus, the intake rates calculated here may be biased upward somewhat.

The recreational fish intake distributions given refer only to marine finfish. In addition, the intake rates calculated are based only on the catch of anglers in their home state. Marine fishing performed out-of-state would not be included in these distributions. Therefore, these distributions give an estimate of consumption of locally caught marine fish. These data are approximately 2 decades old and may not be entirely representative of current intake rates. Also, data were not available for children.

10.4.2. Relevant Marine Recreational Studies

10.4.2.1. *Pierce et al. (1981)—Commencement Bay Seafood Consumption Study*

Pierce et al. (1981) performed a local creel survey to examine seafood consumption patterns and demographics of sport fishermen in Commencement Bay, WA. The objectives of this survey included determining (1) the seafood consumption habits and demographics of non-commercial anglers catching seafood; (2) the extent to which resident fish were used as food; and (3) the method of preparation of the fish to be consumed. Salmon were excluded from the survey because it was believed that they had little potential for contamination. The first half of this survey was conducted from early July to mid-September, 1980 and the second half from mid-September through most of November. During the summer months, interviewers visited each of four sub-areas of Commencement Bay on five mornings and five evenings; in the fall, the areas were sampled on four complete survey days. Interviews were conducted only with persons who had caught fish. The anglers were interviewed only once during the survey period. Data were recorded for species, wet weight, size of the living group (family), place of residence, fishing frequency, planned uses of the fish, age, sex, and race (Pierce et al., 1981). The analysis of Pierce et al. (1981) did not employ explicit sampling weights (i.e., all weights were set to one).

There were 304 interviews in the summer and 204 in the fall. About 60% of anglers were White, 20% Black, and 19% Asian, and the rest were Hispanic or Native American. Table 10-52 gives the distribution of fishing frequency calculated by Pierce et al. (1981); for both the summer and fall, more than half of the fishermen caught and consumed fish weekly. The dominant (by weight) species caught were Pacific hake and walleye pollock. Pierce et al. (1981) did not present a distribution of fish intake or a mean fish intake rate.

Price et al. (1994) obtained the raw data from this survey and performed a re-analysis using sampling weights proportional to inverse fishing frequency. The rationale for these weights is explained in Section 10.1 and in the discussion of the Puffer et al. (1981) study (see Section 10.4.2.2). In the re-analysis, Price et al. (1994) calculated a median intake rate of 1.0 g/day and a 90th percentile rate of 13 g/day. The distribution of fishing frequency generated by Pierce et al. (1981) is shown in Table 10-52. Note that when equal weights were used, Price et al. (1994) found a median rate of 19 g/day (Table 10-53).

The same limitations apply to interpreting the results presented here to those presented in the discussion of Puffer et al. (1981) (see Section 10.4.2.2). As with the Puffer et al. (1981) data described in the following section, these values (1.0 g/day and 19 g/day) are both probably underestimates because the sampling probabilities are less than proportional to fishing frequency; thus, the true target population median is probably somewhat above 1.0 g/day, and the true 50th percentile of the resource utilization distribution is probably somewhat higher than 19 g/day. The data from this survey provide an indication of consumption patterns for the time period around 1980 in the Commencement Bay area. However, the data may not reflect current consumption patterns because fishing advisories were instituted due to local contamination. Another limitation of these data is that fish consumption rates were estimated indirectly from a series of assumptions.

10.4.2.2. *Puffer et al. (1981)—Intake Rates of Potentially Hazardous Marine Fish Caught in the Metropolitan Los Angeles Area*

Puffer et al. (1981) conducted a creel survey with sport fishermen in the Los Angeles area in 1980. The survey was conducted at 12 sites in the harbor and coastal areas to evaluate intake rates of potentially hazardous marine fish and shellfish by local, non-professional fishermen. It was conducted for the full 1980 calendar year, although inclement weather in January, February, and March limited the interview days. Each site was surveyed an average of three times per month, on different days, and at a different time of the day. The survey questionnaire was designed to collect information on demographic characteristics, fishing patterns, species, number of fish caught, and fish consumption patterns. Scales were used to obtain fish weights. Interviews were conducted only with anglers who had caught fish, and the anglers were interviewed only once during the entire survey period.

Puffer et al. (1981) estimated daily consumption rates (g/day) for each angler using the following equation:

$$K \times N \times W \times F)/[E \times 365] \qquad \text{(Eqn. 10-3)}$$

where:

K = edible fraction of fish (0.25 to 0.5 depending on species),
N = number of fish in catch,
W = average weight of (grams) fish in catch,
F = frequency of fishing/year, and
E = number of fish eaters in family/living group.

No explicit survey weights were used in analyzing this survey; thus, each respondent's data were given equal weight.

A total of 1,059 anglers were interviewed for the survey. Table 10-54 shows the ethnic and age distribution of respondents; 88% of respondents were male. The median intake rate was higher for Asian/Samoan anglers (median 70.6 g/day) than for other ethnic groups and higher for those ages over 65 years (median 113.0 g/day) than for other age groups. Puffer et al. (1981) found similar median intake rates for seasons: 36.3 g/day for November through March and 37.7 g/day for April through October. Puffer et al. (1981) also evaluated fish preparation methods; Appendix 10B presents these data. Table 10-55 presents the cumulative distribution of recreational fish (finfish and shellfish) consumption by survey respondents; this distribution was calculated only for those fishermen who indicated they eat the fish they catch. The median fish consumption rate was 37 g/day, and the

90th percentile rate was 225 g/day (Puffer et al., 1981). Table 10-56 presents a description of catch patterns for primary fish species kept.

As mentioned in the introduction to this chapter, intake distributions derived from analyses of creel surveys that did not employ weights reflective of sampling probabilities will overestimate the target population intake distribution and will, in fact, be more reflective of the "resource utilization distribution." Therefore, the reported median level of 37.3 g/day does not reflect the fact that 50% of the target population has intake above this level; instead, 50% of recreational fish consumption is by individuals consuming at or above 37 g/day. In order to generate an intake distribution reflective of that in the target population, weights inversely proportional to sampling probability need to be employed. Price et al. (1994) made this attempt with the Puffer et al. (1981) survey data, using inverse fishing frequencies as the sampling weights. Price et al. (1994) was unable to get the raw data for this survey, but through the use of frequency tables and the average level of fish consumption per fishing trip provided in Puffer et al. (1981), generated an approximate revised intake distribution. This distribution was dramatically lower than that obtained by Puffer et al. (1981); the median was estimated at 2.9 g/day (compared with 37 from Puffer et al. [1981]) and the 90th percentile at 35 g/day (compared to 225 g/day from Puffer et al. [1981]).

There are several limitations to the interpretation of the percentiles presented by both Puffer et al. (1981) and Price et al. (1994). As described in Appendix 10A, the interpretation of percentiles reported from creel surveys in terms of percentiles of the "resource utilization distribution" is approximate and depends on several assumptions. One of these assumptions is that sampling probability is proportional to inverse fishing frequency. In this survey, where interviewers revisited sites numerous times and anglers were not interviewed more than once, this assumption is not valid, though it is likely that the sampling probability is still highly dependent on fishing frequency, so that the assumption does hold in an approximate sense. The validity of this assumption also impacts the interpretation of percentiles reported by Price et al. (1994) because inverse frequency was used as sampling weights. It is likely that the value (2.9 g/day) of Price et al. (1994) underestimates somewhat the median intake in the target population but is much closer to the actual value than the Puffer et al. (1981) estimate of 37.3 g/day. Similar statements would apply about the 90th percentile. Similarly, the 37.3-g/day median value, if interpreted as the 50th percentile of the "resource utilization distribution," is also somewhat of an underestimate.

The fish intake distribution generated by Puffer et al. (1981) (and by Price et al. [1994]) was based only on fishermen who caught fish and ate the fish they caught. If all anglers were included, intake estimates would be somewhat lower. In contrast, the survey assumed that the number of fish caught at the time of the interview was all that would be caught that day. If it were possible to interview fishermen at the conclusion of their fishing day, intake estimates could be potentially higher. An additional factor potentially affecting intake rates is that fishing quarantines were imposed in early spring due to heavy sewage overflow (Puffer et al., 1981). These data are also over 20 years old and may not reflect current behaviors.

10.4.2.3. *Burger and Gochfeld (1991)—Fishing a Superfund Site: Dissonance and Risk Perception of Environmental Hazards by Fishermen in Puerto Rico*

Burger and Gochfeld (1991) examined fishing behavior, consumption patterns, and risk perceptions of fishermen and crabbers engaged in recreational and subsistence fishing in the Humacao Lagoons located in eastern Puerto Rico. For a 20-day period in February and March 1988, all persons encountered fishing and crabbing at the Humacao lagoons and at control sites were interviewed on fishing patterns, consumption patterns, cooking patterns, fishing and crabbing techniques, and consumption warnings. The control interviews were conducted at sites that were ecologically similar to the Humacao lagoons and contained the same species of fish and crabs. A total of 45 groups of people (3 to 4 people per group) fishing at the Humacao Lagoons and 17 control groups (3 to 4 people per group) were interviewed.

Most people fished in the late afternoon or evenings, and on weekends. Eighty percent of the fishing groups from the lagoons were male. The breakdown according to age is as follows: 27% were younger than 20 years, 49% were 21–40 years old, 24% were 41–60 years old, and 2% were over 60. The age groups for fishing were generally lower than the groups for crabbing. Caught fish were primarily tilapia and some tarpon. All crabs caught were blue crabs.

On average, people at Humacao ate about 7 fish ($N = 25$) or 13 crabs ($N = 20$) each week, while people fishing at the control site ate about 2 fish ($N = 9$) and 14 crabs ($N = 9$) a week (see Table 10-57). All of the crabbers (100%) and 96% of the fisherman at the lagoons had heard of a contamination problem.

All the interviewees that knew of a contamination problem knew that the contaminant was mercury. Most fisherman and crabbers believed that the water was clean and the catch was safe (fisherman—96% and crabbers—100%), and all fisherman and crabbers ate their catch. Seventy-two percent of the fisherman and crabbers from the lagoons lived within 3 km, 18% lived 17–30 km away, and 1 group came from 66 km away. Because many of the people interviewed had cars, researchers concluded that they were not impoverished and did not need the fish as a protein substitute.

Burger and Gochfeld (1991) noted that fisherman and crabbers did not know of anyone who had gotten sick from eating catches from the lagoons, and the potential of chronic health effects did not enter into their consideration. The study concluded that fisherman and crabbers experienced an incompatibility between their own experiences, and the risk driven by media reports of pollution and the lack of governmental prohibition of fishing.

One limitation of the study is that consumption rates were based on groups not individuals. In addition, rates were given in terms of fish per week and not mass consumed per time or body weight.

10.4.2.4. *Burger et al. (1992)—Exposure Assessment for Heavy Metal Ingestion from Sport Fish in Puerto Rico: Estimating Risk for Local Fishermen*

Burger et al. (1992) conducted another study in conjunction with the Burger and Gochfeld (1991) study. The study interviewed 45 groups of fishermen at Humacao and 14 groups at Boqueron in Puerto Rico. The respondents were 80% male, 50% were 21 to 40 years old, most fished with pole or cast, and most fished for 1.5 hours. In Humacao, 96% claimed that they ate the entire fish besides the head. The fish were either fried or boiled in stews or soups.

In February and March, 64% of the group caught only tilapia, but respondents stated that in June they caught mostly robalo and tarpon. Generally, the fisherman stated that they ate 2.1 fish (maximum of 11 fish) from Boqueron and 6.8 fish (maximum of 23) from Humacao per week. The study reported that adults ate 374 grams of fish per day, while children ate 127 grams per day. In order to calculate the daily mass intake of fish, the study assumed that an adult ate 4.4 robalos, each weighing 595 grams over a 7-day period, and a child ate 1.5 robalos, each weighing 595 grams over a 7-day period. The study used a maximum consumption value of 200 g/day for fishermen to create various hazard indices.

One limitation of this study is that the consumption rates were based on groups not individuals. In addition, consumption rates were calculated using the average fish weight and the number of meals per week reported by the respondents.

10.4.2.5. *Moya and Phillips (2001)—Analysis of Consumption of Home-Produced Foods*

The 1987–1988 NFCS was also utilized to estimate consumption of home-produced (i.e., self-caught) fish (as well as home-produced fruits, vegetables, meats, and dairy products) in the general U.S. population. The methodology for estimating home-produced intake rates was rather complex and involved combining the household and individual components of the NFCS; the methodology, as well as the estimated intake rates, are described in detail in Chapter 13. Some of the data on fish consumption from households who consumed self-caught fish are also provided in Moya and Phillips (2001). A total of 2.1% of the total survey population reported self-caught fish consumption during the survey week. Among consumers, the mean intake rate was 2.07 g/kg-day, and the 95th percentile was 7.83 g/kg-day; the mean per capita intake rate was 0.04 g/kg-day. Note that intake rates for home-produced foods were indexed to the weight of the survey respondent and reported in g/kg-day.

The NFCS household component contains the question "Does anyone in your household fish?" For the population answering yes to this question (21% of households), the NFCS data show that 9% consumed home-produced fish in the week of the survey; the mean intake rate for fish consumers from fishing households was 2.2 g/kg-day (all ages combined, see Table 13-20) for the fishing population. Note that 92% of individuals reporting home-produced fish consumption for the week of the survey indicated that a household member fishes; the overall mean intake rate among home-produced fish consumers, regardless of fishing status, was the above reported 2.07 g/kg-day). The mean per capita intake rate among all those living in fishing household is then calculated as 0.2 g/kg-day (2.2 × 0.09). Using the estimated average weight of survey participants of 59 kg, this translates into an average national per capita self-caught fish consumption rate of 11.8 g/day among the population of individuals who fish. However, this intake rate represents intake of both freshwater and saltwater fish combined. According to the data in Chapter 13 (see Table 13-68), home-produced fish consumption accounted for 32.5% of total fish consumption among households who fish.

As discussed in Chapter 13 of this handbook, intake rates for home-produced foods, including fish, are based on the results of the household survey, and as such, reflect the weight of fish taken into the household. In most of the recreational fish surveys discussed later in this section, the weight of the fish catch (which generally corresponds to the weight taken into the household) is multiplied by an edible fraction to convert to an uncooked equivalent of the amount consumed. This fraction may be species specific, but some studies used an average value; these average values ranged from 0.3 to 0.5. Using a factor of 0.5 would convert the above 11.8 g/day rate to 5.9 g/day.

The advantage of this study is that it provides a national perspective on the consumption of self-caught fish. A limitation of this study is that these values include both freshwater and saltwater fish. The proportion of freshwater to saltwater is unknown and will vary depending on geographical location. Intake data cannot be presented for various age groups due to sample size limitations. The unweighted number of households, who responded positively to the survey question "do you fish"? was also low (i.e., 220 households).

10.4.2.6. *KCA Research Division (1994)—Fish Consumption of Delaware Recreational Fishermen and Their Households*

In support of the Delaware Estuary Program, the State of Delaware's Department of Natural Resources and Environmental Control conducted a survey of marine recreational fishermen along the coastal areas of Delaware between July 1992 and June 1993 (KCA Research Division, 1994). There were two components of the study: (1) a field survey of fishermen as they returned from their fishing trips, and (2) a telephone follow-up call.

The purpose of the first component was to obtain information on their fishing trips and on their household composition. This information included the method and location of fishing, number of fish caught and kept by species, and weight of each fish kept. Household information included race, age, sex, and number of persons in the household. Information was also recorded as to the location of the angler intercept (i.e., where the angler was interviewed) and the location of the household.

The purpose of the second component was to obtain information on the amount of fish caught and kept from the fishing trip and then eaten by the household. The methods used for preparing and cooking the fish were also documented.

The field portion of the study was designed to interview 2,000 anglers. Data were obtained from 1,901 anglers, representing 6,204 household members (KCA Research Division, 1994). While the primary goal of the study was to collect data on marine recreational fishing practices, the survey included some freshwater fishing and crabbing sites. Follow-up phone interviews typically occurred 2 weeks after the field interview and were used to gather information about consumption. Interviewers aided respondents in their estimation of fish intake by describing the weight of ordinary products, for the purpose of comparison to the quantity of fish eaten. Information on the number of fishing trips a respondent had taken during the month was used to estimate average annual consumption rates.

For all respondents, the average consumption was 17.5 g/day. Males were found to have consumed more fish than women, and Caucasians consumed more fish per day than the other races surveyed (see Table 10-58). More than half of the study respondents reported that they skinned the fish that they ate (i.e., 450 out of 807 who reported whether they skinned their catch); the majority ate filleted fish (i.e., 617 out of 794 who reported the preparation method used), and over half fried their fish (i.e., 506 out of 875 who reported the cooking method). Information on consumption relative to preparation method indicated a higher consumption level for skinned fish (0.627 oz/day) than for un-skinned fish (0.517 oz/day). Although most respondents fried their catch (0.553 oz/day), baking and broiling were also common (0.484 and 0.541 oz/day, respectively).

One limitation of this study is that information on fish consumption is based on anglers' recall of amount of fish eaten. While this study provides information on fish consumption of various ethnic groups, another limitation of this study is that the sample size for ethnic groups was very small. Also, the study was limited to one geographic area and may not be representative of the U.S. population.

10.4.2.7. *Santa Monica Bay Restoration Project (SMBRP) (1994)—Seafood Consumption Habits of Recreational Anglers in Santa Monica Bay, Los Angeles, CA*

The Santa Monica Bay Restoration Project (SMBRP) conducted a study on the seafood consumption habits of recreational anglers in Santa Monica Bay, CA. The study was conducted between September 1991 and August 1992. Surveys were conducted at 11 piers and jetties, three private boat launches and hoists, 11 beach and intertidal sites, and five party boat landings. Information requested in the survey included fishing history, types of fish eaten, consumption habits, methods of preparing fish, and demographics. Consumption rates were calculated based on the anglers' estimates of meal size relative to a model fish fillet that represented a 150-gram meal. Interviewers identified 67 species of fish, 2 species of crustaceans, 2 species of mollusks, and 1 species of echinoderms that had been caught from the study area by recreational anglers during the study period. The most abundant species caught were chub mackerel, barred sand bass, kelp bass, white croaker, Pacific barracuda, and Pacific bonito.

A total of 2,376 anglers were censused during 113 separate surveys. Of those anglers, 1,243 were successfully interviewed, and 554 provided sufficient information for calculation of consumption rates. The socio-demographics of the sample population were as follows: most anglers were male (93%), 21 to 40 years old (54%), White (43%), and had an annual household income of $25,000 to $50,000 (39%).

The results of the survey showed that the mean consumption rate was 50 g/day, while the 90th percentile was over two times higher at 107 g/day (see Table 10-59). Of the identified ethnic groups, Asians had the highest mean consumption rate (51 g/day) and the highest 90th percentile value for consumption rate (116 g/day). Anglers with annual household incomes greater than $50,000 had the highest mean consumption rate (59 g/day) and the highest 90th percentile consumption rate (129 g/day). Species of fish that were consumed in larger amounts than other species included barred sand bass, Pacific barracuda, kelp bass, rockfish species, Pacific bonito, and California halibut.

About 77% of all anglers were aware of health warnings about consumption of fish from Santa Monica Bay. Of these anglers, 50% had altered their seafood consumption habits as a result of the warnings (46% stopped consuming some species, 25% ate less of all species, 19% stopped consuming all fish, and 10% ate less of some species). Most anglers in the ethnic groups surveyed were aware of the health-risk warnings, but Asian and White anglers were more likely to alter their consumption behavior based on these warnings.

One limitation of this study is the low numbers of anglers younger than 21 years of age. In this study, if several anglers from the same household were fishing, only the head of the household was interviewed. Hence, young individuals were frequently not interviewed and, therefore, are under-represented in this study.

It should also be noted that this study was not adjusted for avidity bias, but the California Office of Environmental Health Hazard Assessment has adjusted the distribution of fish consumption for avidity bias and other factors in the Air Toxics Hot Spots Program Risk Assessment Guidelines Part IV: Exposure Assessment and Stochastic Analysis Technical Support (see http://www.oehha.ca.gov/air/hot_spots/finalStoc.html).

10.4.2.8. *U.S. DHHS (1995)—Health Study to Assess the Human Health Effects of Mercury Exposure to Fish Consumed from the Everglades*

A health study was conducted in two phases in the Everglades, Florida for the U.S. Department of Health and Human Services (U.S. DHHS, 1995). The objectives of the first phase were to (a) describe the human populations at risk for mercury exposure through their consumption of fish and other contaminated animals from the Everglades and (b) evaluate the extent of mercury exposure in those persons consuming contaminated food and their compliance with the voluntary health advisory. The second phase of the study involved neurologic testing of all study participants who had total mercury levels in hair greater than 7.5 µg/g.

Study participants were identified by using special targeted screenings, mailings to residents, postings and multi-media advertisements of the study throughout the Everglades region, and direct discussions with people fishing along the canals and waterways in the contaminated areas. The contaminated areas were identified by the interviewers and long-term Everglade residents. Of a total of 1,794 individuals sampled, 405 individuals were eligible to participate in the study because they had consumed fish or wildlife from the Everglades at least once per month in the last 3 months of the study period. The majority of the eligible participants (>93%) were either subsistence fishermen, Everglade residents, or both. Subsistence fishermen were defined in the survey as "people who rely on fish and the wildlife of the Everglades as a source of dietary protein for themselves and their families." Of the total eligible participants, 55 individuals refused to participate in the survey. Useable data were obtained from 330 respondents ranging in age from 10–81 years of age (mean age 39 years ± 18.8) (U.S. DHHS, 1995). Respondents were administered a three-page questionnaire from which demographic information, fishing and eating habits, and other variables were obtained (U.S. DHHS, 1995).

Table 10-60 shows the ranges, means, and standard deviations of selected characteristics by various groups of the survey population. Sixty-two percent of the respondents were male with a slight preponderance of Black individuals (43% White, 46% Black non-Hispanic, and 11% Hispanic). Most of the respondents reported earning an annual income of $15,000 or less per family before taxes (U.S. DHHS, 1995). The mean number of years fished along the canals by the respondents was 15.8 years with a standard deviation of 15.8. The mean number of times per week fish consumers reported eating fish over the last 6 months and last month of the survey period were 1.8 and 1.5 per week with standard deviations of 2.5 and 1.4, respectively. Table 10-60 also indicates that 71% of the respondents reported knowing about the mercury health advisories. Of those who were aware, 26% reported that they had lowered their consumption of fish caught in the Everglades, while the rest (74%) reported no change in consumption patterns (U.S. DHHS, 1995).

A limitation of this study is that fish intake rates (g/day) were not reported. Another limitation is that the survey was site limited and, therefore, not representative of the U.S. population. An advantage of this study is that it is one of the few studies targeting populations expected to have higher consumption rates.

10.4.2.9. *Alcoa (1998)—Draft Report for the Finfish/Shellfish Consumption Study—Alcoa (Point Comfort)/Lavaca Bay Superfund Site*

The Texas Saltwater Angler Survey was conducted in 1996/1997 to evaluate the quantity and species of finfish and shellfish consumed by individuals who fish at Lavaca Bay (Alcoa, 1998). The target population for this study was residents of three Texas counties: Calhoun, Victoria, and Jackson (over 70% of the anglers who fish Lavaca Bay are from these three counties). The random sample design specified that the population percentages for the counties should be as follows: 50% from Calhoun, 30% from Victoria, and 20% from Jackson.

Each individual in the sample population was sent an introductory note describing the study and then was contacted by telephone. People who agreed to participate and had taken fewer than six fishing trips to Lavaca Bay were interviewed by telephone. Persons who agreed to participate and had taken more than five fishing trips to Lavaca Bay were sent a mail survey with the same questions. A total of 1,979 anglers participated in this survey, representing a response rate greater than 68%. Data were collected from the households for men, women, and children.

The information collected as part of the survey included recreational fishing trip information for November 1996 (i.e., fishing site, site facilities, distance traveled, number and species caught), self-caught fish consumption (by the respondent, spouse and child, if applicable), opinions on different types of fishing experiences, and socio-demographics. Portion size for shellfish was determined by utilizing the number of shrimp, crabs, oysters, etc. that an individual consumed during a meal and the assumed tissue weight of the particular species of shellfish.

Table 10-61 presents the results of the study. Adult men consumed 25 grams of self-caught finfish per day while women consumed an average of 18 grams daily. Women of childbearing age consumed 19 grams per day, on average. Small children were found to consume 11 g/day, and youths consumed 16 g/day, on average. Less shellfish was consumed by all individuals than finfish. Men consumed an average of 2 g/day, women and youths an average of 1 g/day, and small children consumed less than 1 g/day of shellfish.

The study results also showed the number of average meals and portion sizes for the respondents, (see Table 10-62). On average, members of each cohort consumed slightly more than 3 meals per month of finfish, although small children and youths consumed slightly less than 3 meals per month of finfish and less than 1 meal per month of shellfish. For finfish, adult men consumed an average, per meal, portion size of 8 ounces, while women and youths consumed 7 ounces, and small children consumed less than 5 ounces per meal. The average number of shellfish meals consumed per month for all cohorts was less than one. Adult men consumed an average shellfish portion size of 4 ounces, women and youth 3 ounces, and small children consumed 2 ounces per meal.

The study also discussed the species composition of self-caught fish consumed by source. Four different sources of fish were included: fish consumed from the closure area, fish consumed from Lavaca Bay, fish consumed from all waters, and all self-caught finfish and shellfish consumed, including preserved (i.e., frozen or smoked) fish where the location of the catch is not known. Red drum comprised the bulk of total finfish grams consumed from any area, while black drum represented the smallest amount of finfish grams consumed. Overall, almost 40% of all self-caught finfish consumed were red drum, followed by speckled sea trout, flounder, all other finfish (all species were not specifically examined in this study), and black drum. Out of all self-caught shellfish, oysters accounted for 37%, blue crabs for 35%, and shrimp for 29% of the total.

The study authors noted that because the survey relied on the anglers' recall of meal frequency and portion, fish consumption may have been overestimated. There was evidence of overestimation when the data were validated, and approximately 10% of anglers reported consuming more fish than what they caught and kept. Also, the study was conducted at one geographic location and may not be representative of the U.S. population.

10.4.2.10. *Burger et al. (1998)—Fishing, Consumption, and Risk Perception in Fisherfolk along an East Coast Estuary*

Burger et al. (1998) examined fishing behavior, consumption patterns, and risk perceptions of 515 people that were fishing and crabbing in Barnegat Bay, NJ. This research also tested the null hypotheses that there are no sex differences in fishing behavior and consumption patterns and no sex differences in the perception of fish and crab safety.

The researchers interviewed 515 people who were fishing or crabbing on Barnegat Bay and Great Bay. Interviews were conducted from June 22 until September 27, 1996. Fifteen percent of the fishermen approached refused to be interviewed, usually because they did not have the time to participate. The questionnaire that researchers used to conduct the interviews contained questions about fishing behavior, consumption patterns, cooking patterns, warnings, and safety associated with the seafood, environmental problems, and changes in the Bay, and personal demographics.

Eighty-four percent of those who were interviewed were men, 95% were White, and the rest were evenly divided between African American, Hispanic, and Asian. The age of interviewees ranged from 13 to 92 years. The subjects fished an average of seven times per month and crabbed three times per month (see Table 10-63). Bluefish (*Pomatomus saltatrix*), fluke or summer flounder (*Paralichthys dentatus*), and weakfish (*Cynoscion regalis*) were the most frequently caught fish. The researchers found that the average consumption rate for people fishing along the Barnegat Bay was 5 fish meals per month (eating just under 10 ounces per meal) for an approximate total of 1,450 grams of fish per month (48.3 g/day). Most of the subjects (80%) ate the fish they caught.

The study found that there were significant differences in fishing behavior and consumption as a function of sex. Women had more children with them when fishing, and more women fished on foot along the Bay. The consumption by women included a significantly lower proportion of self-caught fish than men. Men ate significantly larger portions of fish per meal than did women, and men ate the whole fish more often. The study results showed that there were no sex differences with regard to the average number of fish caught or in fish size. Nearly 90% of the subjects believed the fish and crabs from Barnegat Bay were safe to eat, although approximately 40% of the subjects had heard warnings about their safety. The subjects generally did not have a clear understanding of the relationships between contaminants and fish size or trophic level. The researchers suggested that reducing the risk from contaminants does not necessarily involve a decrease in consumption rates but rather a change in the fish species and sizes consumed.

While the study provides some useful information on sex difference in fishing behavior and consumption, the study is limited in that the majority of the people surveyed were White males. There were low numbers for women and ethnic groups.

10.4.2.11. *Chiang (1998)—A Seafood Consumption Survey of the Laotian Community of West Contra Costa County, CA*

A survey of members of the Laotian community of West Contra Costa, CA, was conducted to obtain data on the fishing and fish consumption activities of this community. A questionnaire was developed and translated by the survey staff into the many ethnic languages spoken by the members of the Laotian community. The survey questions covered the following topics: demographics, fishing and fish consumption habits back home, current fishing and fish consumption habits, fish preparation methods, fish species commonly caught, fishing locations, and awareness of the health advisory for this area. A total of 229 people were surveyed.

Most respondents reported eating fish a few times per month, and the most common portion size was about 3 ounces. The mean amount of fish eaten per day was reported as 18.3 g/day, with a maximum of 182.3 g/day (see Table 10-64). "Fish consumers" were considered to be people who ate fish at least once a month, and this group made up 86.9% of the people surveyed. The mean fish consumption rate for this group ("fish consumers") averaged 21.4 g/day. Catfish was most often mentioned when respondents were asked to name the fish they caught, but striped bass was the species reported caught most often by respondents. Soups/stews were reported as the most common preparation method of fish (86.4%) followed by frying (78.4%), and baking (63.6%).

Of all survey respondents, 48.5% reported having heard of the health advisory about eating fish and shellfish from San Francisco Bay. Of those that had heard the advisory, 59.5% reported recalling its contents, and 60.3% said that it had influenced their fishing and fish consumption patterns.

Some sectors of the Laotian community were not included in the survey such as the Lue, Hmong, and Lahu groups. However, it was noted that the groups excluded from the survey do not differ greatly from the sample population in terms of seafood consumption and fishing practices. The study authors also indicated that participants may have under-reported fishing and fish consumption practices due to recent publicity about contamination of the Bay, fear of losing disability benefits, and fear that the survey was linked to law enforcement actions about fishing from the Bay. Another limitation of the study involved the use of a 3-ounce fish fillet model to estimate portion size of fish consumed. The use of this small model may have biased respondents to choose a smaller portion size than what they actually eat. In addition, the study authors noted that the fillet model may not have been appropriate for estimating fish portions eaten by those respondents who eat "family style" meals.

10.4.2.12. *San Francisco Estuary Institute (SFEI) (2000)—Technical Report: San Francisco Bay Seafood Consumption Report*

A comprehensive study of 1,331 anglers was conducted by the California Department of Health Services between July 1998 and June 1999 at various recreational fishing locations in the San Francisco Bay area (SFEI, 2000). The catching and consumption of 13 finned fish species and 3 shellfish species were investigated to determine the number of meals eaten from recreational and other sources such as restaurants and grocery stores. The method of fish preparation, including the parts of the fish eaten, was also documented. Information was gathered on the amount of fish consumed per meal, as well as respondents' ethnicity, age, income level, education, and the mode of fishing (e.g., pier, boat, and beach). Questions were also asked to ascertain the anglers' knowledge and response to local fish advisories. Respondents were asked to recall their fishing/consumption experiences within the previous 4 weeks. Anglers were not asked about the consumption habits of other members of their families.

About 15% of the anglers reported that they do not eat San Francisco Bay fish (whether self-caught or commercial). Of those who did consume Bay fish, 80% consumed about 1 fish meal per month or less; 10% ate about 2 fish meals per month; and 10% ate more than 2 fish meals per month, which is above the advisory level for fish. (The advisory level was 16 grams per day, or about two 8-ounce meals per 4 weeks.) Two-thirds of those consuming fish at levels above the advisory limit consumed more than twice the advisory limit. Difference in income, education, or fishing mode did not markedly change anglers' likelihood of eating in excess of the advisory limit. African Americans and Filipino anglers reported higher consumption levels than Caucasians (see Table 10-65). The overall mean consumption rate was 23 g/day.

More than 50% of the finfish caught by anglers were striped bass, and about 25% were halibut. Approximately 15% of the anglers caught each of the following fish: jacksmelt, sturgeon, and white croaker. All other species were caught by less than 10% of the anglers. For white croaker fish consumption: (1) lower income anglers consumed statistically more fish than mid- and upper-level income anglers, (2) anglers who did not have a high school education consumed more than those anglers with higher education levels, and (3) anglers of Asian descent consumed significantly more than anglers of other ethnic backgrounds. Asian anglers were more likely to eat fish skin, cooking juices, and raw fish than other anglers. These portions of the fish are believed to be more likely to contain higher levels of contamination. Likewise, skin consumption was higher for lower income and shore-based anglers. Anglers who had eaten Bay fish in the previous 4 weeks indicated, in general, that they were likely to have eaten 1 fish meal from another source in the same time period.

More than 60% of the anglers interviewed reported having knowledge of the health advisories. Of that 60%, only about one-third reported changing their fish-consumption behavior.

A limitation of this study is that the sample size for ethnic groups was very small. Data are also specific to the San Francisco Bay area and may not be representative of anglers in other locations.

10.4.2.13. *Burger (2002a)—Consumption Patterns and Why People Eat Fish*

Burger (2002a) evaluated fishing behavior and consumption patterns among 267 anglers who were interviewed at locations around Newark Bay and the New York-New Jersey Harbor estuary in 1999.

Among the 267 study respondents, 13% were Asian, 21% were Hispanic, 23% were Black, and 43% were White. Survey participants provided demographic information as well as information on their fish and crab consumption, knowledge of fishing advisories, and reasons for angling. Individual monthly fish consumption was estimated by multiplying the reported number of fish meals eaten per month by an average portion size, based on comparisons to a three-dimensional model of an 8-ounce fish fillet. Individual monthly crab consumption was estimated by multiplying the reported number of crabs eaten per month by the edible portion of crab, which was assumed to weigh 70 grams. Yearly fish and crab consumption was estimated by multiplying the monthly consumption rates by the number of months in a year over which the survey respondents reported eating self-caught fish or crabs. Intake rates were provided separately for those who fished only (44%), for those who crabbed only (44%), and for respondents who reported both fishing and crabbing (12%) (Burger, 2002a). Burger (2002a) also reported that more than 30% of the respondents reported that they did not eat the fish or crabs that they caught. Table 10-66 provides the average daily intake rates of fish and crab. U.S. EPA calculated these average daily intake rates by dividing the yearly intake rates provided by Burger (2002a) by 365 days/year.

Burger (2002a) also evaluated potential differences in consumption based on age, income, and race/ethnicity. Consumption was found to be negatively correlated with mean income and positively correlated with age for fish, but not crabs. An evaluation of differences based on ethnicity indicated that Whites were the least likely to eat their catch than other groups; 49% of Whites, 40% of Hispanics, 24% of Asians, and 22% of Blacks reported that they did not eat the fish or crabs that they caught. Among all ethnicities most people indicated that they fished (63%) or crabbed (68%) for recreational purposes, and very few (4%) reported that they angled to obtain food.

The advantages of this study are that it provides information for both fish and crab intake, and that it provides data on intake over a longer period of time than many of the other studies summarized in this chapter. However, the data are for individuals living in the Newark Bay area and may not be representative of the U.S. population as a whole. Also, there may be uncertainties in long-term intake estimates that are based on recall.

10.4.2.14. *Mayfield et al. (2007)—Survey of Fish Consumption Patterns of King County (Washington) Recreational Anglers*

Mayfield et al. (2007) conducted a series of fish consumption surveys among recreational anglers at marine and freshwater sites in King County, WA. The marine surveys were conducted between 1997 and 2002 at public parks and boat launches throughout Elliot Bay and the Duwamish River, and at North King County marine locations. The numbers of individuals interviewed at these three locations were 807, 152, and 228, respectively. The majority of participants were male, 15 years and older, and were either Caucasian or Asian and Pacific Islander. Data were collected on fishing location preferences, fishing frequency, consumption amounts, species preferences, cooking methods, and whether family members would also consume the catch. Respondent demographic data were also collected. Consumption rates were estimated using information on fishing frequency, weight of the catch, a cleaning factor, and the number of individuals consuming the catch. Mean recreational marine fish and shellfish consumption rates were 53 g/day and 25 g/day, respectively (see Table 10-67). Mayfield et al. (2007) also reported differences in intake according to ethnicity. Mean marine fish intake rates were 73, 60, 50, 43, and 35 g/day for Native American, Caucasian, Asian and Pacific Islander, African American, and Hispanic/Latino respondents, respectively.

The advantages of this study are that it provides additional perspective on recreational marine fish intake. However, the data are limited to a specific area of the United States and may not be representative of anglers in other locations.

10.5. FRESHWATER RECREATIONAL STUDIES

10.5.1. Fiore et al. (1989)—Sport Fish Consumption and Body Burden Levels of Chlorinated Hydrocarbons: A Study of Wisconsin Anglers

This survey, reported by Fiore et al. (1989), was conducted to assess socio-demographic factors and sport-fishing habits of anglers, to evaluate anglers' comprehension of and compliance with the Wisconsin Fish Consumption Advisory, to measure body burden levels of polychlorinated biphenyls (PCBs) and Dichlorodiphenyldichloroethylene (DDE) through analysis of blood serum samples, and to examine the relationship between body burden levels and consumption of sport-caught fish. The survey targeted all Wisconsin residents who had purchased fishing or sporting licenses in 1984 in any of 10 pre-selected study counties. These counties were chosen in part based on their proximity to water bodies identified in Wisconsin fish advisories. A total of 1,600 anglers were sent survey questionnaires during the summer of 1985.

The survey questionnaire included questions about fishing history, locations fished, species targeted, kilograms caught for consumption, overall fish consumption (including commercially caught), and knowledge of fish advisories. The recall period was 1 year.

A total of 801 surveys were returned (50% response rate). Of these, 601 (75%) were from males and 200 from females; the mean age was 37 years. Fiore et al. (1989) reported that the mean number of fish meals for 1984 for all respondents was 18 for sport-caught meals and 24 for non-sport-caught meals. Fiore et al. (1989) assumed that each fish meal consisted of 8 ounces (227 grams) of fish to generate means and percentiles of fish intake. The reported mean and 95th percentile intake rate of sport-caught fish for all respondents were 11.2 g/day and 37.3 g/day, respectively. Among consumers, who comprised 91% of all respondents, the mean sport-caught fish intake rate was 12.3 g/day, and the 95th percentile was 37.3 g/day. The mean daily fish intake from all sources (both sport-caught and commercial) was 26.1 g/day, with a 95th percentile of 63.4 g/day. The 95th percentile of 37.3 g/day of sport caught fish represents 60 fish meals per year; the 95th percentile of 63.4 g/day of total fish intake represents 102 fish meals per year.

U.S. EPA obtained the raw data from this study and calculated the distribution of the number of sport-caught fish meals and the distribution of fish intake rates using the same meal size (227 g/meal) used by Fiore et al. (1989). This meal size is higher than the mean meal size of 114 g/meal, but similar to the 90th percentile meal size for general population adults (age 20–39 years) reported in a study by Smiciklas-Wright et al. (2002). However, because data for the general population may underestimate meal size for anglers, use of an upper percentile general population value may reflect higher intake among anglers. This is supported by data from other studies in the literature that have shown that the average meal size for sport fishing populations is higher than those of the general population. For example, Balcom et al. (1999) reported an average meal size for sport-caught fish for the angler population of 7.3 ounces (i.e., 207 grams), while the average meal size for the general population was 5 ounces (142 grams). Other studies reported similar meal sizes for sport-caught fish. West et al. (1989) stated that the meal size most often reported in their survey was 8 ounces (i.e., 227 grams), and Connelly et al. (1996) estimated an average meal size of 216 grams. Another study reported an average meal size of 376 grams (Burger et al., 1999). Therefore, the meal size used by Fiore et al. (1989) was deemed reasonable to represent a mean value for the population of sport anglers. Table 10-68 presents distributions of fish consumption using a meal size of 227 grams.

This study is limited in its ability to accurately estimate intake rates because of the absence of data on weight of fish consumed. Another limitation of this study is that the results are based on 1-year recall, which may tend to over-estimate the number of fishing trips (Ebert et al., 1993). In addition, the response rate was rather low (50%).

10.5.2. West et al. (1989)—Michigan Sport Anglers Fish Consumption Survey

The Michigan Sport Anglers Fish Consumption Survey (West et al., 1989) surveyed a stratified random sample of Michigan residents with fishing licenses. The sample was divided into 18 cohorts, with one cohort receiving a mail questionnaire each week between January and May 1989. The survey included both a short-term recall component, and a usual frequency component. For the short-term recall component, respondents were asked to identify all household members and list all fish meals consumed by each household member during the past 7 days. Information on the source of the fish for each meal was also requested (self-caught, gift, market, or restaurant). Respondents were asked to categorize serving size by comparison with pictures of 8-ounce fish portions; serving sizes could be designated as either “about the same size,” “less,” or “more” than the size pictured. Data on fish species, locations of self-caught fish, and methods of preparation and cooking were also obtained.

The usual frequency component of the survey asked about the frequency of fish meals during each of the four seasons and requested respondents give the overall percentage of household fish meals that came from recreational sources. A sample of 2,600 individuals was selected from state records to receive survey questionnaires. A total of 2,334 survey questionnaires were deliverable, and 1,104 were completed and returned, giving a response rate of 47.3%.

In the analysis of the survey data by West et al. (1989), the authors did not attempt to generate the distribution of recreationally caught fish intake in the survey population. U.S. EPA obtained the raw data of this survey for the purpose of generating fish intake distributions and other specialized analyses.

As described elsewhere in this handbook, percentiles of the distribution of average daily intake reflective of long-term consumption patterns cannot, in general, be estimated using short-term (e.g., 1 week) data. Such data can be used to adequately estimate mean average daily intake rates (reflective of short- or long-term consumption); in addition, short-term data can serve to validate estimates of usual intake based on longer recall.

U.S. EPA first analyzed the short-term data with the intent of estimating mean fish intake rates. In order to compare these results with those based on usual intake, only respondents with information on both short-term and usual intake were included in this analysis. For the analysis of the short-term data, U.S. EPA modified the serving size weights used by West et al. (1989), which were 5, 8, and 10-ounces, respectively, for portions that were less, about the same, and more than the 8-ounce picture. U.S. EPA examined the percentiles of the distribution of fish meal sizes reported in Pao et al. (1982) derived from the 1977–1978 USDA National Food Consumption Survey and observed that a lognormal distribution provided a good visual fit to the percentile data. Using this lognormal distribution, the mean values for serving sizes greater than 8 ounces and for serving sizes at least 10% greater than 8 ounces were determined. In both cases, a serving size of 12 ounces was consistent with the Pao et al. (1982) distribution. The weights used in the U.S. EPA analysis then were 5, 8, and 12 ounces for fish meals described as less, about the same, and more than the 8-ounces picture, respectively. The mean serving size from Pao et al. (1982) was about 5 ounces, well below the value of 8 ounces most commonly reported by respondents in the West et al. (1989) survey.

Table 10-69 displays the mean number of total and recreational fish meals for each household member based on the 7-day recall data. Also shown are mean fish intake rates derived by applying the weights described above to each fish meal. Intake was calculated on both g/day and g/kg body weight-day bases. This analysis was restricted to individuals who eat fish and who reside in households reporting some recreational fish consumption during the previous year. About 75% of survey respondents (i.e., licensed anglers) and about 84% of respondents who fished in the prior year reported some household recreational fish consumption.

The U.S. EPA analysis next attempted to use the short-term data to validate the usual intake data. West et al. (1989) asked the main respondent in each household to provide estimates of their usual frequency of fishing and eating fish, by season, during the previous year. The survey provides a series of frequency categories for each season, and the respondent was asked to check the appropriate range. The ranges used for all questions were almost daily, 2–4 times a week, once a week, 2–3 times a month, once a month, less often, none, and don't know. For quantitative analysis of the data, it is necessary to convert this categorical information into numerical frequency values. As some of the ranges are relatively broad, the choice of conversion values can have some effect on intake estimates. In order to obtain optimal values, the usual fish eating frequency reported by respondents for the season during which the questionnaire was completed was compared to the number of fish meals reportedly consumed by respondents over the 7-day short-term recall period.

The results of these comparisons are displayed in Table 10-70; it shows that, on average, there is general agreement between estimates made using 1-year recall and estimates based on 7-day recall. The average number of meals (1.96/week) was at the bottom of the range for the most frequent consumption group with data (2–4 meals/week). In contrast, for the lower usual frequency categories, the average number of meals was at the top, or exceeded the top of category range. This suggests some tendency for relatively infrequent fish eaters to underestimate their usual frequency of fish consumption. The last column of the table shows the estimated fish eating frequency per week that was selected for use in making quantitative estimates of usual fish intake. These values were guided by the values in the second column, except that frequency values that were inconsistent with the ranges provided to respondents in the survey were avoided.

Using the four seasonal fish-eating frequencies provided by respondents and the above conversions for reported intake frequency, U.S. EPA estimated the average number of fish meals per week for each respondent. This estimate, as well as the analysis above, pertains to the total number of fish meals eaten (in Michigan) regardless of the source of the fish. Respondents were not asked to provide a seasonal breakdown for eating frequency of recreationally caught fish; rather, they provided an overall estimate for the past year of the percent of fish they ate that was obtained from different sources. U.S. EPA estimated the annual frequency of recreationally caught fish meals by multiplying the estimated total number of fish meals by the reported percent of fish meals obtained from recreational sources; recreational sources were defined as either self-caught or a gift from family or friends.

The usual intake component of the survey did not include questions about the usual portion size for fish meals. In order to estimate usual fish intake, a portion size of 8 ounces was applied (the majority of respondents reported this meal size in the 7-day recall data). Individual body-weight data were used to estimate intake on a g/kg-day basis. Table 10-71 displays the fish intake distribution estimated by U.S. EPA.

The distribution shown in Table 10-71 is based on respondents who consumed recreational caught fish. As mentioned above, these represent 75% of all respondents and 84% of respondents who reported having fished in the prior year. Among this latter population, the mean recreational fish intake rate is 14.4 × 0.84 = 12.1 g/day; the value of 38.7 g/day (95^{th} percentile among consumers) corresponds to the 95.8^{th} percentile of the fish intake distribution in this (fishing) population.

The advantages of this data set and analysis are that the survey was relatively large and contained both short-term and usual intake data. The presence of short-term data allowed validation of the usual intake data, which were based on long-term recall; thus, some of the problems associated with surveys relying on long-term recall are mitigated here.

The response rate of this survey, 47%, was relatively low. In addition, the usual fish intake distribution generated here employed a constant fish meal size, 8 ounces. Although use of this value as an average meal size was validated by the short-term recall results, the use of a constant meal size, even if correct on average, may seriously reduce the variation in the estimated fish intake distribution.

This study was conducted in the winter and spring months of 1988. This period does not include the summer months, when peak fishing activity can be anticipated, leading to the possibility that intake results based on the 7-day recall data may understate individuals' usual (annual average) fish consumption. A second survey by West et al. (1993) gathered diary data on fish intake for respondents spaced over a full year. However, this later survey did not include questions about usual fish intake and has not been re-analyzed here. The mean recreational fish intake rates derived from the short-term and usual components were quite similar, however, 14.0 versus 14.4 g/day.

10.5.3. Chemrisk (1992)—Consumption of Freshwater Fish by Maine Anglers

Chemrisk conducted a study to characterize the rates of freshwater fish consumption among Maine residents (Chemrisk, 1992; Ebert et al., 1993). Because the only dietary source of local freshwater fish is recreational fish, the anglers in Maine were chosen as the survey population. The survey was designed to gather information on the consumption of fish caught by anglers from flowing (rivers and streams) and standing (lakes and ponds) water bodies. Respondents were asked to recall the frequency of fishing trips during the 1989–1990 ice-fishing season, and the 1990 open water season, the number of fish species caught during both seasons, and to estimate the number of fish consumed from 15 fish species. The respondents were also asked to describe the number, species, and average length of each sport-caught fish consumed that had been gifts from other members of their households or other households. The weight of fish consumed by anglers was calculated by first multiplying the estimated weight of the fish by the edible fraction and then dividing this product by the number of intended consumers. Species-specific regression equations were utilized to estimate weight from the reported fish length. The edible fractions used were 0.4 for salmon, 0.78 for Atlantic smelt, and 0.3 for all other species (Ebert et al., 1993).

A total of 2,500 prospective survey participants were randomly selected from a list of anglers licensed in Maine. The surveys were mailed in during October 1990. Because this was before the end of the open fishing season, respondents were also asked to predict how many more open water fishing trips they would undertake in 1990.

Chemrisk (1992) and Ebert et al. (1993) calculated distributions of freshwater fish intake for two populations, "all anglers" and "consuming anglers." All anglers were defined as licensed anglers who fished during either the 1989–1990 ice-fishing season or the 1990 open-water season (consumers and non-consumers) and licensed anglers who did not fish but consumed freshwater fish caught in Maine during these seasons. "Consuming anglers" were defined as those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season. In addition, the distribution of fish intake from rivers and streams was also calculated for two populations, those fishing on rivers and streams ("river anglers"), and those consuming fish from rivers and streams ("consuming river anglers").

A total of 1,612 surveys were returned, giving a response rate of 64%; 1,369 (85%) of the 1,612 respondents were included in the "all angler" population, and 1,053 (65%) were included in the "consuming angler" population. Table 10-72 presents freshwater fish intake distributions. The mean and 95^{th} percentile were 5.0 g/day and 21.0 g/day, respectively, for "all anglers," and 6.4 g/day and

26.0 g/day, respectively, for "consuming anglers." Table 10-72 also presents intake distributions for fish caught from rivers and streams. Among "river anglers," the mean and 95th percentile were 1.9 g/day and 6.2 g/day, respectively, while among "consuming river anglers," the mean and the 95th percentile were 3.7 g/day and 12.0 g/day, respectively. Table 10-73 presents fish intake distributions by ethnic group for consuming anglers. The highest mean intake rates reported are for Native Americans (10 g/day) and French Canadians (7.4 g/day). Because there was a low number of respondents for Hispanics, Asian/Pacific Islanders, and African Americans, intake rates within these groups were not calculated (Chemrisk, 1992).

Table 10-74 presents the consumption, by species, of freshwater fish caught. The largest species consumption was salmon from ice fishing (~292,000 grams); white perch (380,000 grams) for lakes and ponds; and Brook trout (420,000 grams) for rivers and streams (Chemrisk, 1992).

U.S. EPA obtained the raw data tapes from the marine anglers survey and performed some specialized analyses. One analysis involved examining the percentiles of the "resource utilization distribution" (this distribution was defined in Section 10.1). The 50th, or more generally, the p^{th} percentile of the resource utilization distribution, is defined as the consumption level such that *p* percent of the resource is consumed by individuals with consumptions below this level and 100–*p* percent by individuals with consumptions above this level. U.S. EPA found that 90% of recreational fish consumption was by individuals with intake rates above 3.1 g/day, and 50% was by individuals with intakes above 20 g/day. Those above 3.1 g/day make up about 30% of the "all angler" population, and those above 20 g/day make up about 5% of this population; thus, the top 5% of the angler population consumed 50% of the recreational fish catch.

U.S. EPA also performed an analysis of fish consumption among anglers and their families. This analysis was possible because the survey included questions on the number, sex, and age of each individual in the household and whether the individual consumed recreationally caught fish. The total population of licensed anglers in this survey and their household members was 4,872; the average household size for the 1,612 anglers in the survey was thus 3.0 persons. Fifty-six percent of the population was male, and 30% was 18 or under.

A total of 55% of this population was reported to consume freshwater recreationally caught fish in the year of the survey. The sex and ethnic distribution of the consumers was similar to that of the overall population. The distribution of fish intake among the overall household population, or among consumers in the household, can be calculated under the assumption that recreationally caught fish was shared equally among all members of the household reporting consumption of such fish (note this assumption was used above to calculate intake rates for anglers). With this assumption, the mean intake rate among consumers was 5.9 g/day, with a median of 1.8 g/day, and a 95th percentile of 23.1 g/day; for the overall population, the mean was 3.2 g/day and the 95th percentile was 14.1 g/day.

The results of this survey can be put into the context of the overall Maine population. The 1,612 anglers surveyed represent about 0.7% of the estimated 225,000 licensed anglers in Maine. It is reasonable to assume that licensed anglers and their families will have the highest exposure to recreationally caught freshwater fish. Thus, to estimate the number of persons in Maine with recreationally caught freshwater fish intake above, for instance, 6.5 g/day (the 80th percentile among household consumers in this survey), one can assume that virtually all persons came from the population of licensed anglers and their families. The number of persons above 6.5 g/day in the household survey population is calculated by taking 20% (i.e., 100–80%) of the consuming population in the survey; this number then is $0.2 \times (0.55 \times 4{,}872) = 536$. Dividing this number by the sampling fraction of 0.007 (0.7%), gives about 77,000 persons above 6.5 g/day of recreational freshwater fish consumption statewide. The 1990 census showed the population of Maine to be 1.2 million people; thus, the 77,000 persons above 6.5 g/day represent about 6% of the state's population.

Chemrisk (1992) reported that the fish consumption estimates were based upon the following assumptions: a 40% estimate as the edible portion of landlocked and Atlantic salmon; inclusion of the intended number of future fishing trips and an assumption that the average success and consumption rates for the individual angler during the trips already taken would continue through future trips. The data collected for this study were based on recall and self-reporting, which may have resulted in a biased estimate. The social desirability of the sport and frequency of fishing are also bias-contributing factors; successful anglers are among the highest consumers of freshwater fish (Chemrisk, 1992). Additionally, fish advisories are in place in these areas and may affect the rate of fish consumption among anglers. The survey results showed that in 1990, 23% of all anglers consumed no freshwater fish, and 55% of the river anglers ate no freshwater fish. An advantage of this study is that the sample size is rather large.

10.5.4. Connelly et al. (1992)—Effects of Health Advisory and Advisory Changes on Fishing Habits and Fish Consumption in New York Sport Fisheries

Connelly et al. (1992) conducted a study to assess the awareness and knowledge of New York anglers about fishing advisories and contaminants found in fish and their fishing and fish consuming behaviors. The survey sample consisted of 2,000 anglers with New York State fishing licenses for the year beginning October 1, 1990, through September 30, 1991. A questionnaire was mailed to the survey sample in January 1992. The questionnaire was designed to measure catch and consumption of fish, as well as methods of fish preparation and knowledge of and attitudes towards health advisories (Connelly et al., 1992). The survey-adjusted response rate was 52.8% (1,030 questionnaires were completed, and 51 were not deliverable).

The average and median number of fishing days per year were 27 and 15 days, respectively (Connelly et al., 1992). The mean number of sport-caught fish meals was 11 meals/year. The maximum number of meals consumed was 757 meals/year. About 25% of anglers reported that they did not consume sport-caught fish.

Connelly et al. (1992) found that 80% of anglers statewide did not eat listed species or ate them within advisory limits and followed the 1 sport-caught fish meal per week recommended maximum. The other 20% of anglers exceeded the advisory recommendations in some way; 15% ate listed species above the limit, and 5% ate more than one sport-caught meal per week.

Connelly et al. (1992) found that respondents eating more than 1 sport-caught meal per week were just as likely as those eating less than one meal per week to know the recommended level of sport-caught fish consumption, although less than 1/3 in each group knew the level. An estimated 85% of anglers were aware of the health advisory. Over 50% of respondents said that they made changes in their fishing or fish consumption behaviors in response to health advisories.

The advisory included a section on methods that can be used to reduce contaminant exposure. Respondents were asked what methods they used for fish cleaning and cooking.

A limitation of this study with respect to estimating fish intake rates is that only the number of sport-caught meals was ascertained, not the weight of fish consumed. The fish meal data can be converted to a mean intake rate (g/day) by assuming a meal size of 227 g/meal (i.e., 8 ounces). This value corresponds to the adult general population 90th percentile meal size derived from Smiciklas-Wright et al. (2002). The resulting mean intake rate among the angler population would be 6.8 g/day. However, about 25% of this population reported no sport-caught fish consumption. Therefore, the mean consumption rate among consuming anglers would be 27.4 g/day (i.e., 6.8 g/day divided by 0.25).

The major focus of this study was not on consumption, per se, but on the knowledge of and impact of fish health advisories; Connelly et al. (1992) provides important information on these issues.

10.5.5. Hudson River Sloop Clearwater, Inc. (1993)—Hudson River Angler Survey

Hudson River Sloop Clearwater, Inc. (1993) conducted a survey of adherence to fish consumption health advisories among Hudson River anglers. All fishing has been banned on the upper Hudson River where high levels of PCB contamination are well documented; while voluntary recreational fish consumption advisories have been issued for areas south of the Troy Dam (Hudson River Sloop Clearwater, Inc., 1993).

The survey consisted of direct interviews with 336 shore-based anglers between the months of June and November 1991, and April and July 1992. Table 10-75 presents socio-demographic characteristics of the respondents. The survey sites were selected based on observations of use by anglers, and legal accessibility. The selected sites included upper-, mid-, and lower- Hudson River sites located in both rural and urban settings. The interviews were conducted on weekends and weekdays during morning, midday, and evening periods. The anglers were asked specific questions concerning: fishing and fish consumption habits; perceptions of presence of contaminants in fish; perceptions of risks associated with consumption of recreationally caught fish; and awareness of, attitude toward, and response to fish consumption advisories or fishing bans.

Approximately 92% of the survey respondents were male. The following statistics were provided by Hudson River Sloop Clearwater, Inc. (1993). The most common reason given for fishing was for recreation or enjoyment. Over 58% of those surveyed indicated that they eat their catch. Of those anglers who eat their catch, 48% reported being aware of advisories. Approximately 24% of those who said they currently do not eat their catch have done so in the past. Anglers were more likely to eat their catch from the lower Hudson areas where health advisories, rather than fishing bans, have been issued. Approximately 94% of Hispanic Americans were likely to eat their catch, while 77% of African Americans and 47% of Caucasian Americans intended to eat their catch. Of those who eat their catch, 87% were likely to share their meal with others (including women of childbearing age, and children under the age of 15).

For subsistence anglers, more low-income than upper-income anglers eat their catch (Hudson River Sloop Clearwater, Inc., 1993). Approximately 10% of the respondents stated that food was their primary reason for fishing; this group is more likely to be in the lowest per capita income group (Hudson River Sloop Clearwater, Inc., 1993).

The average frequency of fish consumption reported was just under 1 (0.9) meal over the previous week, and 3 meals over the previous month. Approximately 35% of all anglers who eat their catch exceeded the amounts recommended by the New York State health advisories. Less than half (48%) of all the anglers interviewed were aware of the State health advisories or fishing bans. Only 42% of those anglers aware of the advisories have changed their fishing habits as a result.

The advantages of this study include in-person interviews with 95% of all anglers approached; field-tested questions designed to minimize interviewer bias; and candid responses concerning consumption of fish from contaminated waters. The limitations of this study are that specific intake amounts are not indicated, and that only shore-based anglers were interviewed.

10.5.6. West et al. (1993)—Michigan Sport Anglers Fish Consumption Study, 1991–1992

West et al. (1993) conducted a survey financed by the Michigan Great Lakes Protection Fund, as a follow-up to the earlier 1989 Michigan survey described previously. The major purpose of 1991–1992 survey was to provide short-term recall data of recreational fish consumption over a full year period; the 1989 survey, in contrast, was conducted over only a half year period (West et al., 1993).

This survey was similar in design to the 1989 Michigan survey. A sample of 7,000 persons with Michigan fishing licenses was drawn, and surveys were mailed in 2-week cohorts over the period January 1991 to January 1992. Respondents were asked to report detailed fish consumption patterns during the preceding 7 days, as well as demographic information; they were also asked if they currently eat fish. Enclosed with the survey were pictures of about a half pound of fish. Respondents were asked to indicate whether reported consumption at each meal was more, less, or about the same as the picture. Based on responses to this question, respondents were assumed to have consumed ten, 5- or 8-ounce portions of fish, respectively.

A total of 2,681 surveys were returned. West et al. (1993) calculated a response rate for the survey of 46.8%; this was derived by removing from the sample those respondents who could not be located or who did not reside in Michigan for at least 6 months.

Of these 2,681 respondents, 2,475 (93%) reported that they currently eat fish; all subsequent analyses were restricted to the current fish eaters. The mean fish consumption rates were found to be 16.7 g/day for sport fish and 26.5 g/day for total fish (West et al., 1993). Table 10-76 shows mean sport-fish consumption rates by demographic categories. Rates were higher among minorities, people with low income, and people residing in smaller communities. Consumption rates in g/day were also higher in males than in females; however, this difference would likely disappear if rates were computed on a g/kg-day basis.

West et al. (1993) estimated the 80th percentile of the survey fish consumption distribution. More extensive percentile calculations were performed by U.S. EPA (1995) using the raw data from the West et al. (1993) survey. However, because this survey only measured fish consumption over a short (1 week) interval, the resulting distribution will not be indicative of the long-term fish consumption distribution, and the upper percentiles reported from the U.S. EPA analysis will likely considerably overestimate the corresponding long-term percentiles. The overall 95th percentile calculated by U.S. EPA (1995) was 77.9; this is about double the 95th percentile estimated using yearlong consumption data from the 1989 Michigan survey.

The limitations of this survey are the relatively low response rate and the fact that only three categories were used to assign fish portion size. The main study strengths were its relatively large size and its reliance on short-term recall.

10.5.7. Alabama Dept. of Environmental Management (ADEM) (1994)—Estimation of Daily Per Capita Freshwater Fish Consumption of Alabama Anglers

The Alabama Department of Environmental Management (1994) conducted a fish consumption survey of sport-fishing Alabama anglers during the time period from August 1992 to August 1993. The target population included all anglers who were Alabama residents. The survey design consisted of personal interviews given to sport fishermen at the end of their fishing trips at 23 sampling sites. Each sampling site was surveyed once during each season (summer, fall, winter, and spring). The survey was conducted for 2 consecutive days, either a Friday and Saturday or a Sunday and Monday. This approach minimized single-day-type bias and maximized surveying the largest number of anglers because a large amount of fishing occurs on weekends. Anglers were asked about consumption of fish caught at the sampling site as well as consumption of fish caught from other lakes and rivers in Alabama.

A total of 1,586 anglers were interviewed during the entire study period, of which, 83% reported eating fish they caught from the sampling sites (1,313 anglers). The number of anglers interviewed during each season was as follows: 488 during the summer, 363 during the fall, 224 during the winter, and 511 during the spring. Fish consumption rates were estimated using two methods: the 4-ounce Serving Method and the Harvest Method. The 4-ounce Serving Method estimated consumption based on a typical 4-ounce serving size. The Harvest Method used the actual harvest of fish and dressing method reported. All of the 1,313 anglers were used in the mean estimates of daily consumption based on the 4-ounce Serving Method, while only 563 anglers were utilized in the calculations of mean estimates of daily consumption, based on the Harvest Method.

Table 10-77 shows the results of the survey. Adults consumed an annual average of 32.6 g/day using the Harvest Method, calculated from study sites, and an annual average of 43.1 g/day using the Harvest Method, calculated from study sites plus other Alabama lakes and rivers. The survey also showed that adults consumed an annual average of 30.3 g/day using the 4-ounce Serving Method, calculated from study sites, and an annual average of 45.8 g/day using the 4-ounce Serving Method, calculated from study sites plus other Alabama lakes and rivers. When the entire sample was pooled, and a mean was taken over all respondents for the 4-ounce Serving Method, the average annual consumption was 44.8 g/day.

The study also examined fish consumption in conjunction with socio-demographic factors. It was noted that fish consumption tended to increase with age. Anglers below the age of 20 years were not well represented in this study. However, based on estimates of consumption rates using the 4-ounce Serving Method, the study found that anglers between 20 and 30 years of age consumed an average of 16 g/day, anglers between 30 and 50 years old consumed 39 g/day, and anglers over 50 years old consumed 76 g/day. Trends also emerged when ethnic groups and income levels were examined together. Using the 4-ounce Serving Method, estimates of fish consumption for Blacks dropped from 60 g/day for poverty-level families to 15 g/day for upper-income families. For Whites, fish consumption rates dropped slightly from 41 g/day for poverty-level families to 35 g/day for upper-income families. Similar trends were observed with the Harvest Method estimates. Averaging the results from the two estimation methods, there was a tendency for upper-income White anglers to eat roughly 30% less fish than poverty-level White anglers, while upper-income Black anglers ate about 80% less fish as poverty-level Black anglers. The analysis of seasonal intake showed that the highest consumption rates were consistently found to occur in the summer (see Table 10-77). It was also found the lowest fish consumption rate occurred in the spring.

The advantages of this study are that it compares estimates of intake using two different methods and provides some perspective on seasonal differences in intake. Data are not provided for children, and the number of observations for some race/ethnic groups is very small.

10.5.8. Connelly et al. (1996)—Sportfish Consumption Patterns of Lake Ontario Anglers and the Relationship to Health Advisories, 1992

The objectives of the Connelly et al. (1996) study were to provide accurate estimates of fish consumption (overall and sport caught) among Lake Ontario anglers and to evaluate the effect of Lake Ontario health advisory recommendations (Connelly et al., 1996). To target Lake Ontario anglers, a sample of 2,500 names was randomly drawn from 1990–1991 New York fishing license records for licenses purchased in six counties bordering Lake Ontario. Participation in the study was solicited by mail with potential participants encouraged to enroll in the study even if they fished infrequently or consumed little or no sport-caught fish. The survey design involved three survey techniques including a mail questionnaire asking for 12-month recall of 1991 fishing trips and fish consumption, self-recording information in a diary for 1992 fishing trips and fish consumption, periodic telephone interviews to gather information recorded in the diary, and a final telephone interview to determine awareness of health advisories (Connelly et al., 1996).

Participants were instructed to record in the diary the species of fish eaten, meal size, method by which fish was acquired (sport-caught or other), fish preparation and cooking techniques used, and the number of household members eating the meal. Fish meals were defined as finfish only. Meal size was estimated by participants by comparing their meal size to pictures of 8-ounce fish steaks and fillets on dinner plates. An 8-ounce size was assumed unless participants noted their meal size was smaller than 8 ounces, in which case, a 4-ounce size was assumed, or they noted it was larger than 8 ounces, in which case, a 12-ounce size was assumed. Participants were also asked to record information on fishing trips to Lake Ontario and species and length of any fish caught.

From the initial sample of 2,500 license buyers, 1,993 (80%) were reachable by phone or mail, and 1,410 of these were eligible for the study, in that they intended to fish Lake Ontario in 1992. A total of 1,202 of these 1,410, or 85%, agreed to participate in the study. Of the 1,202 participants, 853 either returned the diary or provided diary information by telephone. Due to changes in health advisories for Lake Ontario, which resulted in less Lake Ontario fishing in 1992, only 43%, or 366 of these 853 persons indicated that they fished Lake Ontario during 1992. The study analyses summarized below concerning fish consumption and Lake Ontario fishing participation are based on these 366 persons.

Anglers who fished Lake Ontario reported an average of 30.3 (standard error = 2.3) fish meals per person from all sources in 1992; of these meals, 28% were sport caught (Connelly et al., 1996). Less than 1% ate no fish for the year, and 16% ate no sport-caught fish. The mean fish intake rate from all sources was 17.9 g/day, and from sport-caught sources was 4.9 g/day. Table 10-78 gives the distribution of fish intake rates from all sources and from sport-caught fish. The median rates were 14.1 g/day for all sources and 2.2 g/day for sport caught; the 95th percentiles were 42.3 g/day and 17.9 g/day for all sources and sport caught, respectively. As seen in Table 10-79, statistically significant differences in intake rates were seen across age and residence groups, with residents of large cities and younger people having lower intake rates, on average.

The main advantage of this study is the diary format. This format provides more accurate information on fishing participation and fish consumption, than studies based on 1-year recall (Ebert et al., 1993). However, a considerable portion of diary respondents participated in the study for only a portion of the year, and some errors may have been generated in extrapolating these respondents' results to the entire year (Connelly et al., 1996). In addition, the response rate for this study was relatively low—853 of 1,410 eligible respondents, or 60%—which may have engendered some non-response bias.

The presence of health advisories should be taken into account when evaluating the intake rates observed in this study. Nearly all respondents (>95%) were aware of the Lake Ontario health advisory. This advisory counseled to eat none of nine fish species from Lake Ontario and to eat no more than one meal per month of another four species. In addition, New York State issues a general advisory to eat no more than 52 sport-caught fish meals per year. Among participants who fished Lake Ontario in 1992, 32% said they would eat more fish if health advisories did not exist. A significant fraction of respondents did not totally adhere to the fish advisory; however, 36% of respondents, and 72% of respondents reporting Lake Ontario fish consumption, ate at least one species of fish over the advisory limit. Interestingly, 90% of those violating the advisory reported that they believed they were eating within advisory limits.

10.5.9. Balcom et al. (1999)—Quantification of Seafood Consumption Rates for Connecticut

Balcom et al. (1999) conducted a seafood consumption study in Connecticut, utilizing a food frequency questionnaire along with portion size models. Follow-up telephone calls were made to encourage participation 7–10 days after mailing the questionnaires to improve response rates. Information requested in the survey included frequency of fish consumption, types of fish/seafood eaten, portion size, parts eaten, and the source of the fish/seafood eaten. A diary was also given to the sample populations to record fish and seafood consumption over a 10-day period, and to document where the fish/seafood was obtained and how it was prepared.

The sample population size for this study was 2,354 individuals (1,048 households). The study authors divided this overall population into various population groups including the general population (460 individuals/216 households), commercial fishing population (178 individuals/73 households), sport fishing and cultural/subsistence fishing population (514 individuals/348 households), minority population (860 individuals/245 households), Southeast Asian (329 individuals/89 households), non-Southeast Asian (531 individuals/156 households), limited income population (937 individuals/276 households), women of childbearing age population (493 individuals/420 households), and children population (559 individuals/305 households).

It is important to note that the nine population groups used in this study are not mutually exclusive. Many individuals were included in more than one population. For this reason, the authors did not attempt to make any statistical comparisons between the population groups.

The survey showed that over 33% of the respondents ate 1–2 meals of fish or seafood per week, including 39% of the general population, 35% of the sport fishing population, 38% of the commercial and minority populations, and 39% of the limited income population. A total of 36% of the Southeast Asian population consumed 2–3 meals per week with 2.1% consuming 5 or more meals per week, while 43% of non-Southeast Asians consumed 1–2 meals of seafood per week. The general population consumed, on average, 4.2 ounces of fish per meal of purchased fish and 5.0 ounces per meal of caught fish. Individuals in the sport fishing population showed a marked difference, consuming 4.7 ounces per meal of bought fish and 7.3 ounces per meal of caught fish. Southeast Asians consumed smaller portions of fish per meal, and children consumed the smallest portions of fish per meal.

On average, the general population consumed 27.7 g/day of fish and seafood while the sport fishing population consumed 51.1 g/day (see Table 10-80). The consumption of sport fish among consuming anglers can be estimated by dividing the consumption for all respondents by the percentage of consuming anglers reported by Balcom et al. (1999) of 97% to yield 52.7 g/day. The commercial fishing population had an average consumption rate of 47.4 g/day, while the limited income population's rate was 43.1 g/day. The overall minority population consumption rate was 50.3 g/day, with Southeast Asians consuming an average of 59.2 g/day (the highest overall rate) and non-Southeast Asians consuming an average of 45.0 g/day. Child-bearing age women consumed an average of 45.0 g/day, and children consumed an average of 18.3 g/day.

The study also examined fish preparations and cooking practices for each population group. It was found that the sport fishing population was most likely to perform risk-reducing preparation methods compared to the other populations, while the minority population was least likely to use the same risk-reducing methods. Cooking information by specie was only available for the Southeast Asian population, but the most common cooking methods were boiling, poaching-boiling-steaming, sauté/stir fry, and deep frying.

The authors noted that there were some limitations to this study. First, there was some association among household members in terms of the tendency to eat fish and seafood, but there was no dependence between households. Second, the study had a very low percent return rate for the general population mail survey, and it is questionable whether or not the responses accurately reflect the total population's behavior. In addition, the proportion of intake that can be attributed to freshwater fish is not known.

10.5.10. Burger et al. (1999)—Factors in Exposure Assessment: Ethnic and Socioeconomic Differences in Fishing and Consumption of Fish Caught along the Savannah River

Burger et al. (1999) examined the differences in fishing rates and fish consumption of people fishing along the Savannah River as a function of age, education, ethnicity, employment history, and income. A total of 258 people who were fishing on the Savannah River were interviewed. The interviews were conducted both on land and by boat from April to November 1997. Anglers were asked about fishing behavior, consumption patterns, cooking patterns, knowledge of warnings and safety of fish, and personal demographics. The authors used multiple regression procedures to examine the relative contribution of ethnicity, income, age, and education to parameters such as years fished, serving size, meals/month, and total ounces of fish consumed per year.

Eighty-nine percent of people interviewed were men, 70% were White, 28% were African American, and 2% were of other ethnicity not specified in the study. The age of the interviewees ranged from 16 to 82 years (mean = 43 ± 1 years). The study authors reported that the average fish intake for all survey respondents was 1.46 kg of fish per month (48.7 g/day). Although most of the respondents were men, they indicated that their wives and children consumed fish as often as they did, and children began to eat fish at 3 to 5 years of age.

There were significant differences in fishing behavior and consumption as a function of ethnicity (see Table 10-81). African Americans fished more often, consumed fish more frequently, and ate larger portions of fish than did Whites. Given the higher level of consumption by African Americans compared to consumption by Whites, the study authors suggested that the potential for exposure is higher for African Americans than for Whites, although the risks depend on the levels of contaminants in the fish. Income and education also contributed to variations in fishing and consumption behavior. Anglers with low incomes (less than or equal to $20,000) ate fish more often that those with higher incomes. Anglers who had not graduated from high school consumed fish more frequently, ate more fish per month and per year, and deep fried fish more often than anglers with more education. At all levels of education, African Americans consumed more fish than Whites.

The authors acknowledged that there may have been sampling bias in the study because they only interviewed people who were fishing on the river and were, therefore, limited to those people they found. To reduce the bias, the authors conducted the survey at all times of the day, on all days of the week, and along different sections of the river. Another limitation noted by the study authors is that the survey asked questions about consumption of fish from two general sources: self-caught and bought. The study authors indicated that it would have been useful to distinguish between fish obtained directly from the wild by the anglers, their friends or family, and store-bought or restaurant fish.

10.5.11. Williams et al. (1999)—Consumption of Indiana Sport-Caught Fish: Mail Survey of Resident License Holders

In 1997, sport-caught fish consumption among licensed Indiana anglers was assessed using a mail survey (Williams et al., 1999). Anglers were asked about their consumption patterns during a 3-month recall, their fishing rates, species of fish consumed, awareness of advisory warnings, and associated behaviors.

Average meal size among respondents was 9.3 ounces per meal. Consumers indicated that, on average, they ate between 1 and 2 meals per month. The survey population was divided into active consumers (those who actively engage in consuming sport fish meals) and potential consumers (those who eat fish during other times of the year). The average consumption rate for active consumers was reported as 19.8 g/day. For both active and potential consumers, the rate was 16.4 g/day (see Table 10-82).

The statewide mail survey of licensed Indiana anglers did not specifically address lower-income and minority anglers. The respondents to the mail survey were predominately White (94.5%). The recall period for this survey extended from the summer through the end of fall and early winter. No information was collected on consumption during spring or winter. Another limitation of the study was that only sport-caught fish consumption was measured among anglers.

10.5.12. Burger (2000)—Sex Differences in Meal Patterns: Role of Self-Caught Fish and Wild Game in Meat and Fish Diets

Burger (2000) used the hypothesis that there are sex differences in consumption patterns of self-caught fish and wild game in a meat and fish diet. A total of 457 people were randomly selected and interviewed while attending the Palmetto Sportsmen’s Classic in Columbia, SC in March 1998. The mean age of the respondents was 40 years and ranged from 15 to 74. The questionnaire requested information on two different categories: socio-demographics and number of meals consumed that included several types of fish and wild game. The demographics section contained questions dealing with ethnicity, sex, age, location of residence, occupation, and income. The section on consumption of wild game and fish included specific questions about the number of meals eaten and the source (i.e., self-caught fish, store-bought fish, and restaurant fish).

The results of this study indicated that there were no sex differences in the percentage of people who ate commercial protein sources, but there were significant sex differences for the consumption of most wild-caught game and fish. A higher proportion of men (81.5%) ate wild-caught species than women (73.2%). There were also sex differences in mean monthly meals and mean serving sizes for wild-caught fish. Men ate more meals of wild-caught fish than woman, and men also ate larger portions than women. The mean number of wild-caught fish meals eaten per month was 2.24 for men and 1.52 for women. The mean serving size was 373 grams for men and 232 for women. The study authors also found that individuals who consumed a large number of fish meals per month consumed a higher percentage of wild-caught fish meals than individuals who consumed a small number of fish meals per month.

This study provides information on sex differences with regard to consumption of wild-caught fish. Information on the number of monthly meals and meal size is provided. However, the study did not distinguish between marine and freshwater fish. In addition, all subjects interviewed were White.

10.5.13. Williams et al. (2000)—An Examination of Fish Consumption by Indiana Recreational Anglers: An Onsite Survey

An on-site survey of Indiana anglers was conducted in the summer of 1998 (Williams et al., 2000). A total of 946 surveys were completed. Minority anglers accounted for 31.8% of those surveyed, with African American anglers accounting for the majority of this group (25.1% of all respondents). Respondents reporting household incomes below $25,000 comprised 30.9% of the respondents. Anglers were asked to report their Indiana sport-caught fish consumption frequency for a 3-month recall period. Using the meal frequency and portion size reported by the anglers, the amount of fish consumed was calculated into a daily amount called grams per day consumption. Consumption rates were weighted to correct for participation bias.

Consumption was reported as 27.2 g/day among minority consumers and 20.0 g/day among White consumers (see Table 10-83). Of the anglers surveyed, 75.4% of White active consumers reported being aware of the fish consumption advisory, while 70.0% of the minority consumers reported awareness. The study authors also examined angler consumption rate based on the level of awareness of Indiana fish consumption advisories reported by the anglers. The consumption rate for those consumers who were very aware of the advisory was 35.2 g/day. For those with a general awareness of the advisory, the consumption rate was 14.1 g/day, and for those who were not aware of the advisory, the consumption rate was 21.3 g/day. In terms of income, the study authors found that there was a significant difference in grams of Indiana sport-caught fish consumed per day. Anglers reporting a household income below $25,000 had an average consumption rate of 18.9 g/day. Anglers with incomes between $25,000 and $34,999 averaged 18.8 g/day, and anglers with incomes between $35,000 and $49,999 averaged 15.2 g/day. The highest income—those reporting an income $50,000 or above—consumed an average of 48.9 g/day.

The advantages of this study are that it was designed to determine the consumption rates of Indiana anglers, particularly those in minority and low-income groups, during a portion of the year. However, information was not collected for the period of September through January, so calculation of year-round consumption was not possible.

10.5.14. Benson et al. (2001)—Fish Consumption Survey: Minnesota and North Dakota

Benson et al. (2001) conducted a fish consumption survey among Minnesota and North Dakota residents. The target population included the general population, licensed anglers, and members of Native American tribes. The survey focused on obtaining the most recent year's fish intake from all sources, including locally caught fish. Survey questionnaires were mailed to potential respondent households. Groups of interest were selected and allotted a portion of the total number of surveys to be distributed to each group as follows: a group categorized as the general population and anglers received 37.5% of the surveys, and new mothers and Native Americans each received 12.5% of the total surveys distributed. The survey distribution was split 60/40 between Minnesota and North Dakota. For the entire survey population, a total of 1,565 surveys were returned completed (out of 7,835 that were mailed out), resulting in a total of 4,273 respondents. A target of 100 completed telephone interviews of non-respondents was set in order to characterize the non-respondent population. However, this target was not met.

The Minnesota survey showed median total fish and sport fish consumption rates for the general population (2,312 respondents) of 12.3 and 2.8 g/day, respectively (see Table 10-84). The total number of Minnesota Bois Forte Tribe respondents was 232, and median total fish and sport fish consumption rates in g/day were 9.3 and 2.8, respectively. For Minnesota residents with fishing licenses (2,020 respondents), median total fish and sport fish consumption rates in g/day were 13.2 and 3.9, respectively. For Minnesota respondents without fishing licenses, median total fish and sport fish consumption rates in g/day were 7.5 and 0, respectively. Table 10-84 also shows median intake rates for purchased fish, upper percentile intake rates for total fish, sport fish and purchased fish for various age groups.

The North Dakota survey showed median total fish and sport fish consumption rates for the general population (1,406 respondents) of 12.6 and 3.0 g/day, respectively (see Table 10-84). The total number of North Dakota Spirit Lake Nation and Three Affiliated Tribes respondents was 105, and the median total fish and sport fish consumption rates in g/day were 1.4 and 0, respectively. For North Dakota residents with fishing licenses (1,101 respondents), median total fish and sport fish consumption rates in g/day were 14.0 and 4.5, respectively. For North Dakota respondents without fishing licenses, median total fish and sport fish consumption rates in g/day were

7.2 and 0, respectively. Table 10-84 also shows median intake rates for purchased fish, upper percentile intake rates for total fish, sport fish and purchased fish for various age groups.

Westat (2006) analyzed the raw data from Benson et al. (2001) to derive fish consumption rates for various age, sex, and ethnic groups, and according to the source of fish consumed (i.e., bought or caught) and habitat (i.e., freshwater, estuarine, or marine). Westat (2006) calculated consumption rates of freshwater fish for consuming anglers. For Minnesota and North Dakota, these values are identical to the consumption rates estimated by Westat (2006) for consuming anglers of all self-caught fish (i.e., freshwater and saltwater). From this observation, it can be concluded that all the consumption of self-caught fish comes from freshwater. The mean and 95th percentile consumption rate for consuming anglers of freshwater fish reported by Westat (2006) are 14 g/day and 37 g/day, respectively, for Minnesota and 12 g/day and 43 g/day, respectively, for North Dakota.

The authors noted that 80% of respondents in Minnesota and 72% of respondents in North Dakota lived in a household that included a licensed angler. They stated that this was a result of a direct intent to oversample the angling population in both states by sending 37.5% of surveys distributed to persons who purchased a fishing license in either Minnesota or North Dakota. The data were adjusted to incorporate overall licensed angler rates in both states (47.3% of households in Minnesota and 40.0% of households in North Dakota).

An advantage of this study is its large overall sample size. A limitation of the study is the low numbers of Native Americans surveyed; thus, the survey may not be representative of overall Native American populations in Minnesota. In addition, the study did not include Asian Immigrants, African Americans, African immigrants, or Latino populations, and was limited to two states. Therefore, the results may not be representative of the U.S. population as a whole.

10.5.15. Moya and Phillips (2001)—Analysis of Consumption of Home-Produced Foods

As discussed in Section 10.4.2.5, some data on fish consumption from households who fish are provided in Chapter 13 and in Moya and Phillips (2001). This information is based on an analysis of data from the household component of the USDA's 1987–1988 NFCS. This analysis shows a mean consumer-only fish consumption of 2.2 g/kg-day (all ages combined, see Table 13-20) for the fishing population. This value can be converted to a per capita value by multiplying by the number of consumers and dividing by the total number of positive responses to the survey question "do you fish?" Assuming an average body weight of 59 kg for the survey population results in an average national per capita self-caught fish consumption rate of 12 g/day among the population of individuals who fish. However, this mean intake rate represents intake of both freshwater and saltwater fish combined. Converting this number into the edible portion by multiplying by 0.5 as described in Section 10.4.2.5, the mean national per capita self-caught fish consumption rate is about 6 g/day.

The advantage of this study is that it provides a national perspective on the consumption of self-caught fish. A limitation of this study is that these values include both freshwater and saltwater fish. The proportion of freshwater to saltwater is unknown and will vary depending on geographical location. Intake data cannot be presented for various age groups due to sample size limitations. The unweighted number of households, who responded positively to the survey question "do you fish?" was also low (i.e., 220 households).

10.5.16. Campbell et al. (2002)—Fishing along the Clinch River Arm of Watts Bar Reservoir Adjacent to the Oak Ridge Reservation, Tennessee: Behavior, Knowledge, and Risk Perception

Campbell et al. (2002) examined consumption habits of anglers fishing along the Clinch River arm of Watts Bar Reservoir, adjacent to the U.S. Department of Energy's Oak Ridge Reservation in East Tennessee. A total of 202 anglers were interviewed on 65 sampling days, which included 48 weekdays and 17 weekend days. Eighty-six percent of fishermen interviewed were fishing from the shore, while 14% were fishing from a boat. The questionnaire utilized in the study included questions on demographics, fishing behavior, perceptions, cooking patterns, consumption patterns, and consumption warnings. Interviews were conducted by two people who were local to the area in order to promote participation in the study.

Out of all anglers interviewed, approximately 35% did not eat fish. Of the 65% who ate fish, only 38% ate fish from the study area. This 38% (77 people) was considered useful to the study and, thus, were the main focus of the data analysis. These anglers averaged 2 meals of fish per month, with an average consumption rate of 37 grams per day or 13.7 kilograms per year (see Table 10-85). They caught almost 90% of the fish they ate, had a mean age of 42 years, and a mean income of $28,800. The species of fish most often mentioned by anglers who caught and ate fish from the study area were crappie, striped bass, white bass, sauger, and catfish.

A limitation of this study is that the small size of the population does not allow for statistically significant analysis of the data.

10.5.17. Burger (2002b)—Daily Consumption of Wild Fish and Game: Exposure of High-End Recreationists

Burger (2002b) determined consumption patterns for a range of wild-caught fish and game in South Carolina. The population selected for dietary surveys were attendees at the Palmetto Sportsman's Classic in Columbia, South Carolina. Individual dietary surveys were conducted at the show in March, 1998, on 458 participants who were randomly selected from an attending population of approximately 60,000 people. Of the survey participants, 15% were Black, 85% were White, and 33% were women. The age composition was similar for black and white respondents; however, Black participants had significantly lower mean incomes than White participants.

The dietary survey took about 20 minutes to complete and was divided into three parts: a section on demographics; one on the number of meals consumed of different types of fish and meat for each of the past 12 months, and a section collecting information on serving size and cooking methods. The types of fish and meat inquired about included wild-caught fish, store-bought fish, restaurant fish, deer, wild-caught quail, restaurant quail, dove, duck, rabbit, squirrel, raccoon, wild turkey, beef, chicken, pork, and any wild game not listed in the questionnaire. Respondents were asked to provide information regarding serving/portion size and what percent of their meals they consumed as meat as opposed to stews. The average number of meals eaten as meat and stew were separately determined for each of the 12 months, then multiplied by the average serving size. Yearly consumption rates were then determined by summing across months for each type of fish or meat. Means and percentiles were computed using SAS.

Mean daily consumption of wild-caught fish ranged from 32.6 g/kg-day for respondents less than 32 years of age to 171.0 g/kg-day for Black respondents (see Table 10-86). The disparity in mean consumption was the greatest for ethnicity and income level, with black and low income respondents eating more than twice as much wild-caught fish as Whites or higher income respondents. Male fish consumption (mean of 55.2 g/kg-day) was higher than that of females (mean of 39.1 g/kg-day), while by age, fish consumption was highest among the 33−45 year olds (mean intake of 71.3 g/kg-day). The author suggested that although the high consumption of wild-caught fish for this age group may reflect a more active lifestyle, it may also reflect exposure of women of child-bearing age. As shown in Table 10−86, the differences between mean consumption rates and 99th percentile values were very large. For some population groups at the higher end of the distribution, fish consumption was ten times greater than that of the mean.

This study provides useful comparisons on wild-caught fish intake among populations with differing ethnicity, sex, age, and income level. Data on fish consumption at the higher end of the distribution were also provided. A limitation of the study includes the fact that the study was based on dietary recall which is less reliable over time and may have recall bias. In addition, although the methodology indicated that information was collected and/or calculated for serving/portion size, the percent of meals consumed as meat versus stews, and yearly consumption rates, no data were provided for these parameters in the study.

10.5.18. Mayfield et al. (2007)—Survey of Fish Consumption Patterns of King County (Washington) Recreational Anglers

Mayfield et al. (2007) conducted a series of fish consumption surveys among recreational anglers at marine and freshwater sites in King County, WA. The freshwater surveys were conducted between 2002 and 2003 at "freshwater locations around Lake Sammamish, Lake Washington, and Lake Union" (Mayfield et al., 2007). A total of 212 individuals were interviewed at these locations. The majority of participants were male, 18 years and older, and were either Caucasian or Asian and Pacific Islander. Data were collected on fishing location preferences, fishing frequency, consumption amounts, species preferences, cooking methods, and whether family members would also consume the catch. Respondent demographic data were also collected. Consumption rates were estimated using information on fish meal frequency and meal size. The mean recreational freshwater fish consumption rates were 10 g/day for all respondents and 7 g/day for the children of survey respondents (see Table 10-87). Mayfield et al. (2007) also reported differences in intake according to ethnicity. Mean freshwater fish intake rates were 40, 38, 20, 19, and 2 g/day for Native American, African

American, Asian and Pacific Islander, Caucasian, and Hispanic/Latino respondents, respectively.

The advantage of this study is that it provides additional perspective on recreational freshwater fish intake. However, the data are limited to a specific area of the United States and may not be representative of anglers in other locations.

10.6. NATIVE AMERICAN STUDIES

10.6.1. Wolfe and Walker (1987)—Subsistence Economies in Alaska: Productivity, Geography, and Development Impacts

Wolfe and Walker (1987) analyzed a data set from 98 communities for harvests of fish, land mammals, marine mammals, and other wild resources. The analysis was performed to evaluate the distribution and productivity of subsistence harvests in Alaska during the 1980s. Harvest levels were used as a measure of productivity. Wolfe and Walker (1987) defined harvest to represent a single year's production from a complete seasonal round. The harvest levels were derived primarily from a compilation of data from subsistence studies conducted between 1980 and 1985 by various researchers in the Alaska Department of Fish and Game, Division of Subsistence.

Of the 98 communities studied, four were large urban population centers, and 94 were small communities. The harvests for these latter 94 communities were documented through detailed retrospective interviews with harvesters from a sample of households (Wolfe and Walker, 1987). Harvesters were asked to estimate the quantities of a particular species that were harvested and used by members of that household during the previous 12-month period. Wolfe and Walker (1987) converted harvests to a common unit for comparison, pounds dressed weight per capita per year, by multiplying the harvests of households within each community by standard factors, converting total pounds to dressed weight, summing across households, and then dividing by the total number of household members in the household sample. Note average consumption by household member can be misleading because households include both children and adults whose intake rates may be very different. Dressed weight varied by species and community but, in general, was 70% to 75% of total fish weight; dressed weight for fish represents that portion brought into the kitchen for use (Wolfe and Walker, 1987).

Harvests for the four urban populations were developed from a statewide data set gathered by the Alaska Department of Fish and Game Divisions of Game and Sports Fish. Urban sport-fish harvest estimates were derived from a survey that was mailed to a randomly selected statewide sample of anglers (Wolfe and Walker, 1987). Sport-fish harvests were disaggregated by urban residency, and the data set was analyzed by converting the harvests into pounds and dividing by the 1983 urban population.

For the overall analysis, each of the 98 communities was treated as a single unit of analysis, and the entire group of communities was assumed to be a sample of all communities in Alaska (Wolfe and Walker, 1987). Each community was given equal weight, regardless of population size. Annual per capita harvests were calculated for each community. For the four urban centers, fish harvests ranged from 5 to 21 pounds per capita per year (6.2 g/day to 26.2 g/day).

The range for the 94 small communities was 25 to 1,239 pounds per capita per year (31 g/day to 1,541 g/day). For these 94 communities, the median per capita fish harvest was 130 pounds per year (162 g/day). In most (68%) of the 98 communities analyzed, resource harvests for fish were greater than the harvests of the other wildlife categories (land mammal, marine mammal, and other) combined.

The communities in this study were not made up entirely of Alaska Natives. For roughly half the communities, Alaska Natives comprised 80% or more of the population, but for about 40% of the communities, they comprised less than 50% of the population. Wolfe and Walker (1987) performed a regression analysis, which showed that the per capita harvest of a community tended to increase as a function of the percentage of Alaska Natives in the community. Although this analysis was done for total harvest (i.e., fish, land mammal, marine mammal, and others), the same result should hold for fish harvest because it is highly correlated with total harvest.

A limitation of this report is that it presents per capita harvest rates as opposed to individual intake rates. Wolfe and Walker (1987) compared the per capita harvest rates reported to the results for the household component of the 1977–1978 USDA NFCS. The NFCS showed that about 222 pounds of meat, fish, and poultry were purchased and brought into the household kitchen for each person each year in the western region of the United States. This contrasts with a median total resource harvest of 260 lbs/year in the 94 communities studied. This comparison, and the fact that Wolfe and Walker (1987) state that "harvests represent that portion brought into the kitchen for use," suggest that the same factors used to convert household consumption rates in the NFCS to individual intake rates can be used to convert per capita harvest rates to individual intake rates. In Section 10.3, a factor of 0.5 was used to convert fish consumption from household to individual intake rates. Applying this factor, the median per capita individual fish intake in the 94 communities would be 81 g/day and the range 15.5 to 770 g/day.

A limitation of this study is that the data were based on 1-year recall from a mailed survey. An advantage of the study is that it is one of the few studies that present fish harvest patterns for subsistence populations.

10.6.2. Columbia River Inter-Tribal Fish Commission (CRITFC) (1994)—A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin

The Columbia River Inter-Tribal Fish Commission (CRITFC) (1994) conducted a fish consumption survey among four Columbia River Basin Native American tribes during the fall and winter of 1991–1992. The target population included all adult tribal members who lived on or near the Yakama, Warm Springs, Umatilla, or Nez Perce reservations. The survey was based on a stratified random sampling design where respondents were selected from patient registration files at the Indian Health Service. Interviews were performed in person at a central location on the member's reservation.

The overall response rate was 69%, yielding a sample size of 513 tribal members, 18 years old and above. Of these, 58% were female, and 59% were under 40 years old. Each participating adult was asked if there were any children 5 years old or younger in his or her household. Those responding affirmatively were asked a set of survey questions about the fish consumption patterns of the youngest child in the household (CRITFC, 1994). Information for 204 children, 5 years old and younger, was provided by participating adult respondents. Consumption data were available for 194 of these children.

Participants were asked to describe and quantify all food and drink consumed during the previous day. They were then asked to identify the months in which they ate the most and the least fish, and the number of fish meals consumed per week during each of those periods and an average value for the whole year. The typical portion size (in ounces) was determined with the aid of food models provided by the questioner. The next set of questions identified specific species of fish and addressed the number of times per month each was eaten, as well as what parts (e.g., fillet, skin, head, eggs, bones, other) were eaten. Respondents were then asked to identify the frequency with which they used various preparation methods, expressed as a percentage. Respondents sharing a household with a child, aged 5 years or less, were asked to repeat the serving size, eating frequency, and species questions for the child's consumption behavior. All respondents were asked about the geographic origin of any fish they personally caught and consumed, and to identify the major sources of fish in their diet (e.g., self-caught, grocery store, tribe, etc.). Fish intake rates were calculated by multiplying the annual frequency of fish meals by the average serving size per fish meal.

The population sizes of the four tribes were highly unequal, ranging from 818 to 3,872 individuals (CRITFC, 1994). Nearly equal sample sizes were collected from each tribe. Weighting factors were applied to the pooled data (in proportion to tribal population size) so that the survey results would be representative of the overall population of the four tribes for adults only. Because the sample size for children was considered small, only an unweighted analysis was performed for this population. Based on a desired sample size of approximately 500 and an expected response rate of 70%, 744 individuals were selected at random from lists of eligible patients; the numbers from each tribe were approximately equal.

The results of the survey showed that adults consumed an average of 1.71 fish meals/week and had an average intake of 58.7 g/day (CRITFC, 1994). Table 10-88 shows the adult fish intake distribution; the median was between 29 and 32 g/day, and the 95th percentile about 170 g/day. A small percentage (7%) of respondents indicated that they were not fish consumers. Table 10-89 shows that mean intake was slightly higher in males than females (63 g/day versus 56 g/day) and was higher in the over 60 years age group (74.4 g/day) than in the 18–39 years (57.6 g/day) or 40–59 years (55.8 g/day) age groups. Intake also tended to be higher among those living on the reservation. The mean intake for nursing mothers—59.1 g/day—was similar to the overall mean intake. Intake rates were calculated for children for which both the number of fish meals per week and serving size information were available. Appendix 10B presents the weighted percentage of adults consuming specific fish parts.

A total of 49% of respondents of the total survey population reported that they caught fish from the Columbia River basin and its tributaries for personal use or for tribal ceremonies and distributions to other tribe members, and 88% reported that they obtained fish from either self-harvesting, family, or friends; at tribal ceremonies; or from tribal distributions. Of all fish consumed, 41% came from self- or family harvesting, 11% from the harvest of friends, 35% from tribal ceremonies or distribution, 9% from stores, and 4% from other sources (CRITFC, 1994).

Of the 204 children, the total number of respondents used in the analysis varied from 167 to 202, depending on the topic (amount and species consumed, fish meals consumed/week, age consumption began, serving size, consumption of fish parts) of the analysis. The unweighted mean for the age when children begin eating fish was 13.1 months of age (N = 167). The unweighted mean number of fish meals consumed per week by children was 1.2 meals per week (N = 195), and the unweighted mean serving size of fish for children aged 5 years old and less was 95 grams (i.e., 3.36 ounces) (N = 201). The unweighted percent of fish consumed by children by species was 82.7% for salmon, followed by 46.5% (N = 202) for trout.

The analysis of seasonal intake showed that May and June tended to be high-consumption months and December and January, low consumption months. The mean adult intake rate for May and June was 108 g/day, while the mean intake rate for December and January was 30.7 g/day. Salmon was the species eaten by the highest number of respondents (92%) followed by trout (70%), lamprey (54%), and smelt (52%). Table 10-90 gives the fish intake distribution for children under 5 years of age. The mean intake rate was 19.6 g/day, and the 95^{th} percentile was approximately 70 g/day. These mean intake rates include both consumers and non-consumers. These values are based on survey questions involving estimated behavior throughout the year, which survey participants answered in terms of meals per week or per month and typical serving size per meal. Table 10-91 presents consumption rates for children, who were reported to consume particular species of fish.

The authors noted that some non-response bias may have occurred in the survey because respondents were more likely to be female and live near the reservation than non-respondents. In addition, they hypothesized that non-consumers may have been more likely to be non-respondents than fish consumers because non-consumers may have thought their contribution to the survey would be meaningless. If such were the case, this study would overestimate the mean per capita intake rate. It was also noted that the timing of the survey, which was conducted during low fish consumption months, may have led to underestimation of actual fish consumption. The authors conjectured that an individual may have reported higher annual consumption if interviewed during a relatively high consumption month and lower annual consumption if interviewed during a relatively low consumption month. Finally, with respect to children's intake, it was observed that some of the respondents provided the same information for their children as for themselves; thereby, the reliability of some of these data is questioned (CRITFC, 1994). The combination of four different tribes' survey responses into a single pooled data set is somewhat problematic. The data presented are unweighted and, therefore, contain a bias toward the smaller tribes, who were oversampled compared to the larger tribes.

The limitations of this study, particularly with regard to the estimates of children's consumption, result in a high degree of uncertainty in the estimated rates of consumption. Although the authors have noted these limitations, this study does present information on fish consumption patterns and habits for a Native American population.

10.6.3. Peterson et al. (1994)—Fish Consumption Patterns and Blood Mercury Levels in Wisconsin Chippewa Indians

Peterson et al. (1994) investigated the extent of exposure to methylmercury by Chippewa Indians living on a Northern Wisconsin reservation who consume fish caught in Northern Wisconsin lakes. Chippewa have a reputation for high fish consumption (Peterson et al., 1994). The Chippewa Indians fish by the traditional method of spearfishing. Spearfishing (for walleye) occurs for about 2 weeks each spring after the ice breaks, and although only a small number of tribal members participate in it, the spearfishing harvest is distributed widely within the tribe by an informal distribution network of family and friends and through traditional tribal feasts (Peterson et al., 1994).

Potential survey participants, 465 adults, 18 years of age and older, were randomly selected from the tribal registries (Peterson et al., 1994). Participants were asked to complete a questionnaire describing their routine fish consumption and, more extensively, their fish consumption during the 2 previous months. The survey was carried out in May 1990. A follow-up survey was conducted for a random sample of 75 non-respondents (80% were reachable), and their demographic and fish consumption patterns were obtained. Peterson et al. (1994) reported that the non-respondents' socioeconomic information and fish consumption were similar to the respondents.

A total of 175 of the original random sample (38%) participated in the study. In addition, 152 non-randomly selected participants were surveyed and included in the data analysis; these participants were reported by Peterson et al. (1994) to have fish consumption rates similar to those of the randomly selected participants. Results from the survey showed that fish consumption varied seasonally, with 50% of the respondents reporting April and May (spearfishing season) as the highest fish consumption months (Peterson et al., 1994). Table 10-92 shows the number of fish meals consumed per week during the last 2 months (recent consumption) before the survey was conducted and during the respondents' peak consumption months grouped by sex, age, education, and employment level. During peak consumption months, males consumed more fish (1.9 meals per week) than females (1.5 meals per week), respondents under 35 years of age consumed more fish (1.8 meals per week) than respondents 35 years of age and over (1.6 meals per week), and the unemployed consumed more fish (1.9 meals per week) than the employed (1.6 meals per week). During the highest fish consumption season (April and May), 50% of respondents reported eating 1 or less fish meals per week, and only 2% reported daily fish consumption. A total of 72% of respondents reported Walleye consumption in the previous 2 months. Peterson et al. (1994) also reported that the mean number of fish meals usually consumed per week by the respondents was 1.2.

The mean fish consumption rate reported (1.2 fish meals per week, or 62.4 meals per year) in this survey was compared with the rate reported in a previous survey of Wisconsin anglers (Fiore et al., 1989) of 42 fish meals per year. These results indicate that the Chippewa Indians do not consume much more fish than the general Wisconsin angler population (Peterson et al., 1994). The differences in the two values may be attributed to differences in study methodology (Peterson et al., 1994). Note that this number (1.2 fish meals per week) includes fish from all sources. Peterson et al. (1994) noted that subsistence fishing, defined as fishing as a major food source, appears rare among the Chippewa. Using a meal size of 227 g/meal, the rate reported here of 1.2 fish meals per week translates into a mean fish intake rate of 39 g/day in this population. This meal size is similar to an adult general population 90th percentile meal size derived from Smiciklas-Wright et al. (2002) (see Section 10.8.2).

The advantages of this study are that it targeted a specific Native American population and provides some perspective on peak consumption and species of fish consumed. However, the data are more than 2 decades old and may not be entirely representative of current intake patterns.

10.6.4. Fitzgerald et al. (1995)—Fish PCB Concentrations and Consumption Patterns Among Mohawk Women at Akwesasne

Akwesasne is a Native American community of 10,000 plus persons located along the St. Lawrence River (Fitzgerald et al., 1995). Fitzgerald et al. (1995) conducted a recall study from 1986 to 1992 to determine the fish consumption patterns among nursing Mohawk women residing near three industrial sites. The study sample consisted of 97 Mohawk women living on the Akwesasne Reservation and 154 nursing Caucasian controls living in Warren and Schoharie counties, which are primary rural like the Akwesasne. The Mohawk mothers were significantly younger (mean age: 24.9) than the controls (mean age: 26.4) and had significantly more years of education (mean: 13.1 for Mohawks versus 12.4 for controls). A total of 97 out of 119 Mohawk nursing women responded, a response rate of 78%; 154 out of 287 control nursing Caucasian women responded, a response rate of 54%. Statistical analysis focused upon socio-demographic, physical, reproductive, lifestyle, and dietary and consumption differences between the Mohawk and control women.

Potential participants were identified prior to, or shortly after, delivery. The interviews were conducted at home within 1 month postpartum and were structured to collect information for socio-demographics, vital statistics, use of medications, occupational and residential histories, behavioral patterns (cigarette smoking and alcohol consumption), drinking water source, diet, and fish preparation methods (Fitzgerald et al., 1995). The dietary data collected were based on recall for food intake during the index pregnancy, the year before the pregnancy, and more than 1 year before the pregnancy.

The dietary assessment involved the report by each participant on the consumption of various foods with emphasis on local species of fish and game (Fitzgerald et al., 1995). This method combined food frequency and dietary histories to estimate usual intake. Food frequency was evaluated with a checklist of foods for indicating the amount of consumption of a participant per week, month, or year. Information gathered for the dietary history included duration of consumption, changes in the diet, and food preparation method.

Table 10-93 presents the number of local fish meals per year for both the Mohawk and control participants. The highest percentage of participants reported consuming between 1 and 9 local fish meals per year. Table 10-93 indicates that Mohawk respondents consumed statistically significantly more local fish than did control respondents during the two time periods prior to pregnancy; for the time period during pregnancy, there was no significant difference in fish consumption between the two groups. Table 10-94 presents the mean number of local fish meals consumed per year by time period for all respondents and for those ever consuming (consumers only). A total of 82 (85%) Mohawk mothers and 72 (47%) control mothers reported ever consuming local fish. The mean number of local fish meals consumed per year by Mohawk respondents declined over time, from 23.4 (over 1 year before pregnancy) to 9.2 (less than 1 year before pregnancy) to 3.9 (during pregnancy); a similar decline was seen among consuming Mohawks only. There was also a decreasing trend over time in consumption among controls, though it was much less pronounced.

Table 10-95 presents the mean number of fish meals consumed per year for all participants by time period and selected characteristics (age, education, cigarette smoking, and alcohol consumption). Pairwise contrasts indicated that control participants over 34 years of age had the highest fish consumption of local fish meals (22.1) (see Table 10-95). However, neither the overall nor pairwise differences by age among the Mohawk women over 34 years old were statistically significant, which may be due to the small sample size (N = 6) (Fitzgerald et al., 1995). The most common fish consumed by Mohawk mothers was yellow perch; for controls, the most common fish consumed was trout.

An advantage of this study is that it presents data for fish consumption patterns for Native Americans as compared to a demographically similar group of Caucasians. Although the data are based on nursing mothers as participants, the study also captures consumption patterns prior to pregnancy (up to 1 year before and more than 1 year before). Fitzgerald et al. (1995) noted that dietary recall for a period more than 1 year before pregnancy may be inaccurate, but these data were the best available measure of the more distant past. They also noted that the observed decrease in fish consumption among Mohawks from 1 year before pregnancy to the period of pregnancy is due to a secular trend of declining fish consumption over time in Mohawks. This decrease, which was more pronounced than that seen in controls, may be due to health advisories promulgated by tribal, as well as state, officials. The authors noted that this decreasing secular trend in Mohawks is consistent with a survey from 1979–1980 that found an overall mean of 40 fish meals per year among male and female Mohawk adults.

The data are presented as number of fish meals per year; the authors did not assign an average weight to fish meals. If assessors wanted to estimate the weight of fish consumed, some value of weight per fish meal would have to be assumed. Smiciklas-Wright et al. (2002) reported 209 grams as the 90th percentile weight of fish consumed per eating occasion for general population females 20–39 years old. Using this value, the rate reported of 27.6 fish meals per year for consumers only (over 1 year before pregnancy) translates into a mean fish intake rate of 15.8 g/day.

A limitation of this study is that information on meal size was not available. It is not known whether the 90th percentile meal size from the general population is representative of the population of Mohawk women.

10.6.5. Forti et al. (1995)—Health Risk Assessment for the Akwesasne Mohawk Population from Exposure to Chemical Contaminants in Fish and Wildlife

Forti et al. (1995) estimated the potential exposure of residents of the Mohawk Nation at Akwesasne to PCBs through the ingestion of locally caught fish and wildlife, and human milk. The study was part of a remedial investigation/feasibility study (RI/FS) for a National Priorities List site near Massena, NY and the St. Lawrence River. Forti et al. (1995) used data collected in 1979–1980 on the source (store bought or locally caught), species, and frequency of fish consumption among 1,092 adult Mohawk Native Americans. The information on frequency of fish consumption was combined with an assumed meal size of 227 grams to estimate intake among the adult population. This meal size represents the 90th percentile meal size for fish consumers in the U.S. population as reported by Pao et al. (1982). Children were assumed to eat fish at the same frequency as adults but were assumed to have a meal size of 93 grams.

Table 10-96 presents the mean and 95th percentile fish intake estimates for the Mohawk population, as reported by Forti et al. (1995). Mean intake of local fish was estimated to be 25 g/day for all adult fish consumers and 29 g/day for adult consumers only; 95th percentile rates for these groups were 131 and 135 g/day, respectively. Mean intake of local fish was estimated to be 10 g/day among all Mohawk children and 13 g/day among children consumers only; 95th percentile estimates for these groups were 54 and 58 g/day, respectively.

The advantage of this study is that it provides additional perspective on intake among Native

American populations, especially those in the St. Lawrence River area. However, the fish intake survey data used in this analysis were collected more than 3 decades ago and may not represent current intake patterns for this population. Also, the Forti et al. (1995) report provides limited details about the survey methodology and data used to estimate intake. It should also be noted that fish intake rates were estimated using a 90th percentile meal size. It is not known whether the 90th percentile meal size from the general population is representative of this population of Native Americans.

10.6.6. Toy et al. (1996)—A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region

Toy et al. (1996) conducted a study to determine fish and shellfish consumption rates of the Tulalip and Squaxin Island tribes living in the Puget Sound region. These two Indian tribes were selected on the basis of judgment that they would be representative of the expected range of fishing and fish consumption activities of the 14 tribes in the region. Commercial fishing is a major source of income for members of both tribes; some members of the Squaxin Island tribe also participate in commercial shellfishing. Both tribes participate in subsistence fishing and shellfishing.

A survey was conducted to describe fish consumption for Puget Sound tribal members over the age of 18 years, and their dependents, aged 5 years and under, in terms of their consumption rate of anadromous, pelagic, bottom fish, and shellfish in grams per kilogram of body weight per day. The survey focused on the frequency of fish and shellfish consumption (number of fish meals eaten per day, per week, per month, or per year) over a 1-year period, and the portion size of each meal. Data were also collected on fish parts consumed, preparation methods, patterns of acquisition for all fish and shellfish consumption (including seasonal variations in consumption), and children's consumption rates. Interviews were conducted between February 25 and May 15, 1994. A total of 190 tribal members, aged 18 years old and older, and 69 children between birth and 5 years old, were surveyed on consumption of 52 species. The response rate was 77% for the Squaxin Island tribe and 76% for the Tulalip tribes.

The appropriate sample size was calculated based on the enrolled population of each tribe and a desired confidence interval of ±20% from the mean, with an additional 25% added to the total to allow for non-response or unusable data. The target population, derived from lists of enrolled tribal members provided by the tribes, consisted of enrolled tribal members aged 18 years and older and children aged 5 years and younger living in the same household as an enrolled member. Only members living on or within 50 miles of the reservation were considered for the survey. Each eligible enrolled tribal member was assigned a number, and computer-generated random numbers were used to identify the survey participants. Children were not sampled directly but through adult members of their household; if one adult had more than one eligible child in his or her household, one of the children was selected at random. This indirect sampling method was necessitated by the available tribal records but may have introduced sampling bias to the process of selecting children for the study. A total of 190 adult tribal members (ages 18 years old and older) and 69 children between birth and 5 years old (i.e., 0 to <6 years) were surveyed about their consumption of 52 fish species in six categories: anadromous, pelagic, bottom, shellfish, canned tuna, and miscellaneous.

Respondents described their consumption behavior for the past year in terms of frequency of fish meals eaten per week or per month, including seasonal variations in consumption rates. Portion sizes (in ounces) were estimated with the aid of model portions provided by the questioner. Data were also collected on fish parts consumed, preparation methods, patterns of acquisition for all fish and shellfish consumption, and children's consumption rates.

The adult mean and median consumption rates for all forms of fish combined were 0.89 and 0.55 g/kg-day for the Tulalip tribes, and 0.89 and 0.52 g/kg-day for the Squaxin Island tribe, respectively (see Table 10-97). As shown in Table 10-98, consumption per body weight varied by sex (males consumed more as indicated by mean and median consumption). The median rates for the Tulalip Tribes were 53 g/day for males and 34 g/day for females, while the rates were 66 g/day for males and 25 g/day for females for the Squaxin Island tribe (see Table 10-99). Among adults, consumption generally followed a curvilinear pattern, with greater median consumption in the age range of 35 to 64 years old, and lower consumption in the age range of 18 to 34 years old and 65 years old and over (see Table 10-100). No consistent pattern of consumption by income was found for either tribe (see Table 10-101).

The mean and median consumption rates for children 5 years and younger for both tribes combined, were 0.53 and 0.17 g/kg-day, respectively. These values were significantly lower than those of adults, even when the consumption rate was adjusted for body weight (see Table 10-102). Squaxin Island children tended to consume more fish than Tulalip children (mean: 0.825 g/kg-day vs. 0.239 g/kg-day). The data were insufficient to allow re-analysis to fit the data to the standard U.S. EPA age categories used elsewhere in this handbook. A minority of consumers ate fish parts that are considered to have a higher concentration of toxins: skin, head, bones, eggs, and organs, and for the majority of consumers, fish were prepared (baking, boiling, broiling, roasting, and poaching) and eaten in a manner that tends to reduce intake of contaminants. Most anadromous fish and shellfish were obtained by harvesting in the Puget Sound area rather than by purchasing, though sources of harvesting varied between the tribes.

The advantage of this study is that the data can be used to improve how exposure assessments are conducted for populations that include high consumers of fish and shellfish and to identify cultural characteristics that may place tribal members at disproportionate risk to chemical contamination. One limitation associated with this study is that although data from the Tulalip and Squaxin Island tribes may be representative of consumption rates of these specific tribes, fish consumption rates, habits, and patterns can vary among tribes and other population groups. As a result, the consumption rates of these two tribes may not be useful as a surrogate for consumption rates of other Native American tribes. There might also be a possible bias due to the time the survey was conducted; many species in the survey are seasonal, and although the survey was designed to solicit annual consumption rates, respondents may have weighted their responses toward the interview period. For example, because of the timing of the survey, respondents may have overestimated their annual consumption of shellfish and underestimated their annual consumption of salmon. Furthermore, there were differences in consumption patterns between the two tribes included in this study; the study provided data for each tribe and for the pooled data from both tribes, but the latter may not be a statistically valid measure for tribes in the region.

10.6.7. Duncan (2000)—Fish Consumption Survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region

The Suquamish Tribal Council conducted a study of the Suquamish tribal members living on and near the Port Madison Indian Reservation in the Puget Sound region (Duncan, 2000). The study was funded by the Agency for Toxic Substances and Disease Registry (ATSDR) through a grant to the Washington State Department of Health. The purpose of the study was to determine seafood consumption rates, patterns, and habits of the members of the Suquamish Tribe. The second objective was to identify cultural practices and attributes that affect consumption rates, patterns, and habits of members of the Suquamish Tribe.

Adults, 16 years and older, were selected randomly from a Tribal enrollment roster. The study had a participation rate of 64.8%, which was calculated on the basis of 92 respondents out of a total of 142 potentially eligible adults on the list of those selected into the sample. Consumption data for children under 6 years of age were gathered through adult respondents who had children in this age group living in the household at the time of the survey. Data were collected for 31 children under 6 years old.

A survey questionnaire was administered by personal interview. The survey included four parts: (1) 24-hour dietary recall; (2) identification, portions, frequency of consumption, preparation, harvest location of fish; (3) shellfish consumption, preparation, harvest location; and (4) changes in consumption over time, cultural information, physical information, and socioeconomic information. A display booklet was used to assist respondents in providing consumption data and identifying harvest locations of seafood consumed. Physical models of finfish and shellfish were constructed to assist respondents in determining typical food portions. Finfish and shellfish were grouped into categories based on similarities in life history as well as practices of Tribal members who fish for subsistence, ceremonial, and commercial purposes.

Adult respondents reported a mean consumption rate of all finfish and all shellfish of 2.71 g/kg-day (see Table 10-103). Tables 10-104, 10-105, and 10-106 provide consumption rates for adults by species, sex, and age, respectively. For children under 6 years of age, the mean consumption rate of all finfish and shellfish was 1.48 g/kg-day (see Tables 10-107 and 10-108). The Suquamish Tribe's seafood consumption rates for adults and children under 6 years of age were higher than seafood consumption rates reported in studies conducted among the CRITFC, Tulalip Tribes, Squaxin Island Tribe, and the Asian Pacific Island population of King County (Duncan, 2000). This disparity illustrates the high degree of variability found between tribes even within a small geographic region (Puget Sound) and indicates that exposure and risk assessors should exercise care when imputing fish consumption rates to a population of interest using data from tribal studies.

An important attribute of this survey is that it provides consumption rates by individual type of fish and shellfish. It is important to note that the report indicates that increased levels of development as well as pollutants from residential, industrial, and commercial uses have resulted in degraded habitats and harvesting restrictions. Despite degraded water quality and habitat, tribal members continue to rely on fish and shellfish as a significant part of their diet. A limitation of this study is that the sample size for children was fairly small (31 children).

10.6.8. Westat (2006)—Fish Consumption in Connecticut, Florida, Minnesota, and North Dakota

As discussed in Section 10.3.2.7, Westat (2006) analyzed the raw data from three fish consumption studies to derive fish consumption rates for various age, sex, and ethnic groups, and according to the source of fish consumed (i.e., bought or caught) and habitat (i.e., freshwater, estuarine, or marine). The studies represented data from four states: Connecticut, Florida, Minnesota, and North Dakota. Consumption rates for individuals of Native American heritage were available for the states of Florida, Minnesota, and North Dakota. Fish intake distributions for these populations are presented in Table 10-41 for all respondents and 10-42 for consuming individuals. The mean and 95th percentile for all Native American respondents were 0.8 g/kg-day and 4.5 g/kg-day for Florida, respectively. The mean fish intake rate for all Native American respondents for Minnesota was 2.8 g/kg-day. The mean and 90th percentile fish intake rate for all Native American respondents for North Dakota were 0.4 g/kg-day and 0.9 g/kg-day, respectively. The mean and 95th percentile intake rate for Native American consumers only for Florida were 1.5 g/kg-day and 5.7 g/kg-day, respectively. The mean fish intake rate for Native American consumers only for Minnesota was 2.8 g/kg-day. The mean and 90th percentile fish intake rate for Native American consumers only for North Dakota were 0.4 g/kg-day and 0.8 g/kg-day, respectively (Westat, 2006).

A limitation of this study is that sample sizes for these populations were small. Intake rates represent consumption of fish from all sources. Also, the study did not specifically target Native Americans, and it is not known whether the Native Americans included in the survey lived on reservations.

10.6.9. Polissar et al. (2006)—A Fish Consumption Survey of the Tulalip and Squaxin Island Tribes of the Puget Sound Region—Consumption Rates for Fish-Consumers Only

Using fish consumption data from the Toy et al. (1996) survey of the Tulalip and Squaxin Island tribes of Puget Sound, Polissar et al. (2006) calculated consumption rates for various fish species groups, considering only the consumers of fish within each group. Weight-adjusted consumption rates were calculated by tribe, age, sex, and species groups. Species groups (anadromous, bottom, pelagic, and shellfish) were defined by life history and distribution in the water column. Data were available for 69 children, birth to <6 years of age; 18 of these children had no reported fish consumption and were excluded from the analysis. Thus, estimated fish consumption rates are based on data for 51 children; 15 from the Tulalip tribe and 36 from the Squaxin Island tribe. Both median and mean fish consumption rates for adults and children within each tribe were calculated in terms of grams per kilogram of body weight per day (g/kg-day). Anadromous fish and shellfish were the groups of fish most frequently consumed by both tribes and sexes. Consumption per body weight varied by sex (males consumed more) and age (those 35 to 64 years old consumed more than those younger and older). The consumption rates for groups of fish differed between the tribes. The distribution of consumption rates was skewed toward large values. In the Tulalip tribes, the estimated adult mean consumption rate for all forms of fish combined was 1.0 g/kg-day, and in the Squaxin Island tribe, the estimated mean rate was also 1.0 g/kg-day (see Table 10-109). Table 10-110 presents consumption rates for adults by species and sex. Tables 10-111 and 10-112 show consumption rates for adults by species and age for the Squaxin Island and Tulalip tribes, respectively. The mean consumption rate for the Tulalip children was 0.45 g/kg-day, and 2.9 g/kg-day for the Squaxin Island children (see Table 10-113). Table 10-114 presents consumption rates for children by species and sex.

Because this study used the data originally generated by Toy et al. (1996), the advantages and limitations associated with the Toy et al. (1996) study, as described in Section 10.6.6, also apply to this study. However, an advantage of this study is that the consumption rates are based only on individuals who consumed fish within the selected categories.

10.7. OTHER POPULATION STUDIES

10.7.1. U.S. EPA (1999)—Asian and Pacific Islander Seafood Consumption Study in King County, WA

This study was conducted to obtain seafood consumption rates, species, and seafood parts consumed, and cooking methods used by the Asian and Pacific Islander (API) community. Participants were seafood consumers who were first or second generation members of the API ethnic group, 18 years of age or older, and lived in King County, WA. APIs represent one of the most diverse and rapidly growing immigrant populations in the United States. In 1997, APIs (166,000) accounted for 10% of King County's population, an increase from 8% in 1990. Between 1990 and 1997, the total population of King Country increased by 9%, while the population of APIs increased by 43% (U.S. EPA, 1999).

This study was conducted in three phases. Phase I focused on identifying target ethnic groups and developing appropriate questionnaires in the language required for each ethnic group. Phase II focused on characterizing seafood consumption patterns for 10 API ethnic groups (Cambodian, Chinese, Filipino, Hmong, Japanese, Korean, Laotian, Mien, Samoan, and Vietnamese) within the study area. Phase III focused on developing culturally appropriate health messages on risks related to seafood consumption and disseminating this information for the API community. The majority of the 202 respondents (89%) were first generation (i.e., born outside the United States). There were slightly more women (53%) than men (47%), and 35% lived under the 1997 Federal Poverty Level (FPL).

In general, it was found that API members consumed seafood at a very high rate. As shown in Table 10-115, the mean overall consumption rate for all seafood combined was 1.9 g/kg body weight-day (g/kg-day), with a median consumption rate of 1.4 g/kg-day. The predominant seafood consumed was shellfish (46% of all seafood). The API community consumed more shellfish (average consumption rate of 0.87 g/kg-day) than all finfish combined (an average consumption rate of 0.82 g/kg-day). Within the category of finfish, pelagic fish were consumed most by the API members, mean consumption rate of 0.38 g/kg-day (median: 0.22 g/kg-day), followed by anadromous fish with a mean consumption rate of 0.20 g/kg-day (median: 0.09 g/kg-day). The mean consumption for freshwater fish was 0.11 g/kg-day (median: 0.04 g/kg-day), and bottom fish was 0.13 g/kg-day (median: 0.05 g/kg-day). Individuals in the lowest income level (under the FPL) consumed more seafood than those in higher income levels (1–2, 2–3, and >3 times the FPL), but the difference was not statistically significant.

In an effort to capture the participants consuming large quantities of seafood, the survey participants were classified as higher (N = 44) or lower (N = 158) consumers of shellfish or finfish based on their consumption rates being ≥75th (higher) or ≤75th (lower) percentile. Table 10-116 shows that people in the >55-years-old-category had the greatest percentage for high consumers of finfish; they had approximately the same percentage as other age groups for shellfish. The Japanese had a greater percentage (52%) for higher finfish consumers, and Vietnamese (50%) were in the higher shellfish consumer category.

Table 10-117 presents seafood consumption rates by ethnicity. In general, members of the Vietnamese and Japanese communities had the highest overall consumption rate, averaging 2.6 g/kg-day (median 2.4 g/kg-day) and 2.2 g/kg-day (median 1.8 g/kg day), respectively.

Table 10-118 presents consumption rates by sex. The mean consumption rate for all seafood for women was 1.8 g/kg-day (median: 1.4 g/kg-day) and 1.7 g/kg-day (median: 1.3 g/kg-day) for men.

Salmon and tuna were the most frequently consumed finfish. More than 75% of the respondents consumed shrimp, crab, and squid. Table 10-119 presents these data. For all survey participants, the head, bones, eggs, and other organs were consumed 20% of the time. Fillet without skin was consumed 45% of the time, and fillet with skin, 55% of the time. Consumption patterns of shellfish parts varied depending on the type of shellfish.

Preparation methods were also surveyed in the API community. The survey covered two categories of preparation methods: (1) baked, broiled, roasted, or poached and (2) canned, fried, raw, smoked, or dried. The respondents most frequently prepared their finfish and shellfish using the baked, boiled, broiled, roasted, or poached method, averaging 65% and 78%, respectively.

The benefit of this research is that it can be used to improve API-specific risk assessments. API community members consume greater amounts of seafood than the general population, and these consumption patterns may pose a health risk if the consumed seafood is contaminated with toxic chemicals. Because the survey was based on recall, the authors selected 20 respondents for a follow-up re-interview. Its purpose was to assess the reliability of the responses. The results of the re-interview suggest that, based on the difference in means between the original and re-interview responses, the estimated consumption rates from this study are reliable. One limitation associated with this study is that it is based on a relatively small number of respondents within each ethnic group. Caution should be used to avoid extrapolation of data to other ethnic groups that have potentially significant cultural differences. Further study of the consumption patterns and preparation methods for the Hmong, Laotian, Mien, and Vietnamese communities is also needed because of potential health risks from contaminated seafood.

10.7.2 Shilling et al. (2010)—Contaminated Fish Consumption in California's Central Valley Delta

Shilling et al. (2010) conducted a survey of 373 anglers and 137 community members between September 2005 and June 2008, in a region of the Sacramento-San Joaquin River Delta where subsistence fishing rates are high. This area was also chosen as an area where mercury concentrations in fish tissues were likely to be high. Anglers were selected for interviews as they were encountered in order to reduce bias, however, approximately 5% of the anglers approached did not speak English and were unable to be interviewed. Community members were chosen for interviews based on knowledge that an extended family member fished in this area. The interviews were conducted primarily in the early morning and late afternoon, and all days of the week were represented. Subjects were told at the beginning of the interview that the study was about fishing activity along the river, but not that it was related to fish contamination. Anglers and community members were grouped according to ethnicity, and fish consumption rates were calculated based on each individual's 30-day recall of how much and how often types of fish were eaten. Mean, median and 95th percentile fish consumption rates were calculated for study participants according to ethnicity, age, and sex. In addition, fish intake was determined for households containing women of child-bearing age, children, and for respondents whose awareness of warnings about fish contamination in the area ranged from no awareness to high awareness.

Regardless of ethnicity, the fish species that were primarily targeted by anglers in this study were striped bass, salmon, shad, and catfish, similar to those identified in creel survey data for this region from the California Department of Fish and Game. Consumption rates for locally caught and commercially obtained fish are shown in Table 10-120. Mean intake of locally caught fish among all ethnic groups ranged from 6.5 g/day for Native American anglers to 57.6 g/day for Southeast Asian/Lao anglers. For all anglers, the mean and median consumption rates of locally caught fish were 27.4 and 19.7 g/day, respectively. These values increased to 40.6 g/day (mean) and 26.1 g/day (median) when commercially obtained fish were included. The 95th percentile intake rates for all anglers were 126.6 g/day for local fish consumption and 147.3 g/day for total fish consumption. Fish consumption rates were not significantly different among age groups, but were higher for anglers from households with either children or women of child-bearing age.

No significant trend ($p = 0.78$) was observed across the 3-year study period for the consumption of locally caught fish. Peak consumption rates occurred during the fall, when striped bass and salmon return to the area to spawn and fishing activity is the highest. Fish consumption rates were significantly different for anglers and community members, with the exception of Southeast Asians. No significant difference was observed between the day of the week when surveying was conducted and ethnic group or fish consumption rates, or between anglers with higher or lower awareness of warnings about fish contamination in the area.

The advantages of this study are that the sample size was fairly large and that a number of ethnic groups were included. Limitations of the study include the fact that information on fish consumption was based on 30-day recall data and that the study was limited to one geographic area and may not be representative of the U.S. general population.

10.8. SERVING SIZE STUDIES

10.8.1. Pao et al. (1982)—Foods Commonly Eaten in the United States: Amount per Day and per Eating Occasion

Pao et al. (1982) used the 1977–1978 NFCS to examine the quantity of fish consumed per eating occasion. For each individual consuming fish in the 3-day survey period, the quantity of fish consumed per eating occasion was derived by dividing the total reported fish intake over the 3-day period by the number of occasions the individual reported eating fish. Table 10-121 displays the distributions, by age and sex, for the quantity of fish consumed per eating occasion (Pao et al., 1982). For the general population, the average quantity of fish consumed per fish meal was 117 grams, with a 95th percentile of 284 grams. Males in the age groups 19–34, 35–64, and 65–74 years had the highest average and 95th percentile quantities among the age-sex groups presented. It should be noted that the serving size data from this analysis has been superseded by the analysis of the 1994–1996 USDA CSFII data conducted by Smiciklas-Wright et al. (2002).

10.8.2. Smiciklas-Wright et al. (2002)—Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994–1996

Using data gathered in the 1994–1996 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of canned tuna and other finfish consumed per eating occasion by members of the U.S. population (i.e., serving sizes), over a 2-day period. The estimates of serving size are based on data obtained from 14,262 respondents, ages 2 years and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumers-only data).

Table 10-122 and Table 10-123 present serving size data for canned tuna and other finfish, respectively. These data are presented on an as-consumed basis (grams) and represent the quantity of fish consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. The average meal size for finfish (other than tuna) for adults 20 years and older was 114 g/meal (see Table 10-122). It should be noted that this value represents fish eaten in any form (e.g., as an ingredient in a meal) and not just fish eaten as a meal (e.g., fish fillet).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that because the recipes for the mixed foods consumed by respondents were not provided by the respondents, standard recipes were used. As a result, the estimates of the quantity of some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods.

10.9. OTHER FACTORS TO CONSIDER FOR FISH CONSUMPTION

Other factors to consider when using the available survey data include location, climate, season, and ethnicity of the angler or consumer population, as well as the parts of fish consumed and the methods of preparation. Some contaminants (for example, persistent, bioaccumulative, and toxic contaminants such as dioxins and polychlorinated biphenyls) have the affinity to accumulate more in certain tissues, such as the fatty tissue, as well as in certain internal organs. The effects of cooking methods for various food products on the levels of dioxin-like compounds have been addressed by evaluating a number of studies in U.S. EPA (2003). These studies showed various results for contamination losses based on the methodology of the study and the method of food preparation. Refer to U.S. EPA (2003) for a detailed review of these studies.

In addition, some studies suggest that there is a significant decrease of contaminants in cooked fish when compared with raw fish (San Diego County, 1990). Several studies cited in this section have addressed fish preparation methods and parts of fish consumed. Table 10-124 provides summary results from these studies on fish preparation methods; Appendix 10B presents further details on preparation methods, as well as results from some studies on parts of fish consumed.

Users of the data presented in this chapter should ensure that consistent units are used for intake rate and concentration of contaminants in fish. The following sections provide information on converting between wet weight and dry weight, and between wet weight and lipid weight.

10.9.1. Conversion between Wet and Dry Weight

The intake data presented in this chapter are reported in units of wet weight (i.e., as-consumed or uncooked weight of fish consumed per day or per eating occasion). However, data on the concentration of contaminants in fish may be reported in units of either wet or dry weight (e.g., milligram of contaminant per gram-dry-weight of fish). It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of fish, then the dry-weight units should be used for fish intake values).

If necessary, wet-weight (e.g., as-consumed) intake rates may be converted to dry-weight intake rates using the moisture content percentages presented in Table 10-125 and the following equation:

$$IR_{dw} = IR_{ww} \left[\frac{100 - W}{100} \right] \qquad \text{(Eqn. 10-4)}$$

where:

IR_{dw} = dry-weight intake rate,
IR_{ww} = wet-weight intake rate, and
W = percent water content.

Alternately, dry-weight residue levels in fish may be converted to wet-weight residue levels for use with wet-weight (e.g., as-consumed) intake rates, as follows:

$$C_{ww} = C_{dw} \left[\frac{100 - W}{100} \right] \qquad \text{(Eqn. 10-5)}$$

where:

C_{ww} = wet-weight concentration,
C_{dw} = dry-weight concentration, and
W = percent water content.

The moisture content data presented in Table 10-125 are for selected fish taken from USDA (2007). The moisture content is based on the percent of water present.

10.9.2. Conversion Between Wet-Weight and Lipid-Weight Intake Rates

In some cases, the residue levels of contaminants in fish are reported as the concentration of contaminant per gram of fat. This may be particularly true for lipophilic compounds. When using these residue levels, the assessor should ensure consistency in the exposure-assessment calculations by using consumption rates that are based on the amount of fat consumed for the fish product of interest.

The total fat content (percent) measured and/or calculated in various fish forms (i.e., raw, cooked, smoked, etc.) for selected fish species is presented in Table 10-125, based on data from USDA (2007). The total percent fat content is based on the sum of saturated, monounsaturated, and polyunsaturated fat.

If necessary, wet-weight (e.g., as-consumed) intake rates may be converted to lipid-weight intake rates using the fat content percentages presented in Table 10-125 and the following equation:

$$IR_{lw} = IR_{ww} \left[\frac{L}{100} \right] \qquad \text{(Eqn. 10-6)}$$

where:

IR_{lw} = lipid-weight intake rate,
IR_{ww} = wet-weight intake rate, and
L = percent lipid (fat) content.

Alternately, wet-weight residue levels in fish may be estimated by multiplying the levels based on fat by the fraction of fat per product as follows:

$$C_{ww} = C_{lw} \left[\frac{L}{100} \right] \qquad \text{(Eqn. 10-7)}$$

where:

C_{ww} = wet-weight concentration,
C_{lw} = lipid-weight concentration, and
L = percent lipid (fat) content.

The resulting residue levels may then be used in conjunction with wet-weight (e.g., as-consumed) consumption rates. The total fat content data presented in Table 10-125 are for selected fish taken from USDA (2007).

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Table 10-7. Per Capita Intake of Finfish (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	% Consuming	Mean	SE	Lower 95% CL	Upper 95%CL	Percentiles										
							Min	1st	5th	th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,783	23	0.16	0.01	0.14	0.18	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	2.3	13.4[b]
Age Group (years)									10								
0 to 1	865	2.6	0.03	0.01	0.01	0.06	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	1.5[b]	3.7[b]
1 to 2	1,052	14	0.22	0.05	0.12	0.32	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.5	1.2[b]	4.3[b]	13.4[b]
3 to 5	978	15	0.19	0.03	0.13	0.25	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.7	1.4	2.7[b]	7.0[b]
6 to 12	2,256	15	0.16	0.04	0.08	0.24	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.5	1.1	2.6[b]	6.7[b]
13 to 19	3,450	15	0.10	0.01	0.08	0.11	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.7	6.9[b]
20 to 49	4,289	23	0.15	0.01	0.13	0.17	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.2	8.5[b]
Females 13 to 49	4,103	22	0.14	0.01	0.11	0.16	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	1.8	8.5[b]
50+	3,893	29	0.20	0.02	0.16	0.23	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.7	1.2	2.4	6.1[b]
Race																	
Mexican American	4,450	16	0.15	0.02	0.11	0.18	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	2.6	8.5[b]
Non-Hispanic Black	4,265	24	0.18	0.02	0.15	0.22	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.1	2.4	8.8[b]
Non-Hispanic White	6,757	22	0.15	0.01	0.13	0.17	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.0	13.4[b]
Other Hispanic	562	22	0.18	0.03	0.11	0.24	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.7[b]	7.3[b]
Other [a]	749	33	0.31	0.05	0.20	0.42	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.2	1.1	2.0	4.0[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.
Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-8. Consumer-Only Intake of Finfish (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	Mean	SE	Lower 95%CL	Upper 95% CL	Min	Percentiles 1st	5th	th	25th	50th	75th	90th	95th	99th	Max
Whole Population	3,204	0.73	0.03	0.67	0.78	0.0*	0.0	0.0	0.0	0.2	0.5	1.0	1.6	2.2	4.0	13.4[b]
Age Group (years)								10								
0 to 1	22	1.31	0.31	0.68	1.94	0.1[b]	0.1[b]	0.2[b]	0.2[b]	0.4[b]	0.8[b]	2.0[b]	2.8[b]	2.9[b]	3.7[b]	3.7[b]
1 to 2	143	1.61	0.27	1.06	2.16	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.5[b]	0.8[b]	1.7[b]	3.6[b]	4.9[b]	13.4[b]	13.4[b]
3 to 5	156	1.28	0.13	1.01	1.55	0.0[b]	0.0[b]	0.0[b]	0.2[b]	0.5	1.0	1.7	2.7[b]	3.6[b]	5.6[b]	7.0[b]
6 to 12	333	1.05	0.12	0.81	1.29	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3	0.7	1.4	2.1[b]	2.9[b]	6.5[b]	6.7[b]
13 to 19	501	0.66	0.03	0.59	0.73	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	0.9	1.4	1.7	2.6[b]	6.9[b]
20 to 49	961	0.65	0.02	0.60	0.70	0.0[b]	0.0[b]	0.0	0.0	0.2	0.4	0.9	1.5	2.1	3.9[b]	8.5[b]
Females 13 to 49	793		0.04	0.54	0.69	0.0[b]	0.0	0.0	0.0	0.1	0.4	0.9	1.4	1.8	2.9	8.5[b]
50+	1,088	0.68	0.04	0.61	0.76	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	0.9	1.5	2.0	3.2[b]	6.1[b]
Race		0.62				0.0[b]										
Mexican American	584	0.93	0.04	0.84	1.03	0.0[b]	0.0[b]	0.0	0.0	0.3	0.7	1.3	1.9	2.8	4.7[b]	8.5[b]
Non-Hispanic Black	906	0.77	0.05	0.66	0.88	0.0[b]	0.0	0.0	0.1	0.2	0.5	1.0	1.7	2.1	4.9	8.8[b]
Non-Hispanic White	1,405	0.67	0.03	0.62	0.72	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	0.9	1.5	1.9	3.2[b]	13.4[b]
Other Hispanic	101	0.82	0.10	0.61	1.03	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3	0.5	1.0	2.0[b]	2.7[b]	4.9[b]	7.3[b]
Other [a]	208	0.96	0.14	0.68	1.23	0.0[b]	0.0[b]	0.0[b]	0.0	0.2	0.5	1.3	2.2	3.6[b]	5.3[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-9. Per Capita Intake of Shellfish (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	% Consuming	Mean	SE	Lower 95% CL	Upper 95% CL	Percentiles										
							Min	1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,783	11	0.06	0.01	0.05	0.07	0.0[b]	0.0 5	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.4	6.6[b]
Age Group (years)																	
0 to 1	865	0.66	0.00	0.00	0.00	0.01	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	0.0[b]	2.3[b]
1 to 2	1,052	4.4	0.04	0.01	0.02	0.06	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	1.0[b]	6.6[b]
3 to 5	978	4.6	0.05	0.01	0.02	0.08	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4[b]	4.0[b]
6 to 12	2,256	7.0	0.05	0.01	0.02	0.08	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.4[b]	4.9[b]
13 to 19	3,450	5.1	0.03	0.01	0.02	0.04	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.5[b]
20 to 49	4,289	13	0.08	0.01	0.06	0.10	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	1.9	5.4[b]
Females 13 to 49	4,103	11	0.06	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.3	5.3[b]
50+	3,893	13	0.05	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	1.0	5.2[b]
Race																	
Mexican American	4,450	9.5	0.08	0.01	0.05	0.11	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.8	6.6[b]
Non-Hispanic Black	4,265	12	0.06	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.1	4.9[b]
Non-Hispanic White	6,757	10	0.05	0.01	0.04	0.07	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	5.4[b]
Other Hispanic	562		0.09	0.02	0.05	0.14	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.4	0.7	2.1[b]	2.6[b]
Other[a]	749	20	0.13	0.02	0.10	0.17	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.4	0.9	2.6[b]	4.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

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N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max =Maximum value.
Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-10. Consumers-Only Intake of Shellfish (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	Mean	SE	Lower 95%CL	Upper 95% CL	Min	Percentiles 1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	1,563	0.57	0.03	0.50	0.63	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.7	1.3	1.9	3.0[b]	6.6[b]
Age Group (years)							5									
0 to 1	11	0.42	0.21	0.00	0.85	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.2[b]	0.2[b]	1.3[b]	2.3[b]	2.3[b]	2.3[b]
1 to 2	53	0.94	0.18	0.56	1.31	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.6[b]	1.0[b]	1.6[b]	3.5[b]	6.6[b]	6.6[b]
3 to 5	56	1.00	0.18	0.63	1.36	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.4[b]	0.7[b]	1.4[b]	2.9[b]	2.9[b]	4.0[b]	4.0[b]
6 to 12	158	0.72	0.12	0.47	0.97	0.0[b]	0.0[b]	0.1[b]	0.1[b]	0.2	0.5	1.1	1.7[b]	2.0[b]	4.5[b]	4.9[b]
13 to 19	245	0.61	0.06	0.49	0.74	0.0[b]	0.0[b]	0.0	0.0	0.1	0.4	0.9	1.5	1.9	2.7[b]	4.5[b]
20 to 49	605	0.63	0.06	0.52	0.75	0.0[b]	0.0[b]	0.0	0.0	0.1	0.4	0.8	1.8	2.2	4.3[b]	5.4[b]
Females 13 to 49	474		0.06	0.40	0.66	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.6	1.2	1.8	4.5[b]	5.3[b]
50+	435	0.41	0.02	0.36	0.46	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.5	0.9	1.2	1.8[b]	5.2[b]
Race		0.53														
Mexican American	331	0.83	0.10	0.62	1.04	0.0[b]	0.0[b]	0.0	0.1	0.2	0.5	1.1	1.9	2.8	4.3[b]	6.6[b]
Non-Hispanic Black	449	0.48	0.03	0.41	0.54	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.6	1.1	1.7	2.5[b]	4.9[b]
Non-Hispanic White	617	0.53	0.05	0.44	0.63	0.0[b]	0.0[b]	0.0	0.0	0.1	0.3	0.6	1.2	1.9	3.0[b]	5.4[b]
Other Hispanic	49		0.07	0.49	0.79	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3[b]	0.4	0.9[b]	1.3[b]	2.1[b]	2.6[b]	2.6[b]
Other [a]	117	0.67	0.06	0.55	0.80	0.0[b]	0.0[b]	0.1[b]	0.1[b]	0.2	0.4	0.9	1.4[b]	2.6[b]	2.6[b]	4.5[b]

[a] Other: Other Race - including Multiple Races. 0.64

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-11. Per Capita Intake of Total Finfish and Shellfish Combined (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	% Consuming	Mean	SE	Lower 95%CL	Upper 95% CL	Percentiles Min	1st	th	10th	25th	50th	75th	90th	95th	th	Max
Whole Population	16,783	29	0.22	0.014	0.20	0.25	0.0[b]	0.0 5	0.0	0.0	0.0	0.0	0.1	0.8	1.3 9	2.7	13.4[b]
Age Group (years)																	
0 to 1	865	3.1	0.04	0.01	0.02	0.06	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0[b]	1.5[b]	5.1[b]
1 to 2	1,052	17	0.26	0.06	0.15	0.38	0.0[b]	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.7	1.6[b]	4.7[b]	13.4[b]
3 to 5	978	18	0.24	0.03	0.17	0.31	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.9	1.6	3.4[b]	7.0[b]
6 to 12	2,256	22	0.21	0.05	0.12	0.31	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.8	1.4	2.7[b]	6.7[b]
13 to 19	3,450	18	0.13	0.01	0.10	0.15	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.7	6.9[b]
20 to 49	4,289	31	0.23	0.02	0.20	0.27	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.3	2.7	8.6[b]
Females 13 to 49	4,103	28	0.19	0.02	0.16	0.22	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.2	2.4	8.6[b]
50+	3,893	36	0.25	0.02	0.21	0.29	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.3	0.9	1.4	2.6	6.1[b]
Race																	
Mexican American	4,450	22	0.23	0.03	0.17	0.28	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.4	3.5	8.6[b]
Non-Hispanic Black	4,265	32	0.24	0.02	0.20	0.28	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.3	2.7	8.9[b]
Non-Hispanic White	6,757	28	0.20	0.01	0.17	0.23	0.0[b]	0.0	0.0	0.0	0.0	0.0	0.1	0.7	1.2	2.4	13.4[b]
Other Hispanic	562	32	0.27	0.05	0.17	0.37	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.2	0.9	1.7	3.1[b]	7.3[b]
Other [a]	749	43	0.45	0.06	0.32	0.58	0.0[b]	0.0[b]	0.0	0.0	0.0	0.0	0.4	1.5	2.5	4.1[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-12. Consumer-Only Intake of Total Finfish and Shellfish Combined (g/kg-day), Edible Portion, Uncooked Fish Weight

Population Group	N	Mean	SE	Lower 95%CL	Upper 95% CL	Min	Percentiles									
							1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	4,206	0.78	0.03	0.73	0.83	0.0[b]	0.0	0.0	0.1	0.2	0.5	1.1	1.8	2.4	4.2	13.4[b]
Age Group (years)						0.0[b]										
0 to 1	30	1.18	0.29	0.59	1.76	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.7[b]	1.6[b]	2.8[b]	2.9[b]	5.1[b]	5.1[b]
1 to 2	183	1.54	0.25	1.04	2.04	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.4[b]	0.8	1.7[b]	3.5[b]	5.9[b]	13.4[b]	13.4[b]
3 to 5	196	1.31	0.14	1.04	1.59	0.0[b]	0.0[b]	0.1[b]	0.2[b]	0.5	1.0	1.7	2.9[b]	3.6[b]	6.2[b]	7.0[b]
6 to 12	461	0.99	0.08	0.82	1.15	0.0[b]	0.0[b]	0.1[b]	0.1	0.3	0.7	1.4	2.0	2.7[b]	5.2[b]	6.7[b]
13 to 19	685	0.69	0.03	0.63	0.76	0.0[b]	0.0	0.0	0.0	0.2	0.5	1.0	1.5	1.8	3.0	6.9[b]
20 to 49	1,332	0.76	0.04	0.68	0.83	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	1.0	1.8	2.5	4.2[b]	8.6[b]
Females 13 to 49	1,109	0.68	0.04	0.60	0.76	0.0[b]	0.0	0.0	0.0	0.2	0.4	0.9	1.5	1.9	4.0	8.6[b]
50+	1,319	0.71	0.03	0.64	0.77	0.0[b]	0.0[b]	0.0	0.1	0.2	0.5	1.0	1.6	2.1	3.3[b]	6.1[b]
Race						0.0[b]										
Mexican American	831	1.01	0.06	0.88	1.14	0.0[b]	0.0[b]	0.0	0.1	0.3	0.8	1.3	2.1	3.2	5.6[b]	8.6[b]
Non-Hispanic Black	1,212	0.76	0.04	0.67	0.85	0.0[b]	0.0	0.0	0.1	0.2	0.5	1.0	1.8	2.2	4.9	8.9[b]
Non-Hispanic White	1,753	0.73	0.03	0.67	0.78	0.0[b]	0.0[b]	0.0	0.0	0.2	0.5	1.0	1.6	2.1	3.4[b]	13.4[b]
Other Hispanic	136	0.86	0.11	0.63	1.09	0.0[b]	0.0[b]	0.0[b]	0.1[b]	0.3	0.5	1.2	2.0[b]	2.6[b]	5.2[b]	7.3[b]
Other [a]	274	1.03	0.13	0.77	1.29	0.0[b]	0.0[b]	0.0[b]	0.1	0.2	0.6	1.4	2.5	2.9[b]	6.1[b]	6.5[b]

[a] Other: Other Race - including Multiple Races.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

N = Sample size.
SE = Standard error.
CL = Confidence limit.
Min = Minimum value.
Max = Maximum value.

Source: U.S. EPA analysis of NHANES 2003–2006.

Table 10-13. Total Fish Consumption, Consumers Only, by Demographic Variables[a]		
	Intake (g/person-day)	
Demographic Category	Mean	95th Percentile
Overall (all fish consumers)	14.3	41.7
Race		
Caucasian	14.2	41.2
Black	16.0	45.2
Asian	21.0	67.3
Other	13.2	29.4
Sex		
Female	13.2	38.4
Male	15.6	44.8
Age (years)		
0 to 9	6.2	16.5
10 to 19	10.1	26.8
20 to 29	14.5	38.3
30 to 39	15.8	42.9
40 to 49	17.4	48.1
50 to 59	20.9	53.4
60 to 69	21.7	55.4
≥70	13.3	39.8
Sex and Age (years)		
Female		
0 to 9	6.1	17.3
10 to 19	9.0	25.0
20 to 29	13.4	34.5
30 to 39	14.9	41.8
40 to 49	16.7	49.6
50 to 59	19.5	50.1
60 to 69	19.0	46.3
≥70	10.7	31.7
Male		
0 to 9	6.3	15.8
10 to 19	11.2	29.1
20 to 29	16.1	43.7
30 to 39	17.0	45.6
40 to 49	18.2	47.7
50 to 59	22.8	57.5
60 to 69	24.4	61.1
≥70	15.8	45.7
Census Region		
New England	16.3	46.5
Middle Atlantic	16.2	47.8
East North Central	12.9	36.9
West North Central	12.0	35.2
South Atlantic	15.2	44.1
East South Central	13.0	38.4
West South Central	14.4	43.6
Mountain	12.1	32.1
Pacific	14.2	39.6

Table 10-13. Total Fish Consumption, Consumers Only, by Demographic Variables[a] (continued)

	Intake (g/person-day)	
Demographic Category	Mean	95th Percentile
Community Type		
Rural, non-SMSA	13.0	38.3
Central city, 2M or more	19.0	55.6
Outside central city, 2M or more	15.9	47.3
Central city, 1M–2M	15.4	41.7
Outside central city, 1M–2M	14.5	41.5
Central city, 500K–1M	14.2	41.0
Outside central city, 500K–1M	14.0	39.7
Outside central city, 250K–500K	12.2	32.1
Central city, 250K–500K	14.1	40.5
Central city, 50K–250K	13.8	43.4
Outside central city, 50K–250K	11.3	31.7
Other urban	13.5	39.2

[a] The calculations in this table are based on respondents who consumed fish during the survey month. These respondents are estimated to represent 94% of the U.S. population.

SMSA = Standard metropolitan statistical area.

Source: Javitz, 1980.

Table 10-14. Percent Distribution of Total Fish Consumption for Females and Males by Age[a]

Age (years)	Consumption Category (g/day)										
	0.0–5.0	5.1–10.0	10.1–15.0	15.1–20.0	20.1–25.0	25.1–30.0	30.1–37.5	37.6–47.5	47.6–60.0	60.1–122.5	over 122.5
Females											
0 to 9	55.5	26.8	11.0	3.7	1.0	1.1	0.7	0.3	0.0	0.0	0.0
10 to 19	17.8	31.4	15.4	6.9	3.5	2.4	1.2	0.7	0.2	0.4	0.0
20 to 29	28.1	26.1	20.4	11.8	6.7	3.5	4.4	2.2	0.9	0.9	0.0
30 to 39	22.4	23.6	18.0	12.7	8.3	4.8	3.8	2.8	1.9	1.7	0.1
40 to 49	17.5	21.9	20.7	13.2	9.3	4.5	4.6	2.8	3.4	2.1	0.2
50 to 59	17.0	17.4	16.8	15.5	10.5	8.5	6.8	5.2	4.2	2.0	0.2
60 to 69	11.5	16.9	20.6	15.9	9.1	9.2	6.0	6.1	2.4	2.1	0.2
≥70	41.9	22.1	12.3	9.7	5.2	2.9	2.6	1.2	0.8	1.2	0.1
Overall	28.9	24.0	16.8	10.7	6.4	4.3	3.5	2.4	1.6	1.2	0.1
Males											
0 to 9	52.1	30.1	11.9	3.1	1.2	0.6	0.7	0.1	0.2	0.1	0.0
10 to 19	27.8	29.3	19.0	10.4	6.0	3.2	1.7	1.7	0.4	0.5	0.0
20 to 29	16.7	22.9	19.6	14.5	8.8	6.2	4.4	3.1	1.9	1.9	0.1
30 to 39	16.6	21.2	19.2	13.2	9.5	7.3	5.2	3.2	1.3	2.2	0.0
40 to 49	11.9	22.3	18.6	14.7	8.4	8.5	5.3	5.2	3.3	1.7	0.1
50 to 59	9.9	15.2	15.4	14.4	10.4	9.7	8.7	7.6	4.3	4.1	0.2
60 to 69	7.4	15.0	15.6	12.8	11.4	8.5	9.9	8.3	5.5	5.5	0.1
≥70	24.5	21.7	15.7	9.9	9.8	5.3	5.4	3.1	1.7	2.8	0.1
Overall	22.6	23.1	17.0	11.3	7.7	5.7	4.6	3.6	2.2	2.1	0.1

[a] The percentage of females in an age bracket whose average daily fish consumption is within the specified range. The calculations in this table are based upon the respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% of the U.S. population.

Source: Javitz, 1980.

Table 10-15. Mean Total Fish Consumption by Species[a]

Species	Mean consumption (g/day)	Species	Mean consumption (g/day)
Not reported	1.173	Mullet[b]	0.029
Abalone	0.014	Oysters[b]	0.291
Anchovies	0.010	Perch (Freshwater)[b]	0.062
Bass[b]	0.258	Perch (Marine)	0.773
Bluefish	0.070	Pike (Marine)[b]	0.154
Bluegills[b]	0.089	Pollock	0.266
Bonito[b]	0.035	Pompano	0.004
Buffalofish	0.022	Rockfish	0.027
Butterfish	0.010	Sablefish	0.002
Carp[b]	0.016	Salmon[b]	0.533
Catfish (Freshwater)[b]	0.292	Scallops[b]	0.127
Catfish (Marine)[b]	0.014	Scup[b]	0.014
Clams[b]	0.442	Sharks	0.001
Cod	0.407	Shrimp[b]	1.464
Crab, King	0.030	Smelt[b]	0.057
Crab, other than King[b]	0.254	Snapper	0.146
Crappie[b]	0.076	Snook[b]	0.005
Croaker[b]	0.028	Spot[b]	0.046
Dolphin[b]	0.012	Squid and Octopi	0.016
Drums	0.019	Sunfish	0.020
Flounders[b]	1.179	Swordfish	0.012
Groupers	0.026	Tilefish	0.003
Haddock	0.399	Trout (Freshwater)[b]	0.294
Hake	0.117	Trout (Marine)[b]	0.070
Halibut[b]	0.170	Tuna, light	3.491
Herring	0.224	Tuna, White Albacore	0.008
Kingfish	0.009	Whitefish[b]	0.141
Lobster (Northern)[b]	0.162	Other finfish[b]	0.403
Lobster (Spiny)	0.074	Other shellfish[b]	0.013
Mackerel, Jack	0.002		
Mackerel, other than Jack	0.172		

[a] The calculations in this table are based upon respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% of the U.S. population.

[b] Designated as freshwater or estuarine species.

Source: Javitz, 1980.

Table 10-16. Best Fits of Lognormal Distributions Using the Non-Linear Optimization Method

	Adults	Teenagers	Children
Shellfish			
μ	1.370	–0.183	0.854
σ	0.858	1.092	0.730
Finfish (freshwater)			
μ	0.334	0.578	–0.559
σ	1.183	0.822	1.141
Finfish (saltwater)	2.311	1.691	0.881
μ	0.72	0.830	0.970
σ			

The following equations may be used with the appropriate μ and σ values to obtain an average Daily Consumption Rate (DCR), in grams, and percentiles of the DCR distribution.

$DCR50 = \exp(\mu)$

$DCR90 = \exp[\mu + z(0.90) \times \sigma]$

$DCR99 = \exp[\mu + z(0.99) \times \sigma]$

$DCR_{avg} = \exp[\mu + 0.5 \times \sigma^2]$

Source: Ruffle et al., 1994.

Table 10-17. Mean Fish Intake in a Day, by Sex and Age[a]

Sex Age (years)	Per capita intake (g/day)	Percent of population consuming fish in 1 day	Mean intake (g/day) for consumers only[b]
Males or Females			
5 and under	4	6.0	67
Males			
6 to 11	3	3.7	79
12 to 19	3	2.2	136
20 and over	15	10.9	138
Females			
6 to 11	7	7.1	99
12 to 19	9	9.0	100
20 and over	12	10.9	110
All individuals	11	9.4	117

[a] Based on USDA Nationwide Food Consumption Survey 1987–1988 data for 1 day.

[b] Intake for users only was calculated by dividing the per capita consumption rate by the fraction of the population consuming fish in 1 day.

Source: USDA, 1992b.

Table 10-18. Percent of Respondents That Responded Yes, No, or Don't Know to Eating Seafood in 1 Month (including shellfish, eels, or squid)

		Response					
		No		Yes		DK	
Population Group	Total *N*	*N*	%	*N*	%	*N*	%
Overall	4,663	1,811	38.8	2,780	59.6	72	1.5
Sex							
*	2	1	50.0	1	50.0	*	*
Male	2,163	821	38.0	1,311	60.6	31	1.4
Female	2,498	989	39.6	1,468	58.8	41	1.6
Age (years)							
*	84	25	29.8	42	50.0	17	20.2
1 to 4	263	160	60.8	102	38.8	1	0.4
5 to 11	348	177	50.9	166	47.7	5	1.4
12 to 17	326	179	54.9	137	42.0	10	3.1
18 to 64	2,972	997	33.5	1,946	65.5	29	1.0
>64	670	273	40.7	387	57.8	10	1.5
Race							
*	60	20	33.3	22	36.7	18	30.0
White	3,774	1,475	39.1	2,249	59.6	50	1.3
Black	463	156	33.7	304	65.7	3	0.6
Asian	77	21	27.3	56	72.7	*	*
Some Others	96	39	40.6	56	58.3	1	1.0
Hispanic	193	100	51.8	93	48.2	*	*
Hispanic							
*	46	10	21.7	412	43.0	28	41.3
No	4,243	1,625	31.2	1,366	67.7	21	1.2
Yes	348	165	35.4	236	62.3	9	*
DK	26	11	40.4	766	58.5	14	*
Employment							
*	958	518	54.1	412	43.0	28	2.9
Full Time	2,017	630	31.2	1,366	67.7	21	1.0
Part Time	379	134	35.4	236	62.3	9	2.4
Not Employed	1,309	529	40.4	766	58.5	14	1.1
Education							
*	1,021	550	53.9	434	42.5	37	3.6
<High School	399	196	49.1	198	49.6	45	1.3
High School Graduate	1,253	501	40.0	739	59.0	13	1.0
<College	895	304	34.0	584	65.3	7	0.8
College Graduate	650	159	24.5	484	74.5	7	1.1
Post-Graduate	445	101	22.7	341	76.6	3	0.7

Table 10-18. Percent of Respondents That Responded Yes, No, or Don't Know to Eating Seafood in 1 Month (including shellfish, eels, or squid) (continued)

		Response					
		No		Yes		DK	
Population Group	Total *N*	*N*	%	*N*	%	*N*	%
Census Region							
Northeast	1,048	370	35.3	655	62.5	23	2.2
Midwest	1,036	449	43.3	575	55.5	12	1.2
South	1,601	590	36.9	989	61.8	22	1.4
West	978	402	41.1	561	57.4	15	1.5
Day of Week							
Weekday	3,156	1,254	39.7	1,848	58.6	54	1.7
Weekend	1,507	557	37.0	932	61.8	18	1.2
Season							
Winter	1,264	462	36.6	780	61.7	22	1.7
Spring	1,181	469	39.7	691	58.5	21	1.8
Summer	1,275	506	39.7	745	58.4	24	1.9
Fall	943	374	39.7	564	59.8	5	0.5
Asthma							
No	4,287	1,674	39.0	2,563	59.8	50	1.2
Yes	341	131	38.4	207	60.7	3	0.9
DK	35	6	17.7	10	28.6	19	54.3
Angina							
No	4,500	1,750	38.9	2,698	60.0	52	1.2
Yes	125	56	44.8	68	54.4	1	0.8
DK	38	50	13.2	14	36.8	19	50.0
Bronchitis/Emphysema							
No	4,424	1,726	9.0	2,648	59.6	50	1.1
Yes	203	80	39.4	121	59.6	2	1.0
DK	36	5	13.9	11	30.6	20	55.6

* = Missing data.
DK = Don't know.
% = Row percentage.
N = Sample size.

Source: U.S. EPA, 1996.

Table 10-19. Number of Respondents Reporting Consumption of a Specified Number of Servings of Seafood in 1 Month

		Number of Servings in a Month					
Population Group	Total *N*	1–2	3–5	6–10	11–19	20+	DK
Overall	2,780	918	990	519	191	98	64
Sex							
*	1,311	405	458	261	101	57	29
Male	1,468	512	532	258	90	41	35
Female	1	1	*	*	*	*	*
Age (years)							
*	42	13	16	5	4	1	3
1 to 4	102	55	29	12	2	*	4
5 to 11	166	72	57	21	6	4	6
12 to 17	137	68	54	9	2	1	3
18 to 64	1,946	603	679	408	145	79	32
>64	387	107	155	64	32	13	16
Race							
*	2,249	731	818	428	155	76	41
White	304	105	103	56	16	10	14
Black	56	15	17	11	5	5	3
Asian	56	22	18	6	5	3	2
Some Others	93	41	25	14	9	2	2
Hispanic	22	4	9	4	1	2	2
Hispanic							
*	2,566	844	922	480	175	88	57
No	182	68	52	34	15	8	5
Yes	15	5	8	2	*	*	*
DK	17	1	8	3	1	2	2
Employment							
*	399	190	140	40	11	5	13
Full Time	1,366	407	466	307	107	57	22
Part Time	236	70	95	46	14	8	3
Not Employed	766	249	285	124	57	26	25
Refused	13	2	4	2	2	2	1
Education							
*	434	205	149	47	12	7	14
<High School	198	88	62	20	6	10	12
High School Graduate	739	267	266	119	46	21	20
<College	584	161	219	122	48	26	8
College Graduate	484	115	183	121	43	17	5
Post-Graduate	341	82	111	90	36	17	5
Census Region							
Northeast	655	191	241	137	62	12	12
Midwest	575	199	221	102	17	22	14
South	989	336	339	175	70	41	28
West	561	192	189	105	42	23	10

Table 10-19. Number of Respondents Reporting Consumption of a Specified Number of Servings of Seafood in 1 Month (continued)

Population Group	Total *N*	Number of Servings in a Month					
		1–2	3–5	6–10	11–19	20+	DK
Day of Week							
Weekday	1,848	602	661	346	129	70	40
Weekend	932	316	329	173	62	28	24
Season							
Winter	780	262	284	131	60	28	15
Spring	691	240	244	123	45	25	14
Summer	745	220	249	160	59	31	26
Fall	564	196	213	105	27	14	9
Asthma							
No	2,563	846	917	475	180	88	57
Yes	207	69	71	42	11	9	5
DK	10	3	2	2	*	1	2
Angina							
No	2,698	896	960	509	183	95	55
Yes	68	19	27	8	7	1	6
DK	14	3	3	2	1	2	3
Bronchitis/Emphysema							
No	2,648	877	940	495	185	91	60
Yes	121	37	47	23	6	6	2
DK	11	4	3	1	*	1	2

* = Missing data.
DK = Don't know.
% = Row percentage.
N = Sample size.
Refused = Respondent refused to answer.

Source: U.S. EPA, 1996.

Table 10-20. Number of Respondents Reporting Monthly Consumption of Seafood That Was Purchased or Caught by Someone They Knew

Population Group	Total *N*	*	Mostly Purchased	Mostly Caught	DK
Overall	2,780	3	2,584	154	39
Sex					
*	1,311	1	1,206	85	19
Male	1,468	2	1,377	69	20
Female	1	*	1	*	*
Age (years)					
*	42	*	39	3	*
1 to 4	102	*	94	8	*
5 to 11	166	*	153	9	4
12 to 17	137	*	129	6	2
18 to 64	1,946	3	1,810	106	27
>64	387	*	359	22	6
Race					
*	2,249	1	2,092	124	32
White	304	1	280	19	4
Black	56	*	50	4	2
Asian	56	*	55	*	1
Some Others	93	*	86	7	*
Hispanic	22	1	21	*	*
Hispanic					
*	2,566	2	2,387	140	37
No	182	*	169	13	*
Yes	15	*	12	1	2
DK	17	1	16	*	*
Employment					
*	399	*	368	25	6
Full Time	1,366	2	1,285	64	15
Part Time	236	1	217	15	3
Not Employed	766	*	701	50	15
Refused	13	*	13	*	*
Education					
*	434	*	401	26	7
<High School	198	*	174	20	4
High School Graduate	739	*	680	48	11
<College	584	2	547	28	7
College Graduate	484	*	460	19	5
Post-Graduate	341	1	322	13	5
Census Region					
Northeast	655	2	627	21	5
Midwest	575	*	547	20	8
South	989	1	897	73	18
West	561	*	513	40	8

Table 10-20. Number of Respondents Reporting Monthly Consumption of Seafood That Was Purchased or Caught by Someone They Knew (continued)

Population Group	Total *N*	*	Mostly Purchased	Mostly Caught	DK
Day of Week					
Weekday	1,848	2	1,724	100	22
Weekend	932	1	860	54	17
Season					
Winter	780	*	741	35	4
Spring	691	*	655	27	9
Summer	745	2	674	54	15
Fall	564	1	514	38	11
Asthma					
No	2,563	2	2,384	142	35
Yes	207	1	190	12	4
DK	10	*	10	*	*
Angina					37
No	2,698	3	2,507	151	2
Yes	68	*	63	3	*
DK	14	*	14	*	
Bronchitis/Emphysema					
No	2,648	3	2,457	149	39
Yes	121	*	116	5	*
DK	11	*	11	*	*

* = Missing data.
DK = Don't know.
N = Sample size.
Refused = Respondent refused to answer.

Source: U.S. EPA, 1996.

Table 10-21. Distribution of Fish Meals Reported by NJ Consumers During the Recall Period

Meals	*N*	% of Total	Cumulative %
1	288	41.9	41.9
2	204	29.7	71.7
3	118	17.2	88.9
4	34	5.0	93.9
5	16	2.3	96.2
6	13	1.9	98.1
7	7	1.0	99.1
≥7	6	0.9	100.0
Total	686	99.9	--

N = Number of respondents.

Source: Stern et al., 1996.

Table 10-22. Selected Species Among All Reported Meals by NJ Consumers During the Recall Period

Species	% of total reported meals (*N* = 1,447)
Tuna[a]	19.2
Shrimp	13.5
Founder/fluke	11.9
Shellfish/clams, etc.[b]	8.2
Finfish (unidentified)	7.5
Salmon	5.3
Swordfish	1.5
Shark	0.3
Total	67.4

[a] Includes fresh and canned tuna, as fillets, sandwiches, and salads.
[b] Includes soups and stews.
N = Number of meals.

Source: Stern et al., 1996.

Table 10-23. Cumulative Probability Distribution of Average Daily Fish Consumption (g/day)

Percentile	All Adult Fish Consumers (≥18 years)	Fish Consuming Women (18 to 40 years)
Arithmetic mean	50.2	41.0
Geometric mean	36.6	30.8
Percentiles		
5th	9.1	7.0
10th	12.2	10.3
25th	24.3	20.3
40th	28.4	24.3
50th	32.4	28.0
60th	42.6	33.4
75th	62.1	48.6
90th	107.4	88.1
95th	137.7	106.8
99th	210.6	142.3

Source: Stern et al., 1996.

Table 10-24. Distribution of the Usual Frequency of Fish Consumption[a]

Usual frequency	All fish consumers *N* = 933	% of total	Consumers during recall period *N* = 686	% of total
>2 times/week	63	6.8	59	8.6
1 to 2 times/week	365	39.1	335	48.8
2 times/month	173	18.5	136	19.8
1 time/month	206	22.0	121	17.6
Few times/year	126	13.5	35	5.1

[a] Based on survey respondents and household members.
N = Sample size.

Source: Stern et al., 1996.

Table 10-25. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population, as Prepared

Habitat	Statistic	Estimate (90% Interval)	
		Finfish	Shellfish
Fresh/Estuarine	Mean	2.6 (2.3–2.8)	2.0 (1.8–2.3)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.2)
	95th percentile	6.7 (5.3–9.3)	9.6 (7.9–10.6)
	99th percentile	67.2 (63.5–75.5)	59.3 (51.5–64.0)
Marine	Mean	6.6 (6.1–7.0)	1.7 (1.3–2.0)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	26.3 (24.3–27.4)	0.0 (0.0–0.0)
	95th percentile	46.1 (43.1–47.5)	0.0 (0.0–0.0)
	99th percentile	94.7 (89.8–100.4)	67.9 (51.6–84.5)
All Fish	Mean	9.1 (8.6–9.7)	3.7 (3.2–4.2)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	34.8 (31.4–36.6)	0.0 (0.0–0.0)
	95th percentile	59.8 (57.5–61.6)	22.6 (17.2–26.3)
	99th percentile	126.3 (120.6–130.1)	90.6 (82.9–95.7)

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications. Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights.

Source: U.S. EPA, 2002.

Table 10-26. Daily Average Per Capita Estimates of Fish Consumption: U.S. Population—Mean Consumption by Species Within Habitat, as Prepared

Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day
Estuarine	Shrimp	1.63012	Marine (Cont)	Lobster	0.15725	All Species	Perch (Freshwater)	0.12882
	Flounder	0.45769		Scallop (Marine)	0.14813	(Cont)	Squid	0.12121
	Catfish (Estuarine)	0.34065		Squid	0.12121		Oyster	0.11615
	Flatfish (Estuarine)	0.27860		Ocean Perch	0.11135		Ocean Perch	0.11135
	Crab (Estuarine)	0.17971		Sea Bass	0.09766		Sea Bass	0.09766
	Perch (Estuarine)	0.12882		Mackerel	0.08780		Carp	0.09584
	Oyster	0.11615		Swordfish	0.07790		Herring	0.09409
	Herring	0.09409		Sardine	0.07642		Croaker	0.08798
	Croaker	0.08798		Pompano	0.07134		Mackerel	0.08780
	Trout, mixed sp.	0.08582		Flatfish (Marine)	0.05216		Trout (Estuarine)	0.08582
	Salmon (Estuarine)	0.05059		Mussels	0.05177		Trout (Freshwater)	0.08582
	Rockfish	0.03437		Octopus	0.04978		Swordfish	0.07790
	Anchovy	0.02976		Halibut	0.02649		Sardine	0.07642
	Clam (Estuarine)	0.02692		Snapper	0.02405		Pompano	0.07134
	Mullet	0.02483		Whitefish (Marine)	0.00988		Flatfish (Marine)	0.05216
	Smelts (Estuarine)	0.00415		Smelts (Marine)	0.00415		Mussels	0.05177
	Eel	0.00255		Shark	0.00335		Salmon (Estuarine)	0.05059
	Scallop (Estuarine)	0.00100		Snails (Marine)	0.00198		Octopus	0.04978
	Smelts, Rainbow	0.00037		Conch	0.00155		Rockfish	0.03437
	Sturgeon (Estuarine)	0.00013		Roe	0.00081		Anchovy	0.02976
			Unknown				Pike	0.02958
Freshwater	Catfish (Freshwater)	0.34065		Fish	0.23047		Clam (Estuarine)	0.02692
	Trout	0.15832		Seafood	0.00203		Halibut	0.02649
	Perch (Freshwater)	0.12882	All Species				Mullet	0.02483
	Carp	0.09584		Tuna	2.62988		Snapper	0.02405
	Trout, mixed sp.	0.08582		Shrimp	1.63012		Whitefish (Freshwater)	0.00988
	Pike	0.02958		Cod	1.12504		Whitefish (Marine)	0.00988
	Whitefish (Freshwater)	0.00988		Salmon (Marine)	1.01842		Crayfish	0.00575
	Crayfish	0.00575		Clam (Marine)	1.00458		Smelts (Estuarine)	0.00415
	Snails (Freshwater)	0.00198		Flounder	0.45769		Smelts (Marine)	0.00415
	Cisco	0.00160		Catfish (Estuarine)	0.34065		Shark	0.00335
	Salmon (Freshwater)	0.00053		Catfish (Freshwater)	0.34065		Eel	0.00255
	Smelts, Rainbow	0.00037		Flatfish (Estuarine)	0.27860		Seafood	0.00203
	Sturgeon (Freshwater)	0.00013		Pollock	0.27685		Snails (Freshwater)	0.00198
				Porgy	0.27346		Snails (Marine)	0.00198
Marine	Tuna	2.62988		Haddock	0.25358		Cisco	0.00160
	Cod	1.12504		Fish	0.23047		Conch	0.00155
	Salmon (Marine)	1.01842		Crab (Marine)	0.20404		Scallop (Estuarine)	0.00100
	Clam (Marine)	1.00458		Whiting	0.20120		Roe	0.00081
	Pollock	0.27685		Crab (Estuarine)	0.17971		Salmon (Freshwater)	0.00053
	Porgy	0.27346		Trout	0.15832		Smelts, Rainbow (Estuarine)	0.00037
	Haddock	0.25358		Lobster	0.15725		Smelts, Rainbow	0.00037
	Crab (Marine)	0.20404		Scallop (Marine)	0.14813		Sturgeon (Estuarine)	0.00013
	Whiting	0.20120		Perch (Estuarine)	0.12882		Sturgeon (Freshwater)	0.00013

Notes: Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights. Source of individual consumption data: USDA Combined 1994–1996, 1998 CSFII. The fish component of foods containing fish was calculated using data from the recipe file of the USDA's Nutrient Data Base for Individual Food Intake Surveys.

Source: U.S. EPA, 2002.

Table 10-27. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population, Uncooked Fish Weight

Habitat	Statistic	Estimate (90% Interval) Finfish	Shellfish
Fresh/Estuarine	Mean	3.6 (3.2–4.0)	2.7 (2.4–3.1)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	0.0 (0.00–0.7)	0.0 (0.0–0.0)
	95th percentile	14.1 (10.0–16.8)	12.8 (10.5–13.8)
	99th percentile	95.3 (80.7–100.8)	77.0 (69.7–84.1)
Marine	Mean	9.0 (8.4–9.6)	1.6 (1.2–2.0)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	37.5 (35.7–37.6)	0.0 (0.0–0.0)
	95th percentile	62.9 (61.3–65.5)	0.0 (0.0–0.0)
	99th percentile	128.4 (119.3–135.8)	54.8 (33.1–80.6)
All Fish	Mean	12.6 (11.9–13.3)	4.3 (3.7–4.9)
	50th percentile	0.0 (0.0–0.0)	0.0 (0.0–0.0)
	90th percentile	48.7 (45.3–50.4)	0.0 (0.0–0.0)
	95th percentile	81.8 (79.5–85.0)	23.2 (18.3–28.3)
	99th percentile	173.6 (168.0–183.4)	110.5 (93.1–112.9)

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications. Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights.

Source: U.S. EPA, 2002.

Table 10-28. Daily Average Per Capita Estimates of Fish Consumption U.S. Population—Mean Consumption by Species Within Habitat, Uncooked Fish Weight

Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day	Habitat	Species	Estimated Mean g/Person/Day
Estuarine	Shrimp	2.20926	Marine (Cont.)	Lobster	0.21290	All	Perch (Freshwater)	0.18148
	Flounder	0.58273		Scallop (Marine)	0.18951	Species	Squid	0.15438
	Catfish (Estuarine)	0.48928		Squid	0.15438	(Cont.)	Ocean Perch	0.14074
	Flatfish (Estuarine)	0.33365		Ocean Perch	0.14074		Oyster	0.13963
	Crab (Estuarine)	0.25382		Sea Bass	0.12907		Croaker	0.13730
	Perch (Estuarine)	0.18148		Mackerel	0.11468		Carp	0.13406
	Oyster	0.13963		Sardine	0.10565		Herring	0.13298
	Croaker	0.13730		Swordfish	0.10193		Sea Bass	0.12907
	Herring	0.13298		Pompano	0.09905		Trout (Estuarine)	0.11908
	Trout, mixed sp.	0.11908		Mussels	0.07432		Trout (Freshwater)	0.11908
	Salmon (Estuarine)	0.06898		Octopus	0.06430		Mackerel	0.11468
	Rockfish	0.04448		Flatfish (Marine)	0.06247		Sardine	0.10565
	Anchovy	0.04334		Halibut	0.03226		Swordfish	0.10193
	Mullet	0.03617		Snapper	0.02739		Pompano	0.09905
	Clam (Estuarine)	0.01799		Whitefish (Marine)	0.00995		Mussels	0.07432
	Smelts (Estuarine)	0.00611		Smelts (Marine)	0.00611		Salmon (Estuarine)	0.06898
	Eel	0.00324		Shark	0.00424		Octopus	0.06430
	Scallop (Estuarine)	0.00128		Snails (Marine)	0.00249		Flatfish (Marine)	0.06247
	Smelts, Rainbow	0.00052		Conch	0.00207		Rockfish	0.04448
	Sturgeon (Estuarine)	0.00013		Roe	0.00102		Anchovy	0.04334
			Unknown				Mullet	0.03617
Freshwater	Catfish (Freshwater)	0.48928		Fish	0.60608		Pike	0.03260
	Trout	0.19917		Seafood	0.00326		Halibut	0.03226
	Perch (Freshwater)	0.18148	All Species				Snapper	0.02739
	Carp	0.13406		Tuna	3.61778		Clam (Estuarine)	0.01799
	Trout, mixed sp.	0.11908		Shrimp	2.20926		Whitefish (Freshwater)	0.00995
	Pike	0.03260		Cod	1.47734		Whitefish (Marine)	0.00995
	Whitefish (Freshwater)	0.00995		Salmon (Marine)	1.38873		Crayfish	0.00746
	Crayfish	0.00746		Clam (Marine)	0.67135		Smelts (Estuarine)	0.00611
	Snails (Freshwater)	0.00249		Flounder	0.60608		Smelts (Marine)	0.00611
	Cisco	0.00234		Catfish (Estuarine)	0.58273		Shark	0.00424
	Salmon (Freshwater)	0.00073		Catfish (Freshwater)	0.48928		Seafood	0.00326
	Smelts, Rainbow	0.00052		Porgy	0.48928		Eel	0.00324
	Sturgeon (Freshwater)	0.00013		Flatfish (Estuarine)	0.40148		Snails (Freshwater)	0.00249
				Pollock	0.33365		Snails (Marine)	0.00249
Marine	Tuna	3.61778		Haddock	0.32878		Cisco	0.00234
	Cod	1.47734		Fish	0.32461		Conch	0.00207
	Salmon (Marine)	1.38873		Crab (Marine)	0.28818		Scallop (Estuarine)	0.00128
	Clam (Marine)	0.67135		Whiting	0.25725		Roe	0.00102
	Porgy	0.40148		Crab (Estuarine)	0.25382		Salmon (Freshwater)	0.00073
	Pollock	0.32878		Trout	0.21290		Smelts, Rainbow (Estuarine)	0.00052
	Haddock	0.32461		Lobster	0.19917		Smelts, Rainbow	0.00052
	Crab (Marine)	0.28818		Scallop (Marine)	0.18951		Sturgeon (Estuarine)	0.00013
	Whiting	0.25725		Perch (Estuarine)	0.18148		Sturgeon (Freshwater)	0.00013

Notes: Estimates are projected from a sample of 20,607 individuals to the U.S. population of 261,897,236 using 4-year combined survey weights. Source of individual consumption data: USDA Combined 1994–1996, 1998 CSFII. Amount of consumed fish recorded by survey respondents was converted to uncooked fish quantities using data from the recipe file of USDA's Nutrient Data Base for Individual Food Intake Survey. Fish component of foods containing fish was calculated using data from the recipe file of the USDA's Nutrient Data Base for Individual Food Intake Surveys.

Source: U.S. EPA, 2002.

Table 10-29. Per Capita Distributions of Fish (finfish and shellfish) Intake (g/day), as Prepared[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	5,182	1.6 (1.2–1.9)	0.0 (0.0–0.5)	5.8 (4.4–10.2)	40.0 (33.7–52.0)
15 to 44	2,332	4.3 (3.4–5.1)	5.1 (2.8–7.9)	23.9 (21.8–28.6)	82.9 (75.2–111.2)
45 and older	2,654	4.8 (4.0–5.6)	11.8 (5.7–16.8)	32.7 (26.7–40.1)	79.4 (74.2–87.0)
All ages	10,168	3.9 (3.3–4.4)	4.9 (2.6–6.3)	23.8 (22.1–27.5)	77.1 (74.3–85.2)
Males					
14 and under	5,277	2.1 (1.6–2.6)	0.0 (0.0–0.6)	6.6 (4.4–10.4)	60.8 (42.7–74.2)
15 to 44	2,382	5.7 (4.8–6.6)	10.4 (9.2–12.4)	38.6 (33.7–49.0)	112.7 (91.5–125.1)
45 and older	2,780	7.4 (6.3–8.5)	23.6 (19.7–28.1)	56.6 (52.3–57.2)	112.3 (107.5–130.1)
All ages	10,439	5.3 (4.7–6.0)	9.3 (7.1–10.9)	37.1 (32.1–40.3)	107.1 (97.1–125.1)
Both Sexes					
3 to 5	4,391	1.5 (1.2–1.8)	0.1 (0.00–1.0)	5.1 (4.1–6.2)	38.7 (32.9–43.6)
6 to 10	1,670	2.1 (1.4–2.9)	0.0 (0.0–0.6)	5.9 (3.2–12.7)	60.9* (51.0–86.0)
11 to 15	1,005	3.0 (2.2–3.8)	1.4 (0.5–5.5)	18.2 (14.8–21.1)	69.5* (56.0–75.1)
16 to 17	363	3.4 (1.6–5.3)	0.0 (0.0–1.5)	31.1* (5.2–29.2)	81.2* (42.0–117.0)
18 and older	9,596	5.5 (4.9–6.0)	11.7 (9.9–14.7)	38.0 (34.7–43.0)	105.1 (91.5–113.5)
14 and under	10,459	1.8 (1.5–2.1)	0.0 (0.0–0.0)	6.0 (5.5–9.5)	51.7 (39.4–61.2)
15 to 44	4,714	5.0 (4.4–5.6)	8.6 (5.3–10.4)	31.7 (28.6–36.8)	98.9 (85.5–125.1)
45 and older	5,434	6.0 (5.2–6.7)	17.4 (13.9–22.1)	42.7 (37.1–52.8)	104.2 (91.0–112.0)
All ages	20,607	4.6 (4.2–5.0)	6.6 (5.3–8.5)	29.7 (28.1–31.6)	91.0 (82.6–100.1)
Marine					
Females					
14 and under	5,182	3.6 (3.0–4.2)	10.8 (8.1–13.5)	28.1 (24.3–31.0)	61.3 (51.2–70.5)
15 to 44	2,332	7.0 (6.1–7.9)	27.9 (24.3–28.2)	48.1 (42.6–53.7)	97.0 (86.6–137.6)
45 and older	2,654	10.9 (9.6–12.1)	42.0 (38.4–42.5)	63.3 (57.8–66.3)	128.5 (120.5–138.3)
All ages	10,168	7.6 (6.9–8.3)	28.1 (27.9–29.2)	49.6 (46.6–52.4)	106.6 (95.2–119.2)
Males					
14 and under	5,277	4.3 (3.6–5.1)	11.8 (8.4–14.0)	29.1 (26.7–31.4)	84.4 (77.0–113.3)
15 to 44	2,382	9.4 (8.2–10.6)	36.6 (28.0–43.1)	72.8 (58.8–82.8)	127.4 (116.3–153.6)
45 and older	2,780	11.9 (10.5–13.2)	47.1 (42.2–54.5)	71.4 (64.4–81.3)	140.1 (114.9–149.6)
All ages	10,439	8.9 (8.1–9.8)	34.2 (28.2–38.5)	63.3 (59.0–73.2)	122.8 (109.4–139.6)
Both Sexes					
3 to 5	4,391	3.7 (3.2–4.3)	11.1 (10.4–12.6)	27.9 (24.4–29.1)	59.8 (52.4–71.3)
6 to 10	1,670	4.2 (3.5–4.9)	13.1 (9.7–17.0)	28.7 (27.6–33.8)	78.6* (49.2–84.4)
11 to 15	1,005	5.5 (4.2–6.7)	13.9 (9.8–20.6)	38.5 (30.8–50.3)	102.3* (84.4–113.6)
16 to 17	363	4.7 (2.9–6.4)	0.0 (0.0–6.9)	24.2* (7.8–71.5)	107.8* (68.4–118.9)
18 and older	9,596	9.8 (9.0–10.6)	38.6 (36.6–41.5)	63.8 (58.8–68.8)	126.3 (117.3–140.1)
14 and under	10,459	4.0 (3.5–4.5)	10.8 (10.1–13.5)	28.2 (27.9–29.8)	79.0 (63.0–98.8)
15 to 44	4,714	8.2 (7.4–9.1)	28.2 (27.9–34.3)	56.6 (54.5–68.9)	115.7 (98.5–143.8)
45 and older	5,434	11.3 (10.3–12.3)	42.7 (42.0–45.7)	65.1 (63.9–68.0)	136.9 (125.6–140.3)
All ages	20,607	8.3 (7.6–8.9)	29.2 (28.2–32.1)	55.8 (54.7–56.9)	114.6 (108.9–120.8)

Table 10-29. Per Capita Distributions of Fish (finfish and shellfish) Intake (g/day), as Prepared[a] (continued)					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
All Fish					
Females					
14 and under	5,182	5.2 (4.4–5.9)	18.9 (15.3–21.1)	37.5 (30.0–41.7)	80.2 (72.6–83.0)
15 to 44	2,332	11.3 (10.0–12.7)	41.2 (36.6–46.2)	66.3 (61.0–73.0)	143.4 (128.0–148.4)
45 and older	2,654	15.6 (14.0–17.3)	56.2 (52.7–60.6)	82.9 (75.6–88.0)	158.9 (141.6–170.6)
All ages	10,168	11.4 (10.5–12.4)	42.2 (39.0–45.7)	66.8 (63.2–71.4)	140.8 (128.5–148.4)
Males					
14 and under	5,277	6.4 (5.5–7.3)	21.1 (15.7–24.9)	42.2 (34.0–52.5)	114.3 (98.4–130.6)
15 to 44	2,382	15.1 (13.6–16.6)	58.4 (51.0–70.3)	89.1 (85.6–97.5)	177.2 (163.0–185.3)
45 and older	2,780	19.2 (17.6–20.9)	67.7 (65.0–72.2)	98.6 (92.7–105.1)	167.5 (157.0–193.3)
All ages	10,439	14.3 (13.4–15.2)	55.9 (51.0–59.4)	86.1 (84.3–89.7)	162.6 (155.8–178.7)
Both Sexes					
3 to 5	4,391	5.2 (4.6–5.8)	18.9 (15.3–21.3)	35.3 (31.1–39.5)	72.2 (66.7–81.4)
6 to 10	1,670	6.3 (5.3–7.3)	23.9 (21.1–27.0)	39.6 (34.3–51.5)	107.8* (91.6–130.6)
11 to 15	1,005	8.5 (6.9–10.0)	28.1 (24.9–31.4)	60.3 (53.4–74.2)	122.2* (106.8–131.9)
16 to 17	363	8.1 (5.4–10.8)	18.6 (7.0–40.9)	73.8* (29.2–89.8)	142.3* (107.9–200.4)
18 and older	9,596	15.3 (14.3–16.2)	56.2 (55.4–58.3)	86.1 (84.3–87.5)	162.6 (155.8–171.0)
14 and under	10,459	5.8 (5.2–6.5)	19.4 (17.2–21.2)	38.2 (36.6–42.1)	96.5 (83.0–114.3)
15 to 44	4,714	13.2 (12.2–14.2)	50.0 (45.3–56.2)	82.9 (76.2–86.1)	162.6 (147.2–176.2)
45 and older	5,434	17.3 (16.0–18.6)	61.1 (56.6–64.2)	90.5 (86.5–93.2)	162.7 (158.4–170.6)
All ages	20,607	12.8 (12.1–13.6)	48.2 (46.2–49.9)	79.0 (74.6–83.3)	153.2 (145.9–160.9)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval (BI); percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-30. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	4,879	56 (46–66)	0.0 (0.0–3.4)	208 (162–268)	1,516 (1,305–1,801)
15 to 44	2,275	67 (53–81)	75 (40–107)	380 (306–435)	1,329 (1,238–2,021)
45 and older	2,569	72 (58–85)	184 (75–247)	491 (369.3–606.2)	1,339 (1,133–1,462)
All ages	9,723	66 (58–75)	80 (44–104)	398 (364–435)	1,352 (1,222–1,528)
Males					
14 and under	4,994	65 (52–78)	0.0 (0.0–17)	279 (179–384)	1,767 (1,470–1,888)
15 to 44	2,369	72 (60–83)	131 (101–170)	481 (425–574)	1,350 (1,228–1,729)
45 and older	2,764	88 (75–101)	272 (212–321)	666 (540–712)	1,378 (1,260–1,508)
All ages	10,127	75 (67–84)	131 (107–181)	504 (455–560)	1,470 (1,378–1,568)
Both Sexes					
3 to 5	4,112	82.9(67–99)	0.0 (0.0–56)	284 (240–353)	2,317 (1,736–2,463)
6 to 10	1,553	59.3 (39–79)	0.0 (0.0–5.3)	178 (88–402)	1,662* (1,433–2,335)
11 to 15	975	53.3 (42–64)	0.0 (0.0–78)	312 (253–390)	1,237* (950–1,521)
16 to 17	360	49.5(23–76)	0.0 (0.0–33)	213* (106–390)	1,186* (600–2,096)
18 and older	9,432	74 (67–82)	158 (125–198)	502 (452–567)	1,353 (1,238–1,511)
14 and under	9,873	61 (52–70)	0.0 (0.0–0.0)	230 (187–283)	1,689 (1,470–1,805)
15 to 44	4,644	69 (61–78)	104 (72–139)	431 (390–476)	1,335 (1,238–1,684)
45 and older	5,333	79 (69–90)	236 (188–284)	557 (493.7–666)	1,351 (1,260–1,462)
All ages	19,850	71 (65–77)	106 (87–128)	451 (424–484)	1,432 (1,325–1,521)
Marine					
Females					
14 and under	4,879	147 (125–168)	381 (324–506)	1,028 (908–1,149)	2,819 (2,481–2,908)
15 to 44	2,275	114 (98–129)	423 (365–485)	768 (650–881)	1,648 (1,428–2,177)
45 and older	2,569	166 (147–185)	620 (567–658)	950 (900–1,042)	2,022 (1,899–2,683)
All ages	9,723	139 (127–150)	501 (465–534)	892 (847–923)	2,151 (1,858–2,484)
Males					
14 and under	4,994	154 (132–176)	426 (357–494)	1,081 (975–1,293)	2,678 (2,383–3,073)
15 to 44	2,369	118 (104–132)	444 (368–547)	880 (760–954)	1,643 (1,454–1,819)
45 and older	2,764	149 (133–166)	568 (504–673)	889 (831–990)	1,859 (1,725–2,011)
All ages	10,127	136 (125–147)	494 (445–543)	908 (868–954)	1,965 (1,817–2,247)
Both Sexes					
3 to 5	4,112	209 (181–237)	614 (525–696)	1,537 (1,340–1,670)	3,447 (3,274–3,716)
6 to 10	1,553	150 (123–177)	416 (326–546)	1,055 (969–1,275)	2,800* (2,021–3,298)
11 to 15	975	109 (84–133)	338 (179–413)	821 (629–1,034)	1,902* (1,537–2,366)
16 to 17	360	75 (46–103)	0.0 (0.0–124)	381* (132–951)	1,785* (1,226–2,342)
18 and older	9,432	137 (126–147)	527 (501–575)	881 (840–945)	1,798 (1,708–1,971)
14 and under	9,873	150 (134–167)	413 (366–476)	1,037(1,002–1,163)	2,692 (2,481–2,823)
15 to 44	4,644	116 (104–128)	440 (389–488)	830 (750–920)	1,651.83 (1,487–1,793)
45 and older	5,333	158 (144–173)	601 (562–642)	921 (882–977)	1,975.67 (1,785–2,118)
All ages	19,850	137 (128–147)	497 (480–517)	903 (869–938)	2,014.52 (1,947–2,158)

Table 10-30. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
All Fish					
Females					
14 and under	4,879	203 (178–227)	693 (929–1,408)	1,344 (1,224–1,489)	3,297 (2,823–3,680)
15 to 44	2,275	181 (158–204)	641 (641–879)	1,040 (910–1,226)	2,292 (2,096–2,494)
45 and older	2,569	238 (212–263)	812 (797–956)	1,265 (1,165–1,353)	2,696 (2,247–2,974)
All ages	9,723	205 (188–221)	731 (797–912)	1,211 (1,128–1,256)	2,651 (2,358–2,823)
Males					
14 and under	4,994	219 (252–356)	745 (583–881)	1,470 (1,282–1,775)	3,392 (2,893–3,954)
15 to 44	2,369	190 (219–263)	756 (689–851)	1,165 (1,060–1,239)	2,238 (2,045–2,492)
45 and older	2,764	237 (225–277)	849 (812–920)	1,253 (1,183–1,282)	2,310 (2,079–2,438)
All ages	10,127	211 (240–279)	792 (727–884)	1,239 (1,201–1,282)	2,537 (2,324–2,679)
Both Sexes					
3 to 5	4,112	292 (260–326)	1,057 (931–1,232)	1,988 (1,813–2,147)	4,089 (3,733–4,508)
6 to 10	1,553	209 (176–242)	780 (644–842)	1,357 (1,173–1,451)	3,350* (2,725–4,408)
11 to 15	975	162 (133–191)	570 (476–664)	1,051 (991–1,313)	2,305* (1,908–2,767)
16 to 17	360	124 (83–165)	261 (110–600)	1,029* (390–1,239)	2,359* (2,096–2,676)
18 and older	9,432	211 (197–225)	779 (743–816)	1,198 (1,165–1,238)	2,327 (2,198–2,438)
14 and under	9,873	211 (191–231)	713 (652–780)	1,429 (1,344–1,499)	3,354 (3,224–3,458)
15 to 44	4,644	185 (170–200)	714 (645–803)	1,139 (1,014–1,228)	2,290 (2,082–2,476)
45 and older	5,333	238 (219–256)	836 (767–883)	1,261 (1,185–1,314)	2,386 (2,158–2,672)
All ages	19,850	208 (196–220)	762 (737–790)	1,227 (1,198–1,251)	2,539 (2,476–2,679)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-31. Per Capita Distribution of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	5,182	2.3 (1.8–2.8)	0.0 (0.0–0.2)	13.1 (9.9–16.4)	58.8 (45.8–86.4)
15 to 44	2,332	5.8 (4.6–6.9)	6.3 (4.7–11.4)	32.4 (27.7–38.0)	109.8 (100.4–154.5)
45 and older	2,654	6.4 (5.3–7.4)	17.7 (8.9–23.6)	44.9 (37.4–55.4)	108.8 (95.4–123.9)
All ages	10,168	5.2 (4.5–5.9)	7.3 (3.8–11.9)	31.9 (28.3–37.4)	102.1(95.5–114.0)
Males					
14 and under	5,277	3.0 (2.3–3.7)	0.0 (0.0–0.2)	13.5 (10.2–17.0)	79.0 (55.2–97.9)
15 to 44	2,382	7.9 (6.7–9.1)	15.6 (13.2–19.8)	49.7 (45.7–66.4)	151.2 (126.4–183.4)
45 and older	2,780	10.2 (8.6–11.7)	32.5 (27.3–37.2)	73.5 (66.2–77.1)	165.9 (147.7–190.7)
All ages	10,439	7.4 (6.6–8.3)	14.6 (12.6–17.7)	49.3 (45.6–53.2)	147.8 (132.3–183.4)
Both Sexes					
3 to 5	4,391	2.2 (1.8–2.6)	0.1 (0.0–1.5)	12.2 (10.3–14.1)	52.5 (45.6–61.5)
6 to 10	1,670	3.0 (1.9–4.1)	0.0 (0.0–0.5)	13.1 (4.8–20.1)	78.5* (63.8–110.5)
11 to 15	1,005	4.3 (3.2–5.4)	2.3 (0.1–7.7)	25.8 (21.0–28.9)	94.8* (83.1–109.5)
16 to 17	363	4.6 (2.2–6.9)	0.0 (0.0–1.9)	19.3* (13.3–36.8)	109.2* (57.7–154.5)
18 and older	9,596	7.5 (6.8–8.3)	17.4 (14.3–21.6)	49.6 (46.9–55.4)	143.4 (125.3–156.8)
14 and under	10,459	2.6 (2.2–3.1)	0.0 (0.0–0.0)	13.1 (11.9–14.8)	73.7 (51.5–86.4)
15 to 44	4,714	6.8 (6.0–7.6)	13.0 (8.6–15.6)	43.6 (37.8–47.4)	135.9 (121.0–167.0)
45 and older	5,434	8.1 (7.1–9.2)	24.8 (18.8–28.6)	56.5 (48.9–69.7)	144.3 (121.7–156.8)
All ages	20,607	6.3 (5.7–6.9)	11.7 (8.4–13.7)	41.1 (37.9–43.7)	123.9 (114.0–138.8)
Marine					
Females					
14 and under	5,182	5.2 (4.5–6.0)	18.8 (13.5–21.9)	40.1 (37.9–47.7)	81.3 (67.0–98.4)
15 to 44	2,332	9.0 (7.8–10.1)	37.5 (31.0–37.9)	61.7 (55.8–71.2)	120.6 (116.5–132.5)
45 and older	2,654	13.7 (12.0–15.4)	51.4 (49.0–55.4)	80.4 (76.9–82.6)	155.6 (148.7–179.2)
All ages	10,168	9.8 (8.9–10.6)	37.8 (37.3–40.2)	64.7 (59.2–67.7)	128.5 (119.4–142.9)
Males					
14 and under	5,277	6.0 (4.9–7.0)	17.0 (13.0–21.4)	39.7 (35.9–41.1)	113.3 (106.3–140.3)
15 to 44	2,382	12.0 (10.5–13.5)	41.7 (37.8–56.3)	90.2 (75.7–106.7)	151.5 (134.9–192.5)
45 and older	2,780	15.0 (13.3–16.7)	58.0 (53.5–68.3)	90.7 (85.4–97.3)	168.8 (157.1–186.9)
All ages	10,439	11.5 (10.4–12.5)	41.3 (37.8–49.7)	82.9 (75.7–96.8)	152.3 (136.6–166.9)
Both Sexes					
3 to 5	4,391	5.5 (4.8–6.2)	19.8 (16.6–23.1)	39.4 (37.7–41.4)	82.3 (73.0–95.4)
6 to 10	1,670	5.6 (4.6–6.5)	18.9 (14.2–24.3)	38.4 (37.9–41.6)	99.8* (62.8–111.4)
11 to 15	1,005	7.6 (5.9–9.4)	25.3 (16.4–34.5)	56.5 (45.3–67.1)	131.8* (110.3–148.7)
16 to 17	363	6.1 (3.7–8.4)	0.0 (0.0–9.3)	29.5* (11.6–90.7)	135.6* (92.0–177.1)
18 and older	9,596	12.4 (11.5–13.4)	48.9 (47.1–51.2)	80.7 (77.8–83.5)	150.8 (139.7–164.3)
14 and under	10,459	5.59 (4.9–6.3)	18.7 (16.1–19.7)	40.2 (39.6–40.4)	103.4 (82.6–123.5)
15 to 44	4,714	10.5 (9.4–11.6)	37.9 (37.5–41.3)	75.3 (67.3–83.5)	137.1 (122.0–151.0)
45 and older	5,434	14.3 (13.0–15.6)	55.7 (53.1–57.9)	83.4 (80.7–85.8)	166.0 (155.5–178.0)
All ages	20,607	10.6 (9.8–11.4)	38.4 (37.8–40.6)	74.9 (69.9–75.6)	139.2 (131.3–148.3)

Table 10-31. Per Capita Distribution of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
			All Fish		
Females					
14 and under	5,182	7.5 (6.5–8.5)	28.5 (25.4–34.0)	55.2 (49.0–59.2)	103.9 (95.1–126.2)
15 to 44	2,332	14.7 (13.0–16.5)	53.6 (46.6–58.8)	85.2 (77.3–94.6)	189.9 (165.1–197.1)
45 and older	2,654	20.1 (17.9–22.2)	73.4 (67.7–77.3)	104.0 (96.7–112.1)	213.7 (190.1–221.6)
All ages	10,168	15.0 (13.7–16.2)	56.2 (51.0–59.2)	86.3 (81.2–93.2)	185.7 (162.6–187.2)
Males					
14 and under	5,277	9.0 (7.6–10.3)	31.5 (24.6–37.5)	56.5 (49.0–69.9)	165.2 (141.6–177.4)
15 to 44	2,382	19.9 (18.0–21.7)	77.0 (65.8–88.8)	118.6 (110.7–127.1)	242.7 (224.3–254.9)
45 and older	2,780	25.2 (23.0–27.3)	89.7 (86.5–94.2)	130.7 (125.8–135.5)	226.5 (207.3–278.3)
All ages	10,439	18.9 (17.7–20.1)	73.5 (66.6–80.5)	113.4 (110.7–118.6)	219.3 (204.8–236.5)
Both Sexes					
3 to 5	4,391	7.7 (6.9–8.6)	32.6 (27.6–34.0)	51.0 (46.3–56.7)	100.5 (89.1–111.4)
6 to 10	1,670	8.5 (7.1–10.0)	32.6 (27.0–37.9)	56.4 (49.6–69.8)	144.4* (117.4–183.4)
11 to 15	1,005	12.0 (9.7–14.2)	43.4 (36.7–50.8)	87.4 (69.6–102.6)	170.7* (147.9–176.8)
16 to 17	363	10.6 (7.0–14.2)	29.3 (9.4–48.7)	83.5* (42.3–114.5)	192.5* (120.5–266.0)
18 and older	9,596	19.9 (18.7–21.1)	74.8 (71.7–75.7)	111.4 (110.0–114.0)	215.7 (197.1–228.5)
14 and under	10,459	8.2 (7.3–9.2)	29.0 (27.6–32.6)	56.3 (52.2–56.7)	127.2 (118.2–149.5)
15 to 44	4,714	17.3 (15.9–18.7)	64.6 (57.0–73.5)	107.7 (99.2–113.6)	211.3 (197.1–242.3)
45 and older	5,434	22.4 (20.7–24.1)	80.6 (75.0–85.3)	115.3 (111.7–122.2)	215.7 (208.3–227.6)
All ages	20,607	16.9 (15.9–17.9)	63.5 (59.5–66.2)	102.3 (97.9–107.6)	198.2 (190.7–208.8)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-32. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	4,879	83 (69–96)	0.0 (0.0–1.6)	443 (269–572)	2,179 (1,866–2,345)
15 to 44	2,275	91 (71–110)	107 (57–145)	482 (403–538)	1,818 (1,633–2,767)
45 and older	2,569	96 (78–113)	250 (123–322)	655 (485–776)	1,822 (1,515–1,909)
All ages	9,723	91 (79–103)	117 (63–165)	535 (485–613)	1,871 (1,629–2,025)
Males					
14 and under	4,994	95 (76–113)	0.0 (0.0–1.7)	534 (371–605)	2,351 (1,920–2,501)
15 to 44	2,369	99 (84–115)	201 (151–254)	623 (558–810)	1,910 (1,760–2,221)
45 and older	2,764	121 (102–140)	378 (317–429)	891 (754–974)	1,963 (1,731–2,132)
All ages	10,127	106 (94–117)	208 (165–272)	697 (629–782)	2,034 (1,856–2,221)
Both Sexes					
3 to 5	4,112	124 (102–146)	0.0 (0.0–83)	712 (599–784)	3,091 (2,495–3,475)
6 to 10	1,553	84 (55–112)	0.0 (0.0–1.4)	354 (116–685)	2,322* (1,856–2,994)
11 to 15	975	77 (60–94)	20 (0.0–116)	477 (411–618)	1,610* (1,358–2,203)
16 to 17	360	65 (30–100)	0.0 (0.0–23)	285* (167–491)	1,542* (760–2,767)
18 and older	9,432	102 (92–112)	236 (183–277)	669 (597–749)	1,886 (1,700–2,049)
14 and under	9,873	89 (76–101)	0.0 (0.0–0.0)	485 (411–557)	2,246 (1,987–2,495)
15 to 44	4,644	95 (83–107)	150 (115–195)	558 (506–623)	1,893 (1,683–2,221)
45 and older	5,333	108 (94–122)	322 (250–379)	751 (653.97–870)	1,868 (1,709–1,941)
All ages	19,850	98 (90–107)	159 (131–198)	631 (590–675)	1,943 (1,816–2,086)
Marine					
Females					
14 and under	4,879	212 (183–242)	592 (508–785)	1,532 (1,418–1,703)	3,708 (3,276–4,295)
15 to 44	2,275	146 (126–166)	557 (463–632)	995 (874–1,078)	2,056 (1,848–2,330)
45 and older	2,569	209 (185–233)	802 (757–844)	1,184 (1,132–1,281)	2,464 (2,282–2,820)
All ages	9,723	181 (167–196)	657 (601–718)	1,158 (1,094–1,216)	2,716 (2,382–3,051)
Males					
14 and under	4,994	214 (183–244)	609 (480–808)	1,542 (1,380–1,887)	3,603 (3,212–4,131)
15 to 44	2,369	150 (132–168)	576 (461–675)	1,113 (963–1,226)	1,990 (1,782–2,317)
45 and older	2,764	187 (167–208)	713 (658–851)	1,138 (1,103–1,213)	2,275 (1,993–2,495)
All ages	10,127	175 (161–189)	649 (575–711)	1,205 (1,127–1,233)	2,545 (2,314–2,705)
Both Sexes					
3 to 5	4,112	309 (270–348)	1,108 (984–1,332)	2,314 (2,097–2,481)	4,608 (4,301–5,354)
6 to 10	1,553	198 (161–235)	600 (474–733)	1,481 (1,310–1,549)	3,684* (2,458–4,353)
11 to 15	975	153 (117–189)	481 (361–609)	1,251 (808–1,390)	2,381* (2,162–3,207)
16 to 17	360	98 (58–137)	0.0 (0.0–177)	460* (197–1,079)	2,148* (1,648–3,901)
18 and older	9,432	173 (160–186)	672 (651–732)	1,115 (1,078–1,182)	2,157 (2,024–2,412)
14 and under	9,873	213 (190–237)	606 (517–688)	1,543 (1,491–1,670)	3,694 (3,318–4,065)
15 to 44	4,644	148 (132–163)	568 (502–630)	1,052 (973–1,184)	2,023 (1,925–2,197)
45 and older	5,333	199 (181–217)	767 (718–828)	1,156 (1,115–1,214)	2,389 (2,273–2,546)
All ages	19,850	178 (167–190)	651 (620–675)	1,178 (1,134–1,226)	2,587 (2,454–2,705)

Table 10-32. Per Capita Distribution of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
All Fish					
Females					
14 and under	4,879	295 (261–330)	1,046 (885–1,262)	2,03,8 (1,853–2,251)	4,548 (4,117–4,977)
15 to 44	2,275	237 (206–267)	834.58 (771–981)	1,362 (1,181–1,556)	3,113 (2,767,–3,361)
45 and older	2,569	305 (272–338)	1,065.15 (98–1,200)	1,568 (1,472–1,671)	3,071 (2,716–3,941)
All ages	9,723	272 (251–294)	970.64 (906–1,040)	1,566 (1,511–1,633)	3,566 (3,270–3,782)
Males					
14 and under	4,994	308 (273–344)	1,122 (774–1,310)	2,136 (1,856–2,371)	4,518 (4,055–5,465)
15 to 44	2,369	249 (226–272)	982 (908–1,154)	1,533 (1,407–1,619)	3,011 (2,820–3,349)
45 and older	2,764	309 (282–335)	1,128 (1,078–1,206)	1,605 (1,534–1,731)	2,821 (2,587–3,204)
All ages	10,127	281 (264–297)	1,058 (962–1,201)	1,644 (1,559–1,731)	3,369 (3,204–3,680)
Both Sexes					
3 to 5	4,112	433 (385–482)	1,842 (1,555–1,957)	2,964 (2,790–3,194)	5,604 (5,231–6,135)
6 to 10	1,553	282 (235–328)	1,045 (744.58–1,219)	1,854 (1,638–2,175)	4,371* (3,433–5,814)
11 to 15	975	231 (186–275)	824 (657–952)	1,531 (1,362–1,850)	3,651* (2,745–3,795)
16 to 17	360	163 (107–219)	406 (145–756)	1,272* (558–1,500)	3,544* (2,767–3,946)
18 and older	9,432	275 (258–292)	1,017 (975–1,065)	1,549 (1,481–1,591)	3,060 (2,771–3,204)
14 and under	9,873	302 (274–330)	1,072 (961–1,162)	2,089 (1,987–2,207)	4,539 (4,391–5,108)
15 to 44	4,644	243 (223–262)	938 (878–1,019)	1,451 (1,342–1,602)	3,094 (2,788–3,349)
45 and older	5,333	307 (283–331)	1,112 (1,002–1,168)	1,591 (1,517–1,685)	3,014 (2,714–3,226)
All ages	19,850	276 (261–292)	1,013 (976–1,052)	1,613 (1,561–1,651)	3,457 (3,349–3,680)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights.
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-33. Consumer-Only Distribution of Fish (finfish and shellfish) Intake (g/day), as Prepared[a]					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	445	32.7 (26.8–36.6)	79.9 (77.1–103.9)	111.0 (103.0–163.5)	185.4 (163.5–384.3)
15 to 44	325	55.4 (45.9–64.8)	125.9 (117.0–157.8)	189.4 (154.2–259.9)	341.4 (260.2–853.4)
45 and older	449	49.0 (44.3–53.6)	122.8 (118.7–128.0)	158.3 (151.3–165.8)	284.7 (241.2–308.5)
All ages	1,219	49.4 (44.5–54.3)	122.7 (117.0–126.6)	163.2 (151.5–193.8)	320.6 (260.2–345.2)
Males					
14 and under	442	41.7 (34.9–48.4)	121.5 (85.3–148.4)	161.9 (138.6–229.2)	260.8 (260.2–292.5)
15 to 44	361	66.6 (59.7–73.6)	165.0 (158.8–171.0)	226.3 (194.2–250.2)	336.9 (327.0–402.9)
45 and older	553	65.8 (59.0–72.6)	154.3 (148.1–174.0)	214.4 (200.2–222.3)	400.2 (300.8–571.0)
All ages	1,356	62.9 (57.8–67.9)	158.2(148.4–165.8)	215.4 (202.4–226.5)	335.9 (316.5–437.1)
Both Sexes					
3 to 5	442	27.1 (23.2–31.1)	72.6 (65.0–79.0)	95.6 (87.2–109.6)	159.0* (136.1–260.2)
6 to 10	147	43.5 (31.8–55.2)	121.6* (82.5–187.3)	186.7* (114.8–260.2)	260.4* (172.1–261.3)
11 to 15	107	49.0 (39.4–58.5)	126.6* (103.9–148.4)	149.9* (134.6–192.7)	307.1* (192.7–384.3)
16 to 17	28	75.8* (58.9–92.7)	158.5* (151.1–171.0)	167.8* (158.8–484.4)	371.6* (171.0–484.4)
18 and older	1,633	59.2 (54.9–63.4)	150.2 (141.8–154.2)	201.0 (181.9–216.6)	338.2 (308.5–345.2)
14 and under	887	36.8 (32.5–41.1)	103.1 (75.5–120.7)	146.8 (114.8–167.4)	260.0 (250.2–292.5)
15 to 44	686	61.3 (56.4–66.2)	157.8 (150.3–163.5)	217.1 (181.8–253.2)	342.6 (321.1–484.4)
45 and older	1,002	57.3 (51.9–62.7)	141.1 (127.6–151.0)	182.5 (170.5–200.1)	306.9 (261.8–345.5)
All ages	2,575	56.3 (52.5–60.0)	145.3 (138.6–151.3)	188.8 (178.5–211.9)	332.9 (308.5–361.3)
Marine					
Females					
14 and under	670	48.7 (43.7–53.7)	98.1 (93.3–112.6)	135.9 (112.6–162.2)	196.2 (162.2–238.4)
15 to 44	412	71.0 (66.2–75.7)	158.5 (128.0–170.8)	181.5 (167.4–202.8)	286.7 (234.6–293.2)
45 and older	588	82.3 (75.9–88.6)	153.3 (140.1–166.1)	203.5 (181.2–252.5)	362.3 (275.4–485.4)
All ages	1,670	72.2 (68.6–75.8)	146.3 (140.3–158.7)	181.6 (169.0–201.6)	286.6 (269.5–293.2)
Males					
14 and under	677	59.5 (51.3–67.7)	144.6 (113.3–168.7)	168.8 (167.0–227.2)	265.1 (170.0–291.6)
15 to 44	412	99.1 (91.3–106.9)	186.1 (174.7–199.5)	232.5 (214.0–254.4)	403.8 (321.5–407.2)
45 and older	623	90.0 (84.9–95.1)	179.8 (167.3–200.1)	224.4 (207.2–280.1)	306.3 (292.5–380.9)
All ages	1,712	88.7 (83.7–93.7)	178.2 (170.0–181.2)	226.1 (214.4–232.7)	354.2 (315.3–403.6)
Both Sexes					
3 to 5	682	44.5 (40.6–48.5)	90.6 (84.3–104.8)	119.1 (102.0–142.8)	227.6* (168.7–292.5)
6 to 10	217	59.4 (52.6–66.1)	128.7 (111.6–158.4)	159.2* (134.9–219.05)	242.5* (219.0–291.6)
11 to 15	122	72.4 (59.9–84.9)	165.3* (157.6–202.8)	203.6* (168.8–227.2)	245.6* (213.6–268.6)
16 to 17	37	96.9* (65.3–128.5)	218.9* (179.6–237.8)	237.5* (179.6–292.5)	365.3* (229.8–428.0)
18 and older	1.978	85.1 (81.3–88.9)	168.9 (168.9–174.6)	214.1 (195.9–227.2)	337.2 (306.4–380.9)
14 and under	1,347	54.1 (48.4–59.9)	119.1 (112.3–144.8)	162.3 (141.9–168.7)	238.2 (219.0–269.4)
15 to 44	824	85.0 (79.5–90.4)	172.0 (168.8–179.6)	213.7 (194.3–229.7)	343.7 (304.9–404.2)
45 and older	1,211	85.8 (81.5–90.2)	168.4 (158.7–181.2)	218.7 (207.3–229.8)	320.1 (299.2–485.4)
All ages	3,382	80.2 (76.6–83.8)	168.9 (165.6–169.0)	207.6 (197.0–214.4)	310.2 (299.2–383.5)

Table 10-33. Consumer-Only Distribution of Fish (finfish and shellfish) Intake (g/day), as Prepared[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
All Fish					
Females					
14 and under	836	54.2 (49.3–59.0)	112.5 (97.2–136.9)	155.4 (128.5–162.2)	237.5 (197.9–285.6)
15 to 44	554	82.5 (74.8–90.2)	170.8 (151.0–184.7)	221.7 (197.9–260.2)	336.5 (294.3–345.2)
45 and older	751	90.5 (85.3–95.7)	170.5 (158.7–181.7)	219.8 (197.0–242.5)	326.0 (308.5–612.9)
All ages	2,141	81.5 (77.3–85.7)	163.6 (151.3–171.0)	208.2 (193.8–238.4)	327.0 (285.6–359.6)
Males					
14 and under	836	69.1 (61.9–76.3)	157.0 (136.1–168.8)	227.5 (168.7–260.2)	276.0 (269.4–292.5)
15 to 44	565	111.9 (106.0–117.9)	210.6 (195.0–242.5)	296.1 (249.7–316.5)	427.9 (403.6–465.6)
45 and older	849	106.5 (101.5–111.5)	210.3 (193.3–229.8)	271.1 (241.4–292.5)	392.5 (330.6–535.5)
All ages	2,250	102.9 (99.0–106.8)	206.0 (192.7–219.0)	262.0 (251.3–285.8)	404.1 (380.9–428.4)
Both Sexes					
3 to 5	834	50.2 (46.3–54.0)	103.1 (94.5–124.9)	133.9 (120.7–151.8)	260.0* (195.3–293.3)
6 to 10	270	70.6 (63.8–77.4)	154.7 (130.0–183.2)	218.2* (197.9–261.3)	280.9* (260.2–291.6)
11 to 15	172	79.6 (70.4–88.7)	167.1* (154.0–192.7)	208.8* (205.9–257.0	285.2* (263.8–327.0)
16 to 17	52	104.1* (75.0–133.1)	200.5* (167.4–242.5)	241.9* (215.7–484.4)	451.0* (292.5–484.4)
18 and older	2,634	97.56 (93.7–101.4)	191.8 (184.7–197.9)	253.2 (243.6–261.8)	399.5 (359.1–407.2)
14 and under	1,672	61.7 (56.6–66.8)	138.4 (125.1–150.1)	168.7 (162.4–232.8)	271.4 (260.2–291.6)
15 to 44	1,119	97.2 (92.1–102.4)	195.1 (183.2–206.0)	256.0 (240.2–283.9)	404.0 (352.4–450.4)
45 and older	1,600	98.1 (93.6–102.6)	187.0 (184.1–198.0)	248.5 (238.00–260.2)	381.4 (300.6–413.0)
All ages	4,391	92.0 (88.5–95.5)	184.5 (179.6–195.0)	249.3 (234.3–259.8)	379.0 (340.2–413.0)

[a] Estimates were projected from sample size to the U.S. population using 4–year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period.

N = Sample size.

CI = Confidence interval.

BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-34. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a]

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	410	1,198 (1,029–1,367)	3,167 (2,626–3,601)	4,921 (3,601–6,563)	9,106 (6,875–10,967)
15 to 44	315	872 (7,13–1,032)	2,702 (1,777–2,484)	3,153 (2,484–4,067)	5,738 (4,584–15,930)
45 and older	432	736 (658–813)	1,943 (1,803–2,128)	2,487 (2,249–2,706)	3,169 (3,027–7,078)
All ages	1,157	859 (776–943)	2,151 (1,941–2,476)	3,004 (2,602–3,368)	6,102 (5,475–7,078)
Males					
14 and under	419	1,299 (1,106–1,492)	3,556 (3,068–3,830)	4,495 (3,830–4,982)	8,714 (6,266–11,276)
15 to 44	358	841 (751–931)	2,182 (2,057–2,318)	2,819 (2,539–3,241)	4,379 (4,057–4,931)
45 and older	548	782 (701–862)	1,804 (1,696–1,903)	2,511 (2,175–2,652)	4,812 (4,036–6,987)
All ages	1,325	882 (814–950)	2,148 (2,045–2,318)	3,021 (2,867–3,241)	5,333 (4,548–6,775)
Both Sexes					
3 to 5	416	1,532 (1,320–1,743)	4,307 (3,472–4,624)	5,257 (4,926–5,746)	10,644* (9,083–12,735)
6 to 10	132	1,296 (1,004–1,588)	3,453* (2,626–4,671)	4,675* (3,459–8,816)	8,314* (4,684–9,172)
11 to 15	101	869 (724.60–1,013)	2,030* (1,628–2,104)	3,162* (2,104–3,601)	4,665* (3,597–7,361)
16 to 17	28	1,063* (781–1,346)	2,293* (2,096–2,577)	2,505* (2,096–6,466)	5,067* (2,295–6,466)
18 and older	1,599	805 (748–861)	2,025 (1,888–2,072)	2,679 (2,539–2,947)	4,930 (4,285–5,849)
14 and under	829	1,251 (1,135–1,367)	3,456 (3,136–3,597)	4,681 (4,084–5,247)	8,792 (7,361–10,967)
15 to 44	673	855 (778–933)	2,136 (2,057–2,371)	3,071 (2,675–3,478)	5,795 (4,066–6,096)
45 and older	980	759 (694–824)	1,896 (1,739–1,983)	2,512 (2,262–2,706)	4,261 (3,117–6,419)
All ages	2,482	871 (816–926)	2,152 (2,063–2,295)	3,019 (2,924–3,101)	5,839 (4,926–7,078)
Marine					
Females					
14 and under	629	1,988 (1,827–2,148)	4,378 (3,927–4,962)	5,767 (5,041–6,519)	8,185 (6,907–8,842)
15 to 44	403	1,147 (1,061–1,234)	2,404 (2,014–2,660)	3,151 (2,621–3,325)	4,774 (4,523–5,510)
45 and older	568	1,259 (1,159–1,360)	2,430 (2,258–2,627)	3,274 (2,699–4,029)	5,798 (5,365–9,297)
All ages	1,600	1,323 (1,260–1,385)	2,680 (2,477–2,977)	3,644 (3,381–4,305)	5,895 (5,750–6,956)
Males					
14 and under	643	2,084 (1,842–2,326)	4,734 (3,911–5,307)	5,490 (4,944–6,628)	9,004 (7,432–10,962)
15 to 44	409	1,242 (1,151–1,333)	2,448 (2,349–2,773)	2,985 (2,870–3,265)	4,674 (3,637–5,926)
45 and older	621	1,129 (1,063–1,195)	2,294 (2,106–2,452)	2,942 (2,809–3,526)	4,622 (4,094–4,936)
All ages	1,673	1,337 (1,267–1,408)	2,745 (2,513–2,858)	3,636 (3,450–3,922)	5,908 (5,359–6,366)
Both Sexes					
3 to 5	640	2,492 (2,275–2,709)	5,303 (4,873–5,930)	6,762 (6,097–7,168)	11,457* (7,432–14,391)
6 to 10	203	2,120 (1,880–2,361)	4,950 (4,043–5,384)	5,817* (5,333–6,596)	8,092* (6,146–9,184)
11 to 15	120	1,427 (1,203–1,651)	2,971* (2,858–3,741)	4,278* (3,026–4,766)	5,214* (4,647–5,646)
16 to 17	37	1,534* (1,063–2,004)	3,602* (2,974–4,649)	4,475* (3,068–4,685)	4,982* (3,467–5,238)
18 and older	1,944	1,187 (1,137–1,238)	2,386 (2,265–2,450)	2,998 (2,907–3,191)	4,961 (4,523–5,510)
14 and under	1,272	2,037 (1,880–2,195)	4,646 (4,213–4,892)	5,664 (5,384–6,093)	8,611 (7,755–9,184)
15 to 44	812	1,195 (1,127–1,263)	2,442 (2,349–2,660)	3,046 (2,856–3,309)	4,817 (3,932–5,238)
45 and older	1,189	1,198 (1,135–1,261)	2,394 (2,205–2,534)	3,100 (2,933–3,500)	5,436 (4,655–7,504)
All ages	3,273	1,330 (1,278–1,382)	2,710 (2,618–2,870)	3,637 (3,544–3,927)	5,910 (5,646–6,711)

Table 10-34. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), as Prepared[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
All Fish					
Females					
14 and under	779	2,183 (2,021–2,344)	4,786 (4,422–5,138)	6,218 (5,766–6,738)	10,395 (8,680–10,967)
15 to 44	541	1,317 (1,184–1,451)	2,636 (2,385–3,051)	3,611 (3,225–4,584)	5,712 (4,952–5,849)
45 and older	725	1,380 (1,299–1,460)	2,639 (2,406–2,950)	3,560 (3,008–3,967)	5,929 (5,452–9,905)
All ages	2,045	1,469 (1,400–1,539)	3,008 (2,752–3,169)	4,088 (3,649–4,544)	7,074 (6,519–8,761)
Males					
14 and under	788	2,355 (2,164–2,545)	5,097 (4,680–5,535)	6,712 (6,146–7,432)	9,182 (8,816–11,276)
15 to 44	561	1,409 (1,339–1,478)	2,770 (2,570–3,241)	3,490 (3,092–3,725)	5,612 (5,163–5,926)
45 and older	842	1,311 (1,250–1,373	2,564 (2,501–2,801)	3,133 (3,050–3,584)	4,935 (4,548–6,987)
All ages	2,191	1,518 (1,461–1,575)	3,043 (2,867–3,159)	4,029 (3,779–4,477)	6,736 (6,096–7,117)
Both Sexes					
3 to 5	779	2,828 (2,608–3,049)	5,734 (5,268–6,706)	7,422 (6,907–8,393)	13,829* (11,349–14,391)
6 to 10	250	2,375 (2,199–2,551)	5,135 (4,684–5,816)	6,561* (5,404–8,816)	9,179* (8,130–10,485)
11 to 15	164	1,533 (1,384–1,682)	3,207* (2,945–3,485)	3,924.64* (3,485–4,764)	5,624* (4,764–6,929)
16 to 17	52	1,578*(1,187–1,969)	3,468* (2,676–4,752)	4,504.25* (3,709–6,466)	5,738* (4,752–6,466)
18 and older	2,585	1,349 (1,297–1,401)	2,641 (2,539–2,773)	3,493 (3,258–3,628)	5,708 (5,085–5,926)
14 and under	1,567	2,271 (2,130–2,412)	4,959 (4,647–5,450)	6,531 (5,887–6,929)	10,389 (8,982–10,967)
15 to 44	1,102	1,363 (1,292–1,435)	2,728 (2,570–2,974)	3,583 (3,275–3,999)	5,694 (4,987–5,849)
45 and older	1,567	1,347 (1,288–1,406)	2,619 (2,546–2,752)	3,265 (3,115–3,569)	5,807 (5,073–6,987)
All ages	4,236	1,494 (1,440–1,548)	3,021 (2,941–3,082)	4,055 (3,816–4,218)	6,920 (6,466–7,527)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period..

N = Sample size.

CI = Confidence interval.

BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-35. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a]					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	445	47 (40–54)	117 (104–142)	172 (150–204)	243 (220–514)
15 to 44	325	75 (62–88)	173 (155–204)	274 (204–331)	503 (381–1,144)
45 and older	449	66 (59–72)	163 (153–168)	204 (192–226)	394 (303–431)
All ages	1,219	67 (60–74)	163 (154–170)	219 (199–267)	461 (381–508)
Males					
14 and under	442	60 (50–70)	158 (110–196)	199 (189–296)	381 (381–401)
15 to 44	361	93 (82.33–103)	236 (226–246)	305 (272–367)	495 (444–643)
45 and older	553	91 (81.11–100)	221 (204–236)	295 (264–332)	562 (402–764)
All ages	1,356	87 (80–95)	220 (200–232)	296 (289–333)	490 (444–595)
Both Sexes					
3 to 5	442	40 (35–46)	95 (86–102)	129 (120–142)	205* (200–381)
6 to 10	147	61 (44–79)	157* (117–250)	248* (150–381)	386* (221–401)
11 to 15	107	71 (58–83)	173* (166–196)	199* (173–296)	392* (296–514)
16 to 17	28	100* (80–121)	203* (197–248)	242* (206–643)	501* (241–643)
18 and older	1,633	81 (75–87)	200 (190–206)	279 (253–301)	506 (444–508)
14 and under	887	53 (47–59)	144 (101–173)	196 (173–220)	381 (367–401)
15 to 44	686	84 (77–91)	205 (197–226)	295 (253–345)	504 (438–818)
45 and older	1,002	78 (70–86)	191 (170–202)	245 (230–264)	413 (382–505)
All ages	2,575	78 (72–83)	196 (189–202)	258 (243–289)	468 (431–531)
Marine					
Females					
14 and under	670	71 (65–77)	134 (124–155)	183 (151–205)	240 (209–379)
15 to 44	412	91 (85–96)	188 (163–210)	241 (227–265)	376 (347–391)
45 and older	588	104 (94–113)	189 (170–213)	239 (222–283)	441 (359–647)
All ages	1,670	93 (88–98)	183 (174–192)	232 (227–250)	385 (354–397)
Males					
14 and under	677	81 (69–93)	198 (162–227)	231 (225–307)	353 (244–392)
15 to 44	412	127 (116–137)	240 (227–258)	279 (271–370)	568 (488–647)
45 and older	623	113 (107–120)	223 (205–252)	285 (250–324)	384 (359–480)
All ages	1,712	114 (107–120)	227 (223–236)	277 (270–297)	483 (390–501)
Both Sexes					
3 to 5	682	66 (60–71)	125 (114–150)	165 (139–190)	316* (227–390)
6 to 10	217	78 (67–89)	150 (129–201)	202* (165–317)	350* (223–392)
11 to 15	122	102 (85–118)	220* (205–265)	262* (227–307)	320* (277–379)
16 to 17	37	126* (80–171)	281* (241–354)	353* (241–390)	530* (291–650)
18 and older	1,978	108 (103–113)	217 (213–223)	270 (251–283)	464 (391–487)
14 and under	1,347	76 (68–85)	161 (149–201)	220 (183–227)	335 (307–379)
15 to 44	824	109 (101–116)	225 (213–233)	270 (247–279)	483 (390–634)
45 and older	1,211	108 (102–114)	206 (195–224)	272 (250–293)	407 (374–647)
All ages	3,382	103 (98–108)	215 (207–217)	258 (247–270)	395 (390–487)

Table 10-35. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (g/day), Uncooked Fish Weight[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
			All Fish		
Females					
14 and under	836	79 (73–85)	158 (142–198)	205 (180–218)	372 (254–381)
15 to 44	554	108 (97–118)	221 (197–236)	315 (246–378)	495 (394–508)
45 and older	751	117 (109–124)	215 (200–228)	270 (236–286)	444 (428–817)
All ages	2,141	107 (101–113)	207 (196–227)	275 (246–300)	453 (394–508)
Males					
14 and under	836	96 (85–107)	225 (195–254)	336 (286–353)	390 (381–401)
15 to 44	565	148 (139–156)	272 (253–334)	381 (323–431)	636 (595–647)
45 and older	849	139 (132–146)	274 (285–304)	348 (320–374)	505 (439–693)
All ages	2,250	136 (130–142)	266 (248–289)	354 (315–379)	595 (505–643)
Both Sexes					
3 to 5	834	74 (69–79)	149 (136–165)	184 (172–223)	363* (310–391)
6 to 10	270	95 (85–106)	200 (177–235)	313* (254–381)	387* (381–401)
11 to 15	172	113 (99–127)	227* (205–296)	308* (271–348)	380* (353–409)
16 to 17	52	136* (97–174)	242* (206–358)	357* (266–643)	645* (390–650)
18 and older	2,634	127 (122–133)	248 (236–264)	334 (321–349)	519 (508–634)
14 and under	1,672	88 (80–95)	191 (173–201)	249 (214–330)	381 (367–392)
15 to 44	1,119	128 (121–135)	255 (241–271)	358 (330–381)	609 (508–647)
45 and older	1,600	127 (120–134)	244 (230–258)	317 (304–330)	476 (439–593)
All ages	4,391	121 (116–126)	241 (233–255)	329 (314–343)	507 (486–593)

[a] Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period..

N = Sample size.

CI = Confidence interval.

BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.

* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-36. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a]					
Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
Freshwater and Estuarine					
Females					
14 and under	410	1,776 (1,543–2,009)	4,397 (3,635–4,535)	6,855 (4,881–9,166)	11,544 (9,166–16,108)
15 to 44	315	1,185 (962–1,408)	2,922 (2,294–3,314)	4,260 (3,266–5,973)	8,154 (6,721–20,620)
45 and older	432	986 (880–1,093)	2,655 (2,313–2,875)	3,263 (2,944–3,716)	4,630 (4,037–9,900)
All ages	1,157	1,185 (1,071–1,299)	2,875 (2,654–3,266)	4,033 (3,516–4,406)	8,608 (7,087–9,900)
Males					
14 and under	419	1,895 (1,618–2,172)	4,707 (3,992–4,990)	5,905 (5,522–6,103)	12,628 (8,111–15,495)
15 to 44	358	1,167 (1,034–1,299)	2,998 (2,724–3,349)	4,015 (3,712–4,635)	6,534 (5,511–8,577)
45 and older	548	1,076 (963–1,190)	2,467 (2,378–2,597)	3,447 (3,093–3,849)	6,574 (5,557–9,351)
All ages	1,325	1,238 (1,140–1,336)	3,052 (2,735–3,221)	4,257 (4,039–4,473)	7,998 (6,539–9,351)
Both Sexes					
3 to 5	416	2,292 (2,012–2,572)	5,852 (4,703–6,068)	7,160 (6,950–7,442)	15,600* (11,877–18,670)
6 to 10	132	1,830 (1,416–2,245)	4,688* (3,673–5,987)	6,207* (4,767–12,926)	12,365* (6,763–12,926)
11 to 15	101	1,273 (1,082–1,464)	2,777* (2,091–3,026)	4,419* (3,026–5,522)	5,717* (5,457–9,852)
16 to 17	28	1,401* (10,588–1,744)	2,971* (2,743–3,692)	3,279* (2,767–8,577)	6,819* (3,221–8,577)
18 and older	1,599	1,102 (1,023–1,181)	2,693 (2,507–2,820)	3,744 (3,520–4,037)	7,140 (6,388–8,604)
14 and under	829	1,834 (1,680–1,987)	4,512 (4,045–4,780)	5,986 (5,531–6,867)	12,389.(9,852–15,495)
15 to 44	673	1,175 (1,067–1,282)	2,978 (2,739–3,221)	4,125 (3,815–4,841)	8,580(5,973–9,477)
45 and older	980	1,032 (941–1,123)	2,508 (2,383–2,797)	3,319 (3,034–3,716)	6,122 (4,422–8,254)
All ages	2,482	1,213 (1,136–1,291)	2,947 (2,808–3,118)	4,135 (4,037–4,287)	8,587 (6,950–9,900)
Marine					
Females					
14 and under	629	2,893 (2,679–3,107)	6,279 (5,286–6,554)	7,899 (7,033–8,478)	10,514 (9,322–11,981)
15 to 44	403	1,475 (1,366–1,584)	3,102 (2,580–3,378)	3,927 (3,440–4,929)	6,491 (5,931–7,802)
45 and older	568	1,579 (1,439–1,719)	3,028 (2,676–3,239)	3,917 (3,584–4,560)	7,416 (6,021–12,395)
All ages	1,600	1,732 (1,649–1,815)	3,558 (3,335–3,880)	4,878 (4,560–5,640)	8,618 (7,802–9,322)
Males					
14 and under	643	2,885 (2,540–3,230)	6,244 (5,390–6,931)	8,068 (6,577–8,707)	11,871 (10,365–14,194)
15 to 44	409	1,579 (1,458–1,701)	3,063 (2,855–3,481)	3,736 (3,554–4,048)	7,103 (4,634–7,701)
45 and older	621	1,412 (1,328–1,496)	2,812 (2,589–3,072)	3,724 (3,386–3,987)	5,504 (5,134–6,321)
All ages					
Both Sexes					
3 to 5	640	3,689 (3,395–3,982)	7,253 (6,777–8,504)	9,270 (8,415–9,991)	16,100* (11,980–17,989)
6 to 10	203	2,787 (2,417–3,157)	5,910 (4,813–7,365)	8,001* (6,375–8,707)	10,754* (8,707–12,055)
11 to 15	120	2,020 (1,741–2,327)	4,224* (3,744–4,781)	5,195* (3,859–6,448)	6,839* (6,076–8,970)
16 to 17	37	2,007* (1,302–2,712)	4,468* (3,880–7,802)	6,537* (3,991–7,802)	7,886* (4,661–7,958)
18 and older	1,944	1,501 (1,440–1,562)	2,971 (2,740–3,098)	3,749 (3,579–3,962)	6,345 (5,653–7,224)
14 and under	1,272	2,892 (2,674–3,111)	6,290 (5,748–6,448)	8,047 (7,365–8,564)	11,507 (10,124–12,054)
15 to 44	812	1,527 (1,441–1,614)	3,093 (2,855–3,318)	3,872 (3,564–4,131)	6,898 (5,287–7,701)
45 and older	1,189	1,501 (1,416–1,586)	2,948 (2,664–3,232)	3,889 (3,494–4,030)	6,229 (5,409–9,759)
All ages					

Table 10-36. Consumer-Only Distributions of Fish (finfish and shellfish) Intake (mg/kg-day), Uncooked Fish Weight[a] (continued)

Age (years)	*N*	Mean (90% CI)	90th Percentile (90% BI)	95th Percentile (90% BI)	99th Percentile (90% BI)
			All Fish		
Females					
14 and under	779	3,202 (2,983–3,421)	6,854 (6,596–7,365)	8,808 (8,451–9,408)	13,907 (11,461–16,108)
15 to 44	541	1,728 (1,547–1,909)	3,437 (3,153–3,925)	5,045 (4,221–6,122)	8,011 (6,721–8,604)
45 and older	725	1,774 (1,657–1,890)	3,422 (3,098–3,767)	4,098 (3,870–4,853)	7,996 (6,121–15,117)
All ages	2,045	1,962 (1,864–2,061)	4,005 (3,831–4,278)	5,792 (5,097–6,059)	9,878 (8,970–12,235)
Males					
14 and under	788	3,314 (3,022–3,607)	7,402 (6,241–7,626)	8,720 (8,323–10,591)	13,025 (12,278–16,803)
15 to 44	561	1,851 (1,754–1,947)	3,599 (3,232–4,197)	4,461 (3,991–5,063)	7,621 (7,361–8,473)
45 and older	842	1,703 (1,616–1,791)	3,395 (3,118–3,638)	4,253 (3,912–4,685)	6,376 (5,514–9,351)
All ages	-	-	-	-	-
Both Sexes					
3 to 5	779	4,198 (3,894–4,502)	8,061 (7,366–9,223)	10,444 (9,475–12,261)	17,874* (15,290–18,670)
6 to 10	250	3,188 (2,923–3,452)	6,544 (6,013–8,707)	8,654* (7,086–11,756)	12,785* (10,930–13,979)
11 to 15	164	2,199 (1,950–2,449)	4,387* (3,785–5,522)	6,234* (4,420–7,589)	8,345* (6,076–8,970)
16 to 17	52	2,066* (1,529–2,603)	3,902* (3,536–7,892)	6,594* (4,661–8,577)	8,210* (7,892–8,577)
18 and older	2,585	1,758 (1,687–1,829)	3,438 (3,303–3,584)	4,492 (4,271–4,810)	7,510 (6,679–8,604)
14 and under	1,567	3,260 (3,062–3,457)	7,120 (6,533–7,859)	8,758 (8,487–9,362)	13,955 (12,926–15,495)
15 to 44	1,102	1,790 (1,696–1,884)	3,549 (3,318–3,833)	4,806 (4,214–5,422)	7,839 (7,361–8,604)
45 and older	1,567	1,740 (1,650–1,830)	3,416 (3,227–3,572)	4,261 (4,017–4,497)	6,704 (6,195–9,351)
All ages	-	-	-	-	-

a Estimates were projected from sample size to the U.S. population using 4-year combined survey weights; consumers only are those individuals who consumed fish at least once during the 2-day reporting period..
N = Sample size.
CI = Confidence interval.
BI = Bootstrap interval; percentile intervals (BI) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
* The sample size does not meet minimum reporting requirements as described in the *Third Report on Nutrition Monitoring in the United States* (LSRO, 1995).

Source: U.S. EPA, 2002.

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.41	85.1	0.00	0.25	1.00	1.32
Sex								
	Male	201	0.39	86.2	0.00	0.24	1.05	1.34
	Female	219	0.43	84.0	0.00	0.28	0.95	1.30
Age (years)-Sex Category								
	Child 1 to 5	26	0.32	51.7	0.00	0.05	0.95	1.47
	Child 6 to 10	26	0.51	86.7	0.00	0.35	1.13	1.29
	Child 11 to 15	21	0.27	85.6	0.00	0.19	0.52	0.89
	Female 16 to 29	17	0.67	79.9	0.00	0.31	1.06	4.02
	Female 30 to 49	85	0.46	86.7	0.00	0.28	1.00	1.36
	Female 50+	77	0.43	90.6	0.01	0.33	0.96	1.33
	Male 16 to 29	14	0.16	70.5	0.00	0.14	0.41	0.53
	Male 30 to 49	80	0.47	92.8	0.03	0.29	1.13	1.44
	Male 50+	63	0.35	90.5	0.02	0.22	0.86	1.11
	Unknown	11	0.09	76.1	0.00	0.02	0.37	0.45
Race/Ethnicity								
	White, Non-Hispanic	370	0.41	88.7	0.00	0.27	0.98	1.27
	Black, Non-Hispanic	9	0.05	33.5	0.00	0.00	0.17	*
	Hispanic	20	0.48	70.9	0.00	0.21	1.53	2.29
	Asian	19	0.61	59.2	0.00	0.14	1.33	3.80
	Unknown	2	0.01	43.4	0.00	0.00	*	*
Respondent Education								
	0 to 11 years	13	0.33	100.0	0.05	0.15	1.04	1.39
	High School	87	0.38	85.3	0.00	0.22	1.00	1.14
	Some College	62	0.41	88.7	0.00	0.30	0.80	1.41
	College Grad	258	0.43	83.4	0.00	0.25	1.03	1.32
Household Income ($)								
	0 to 20,000	40	0.39	86.4	0.00	0.26	0.96	1.45
	20,000 to 50,000	150	0.47	87.4	0.00	0.28	1.04	1.43
	>50,000	214	0.38	84.1	0.00	0.24	0.99	1.27
	Unknown	16	0.32	73.4	0.00	0.30	0.75	1.00
Florida								
All		15,367	0.47	50.5	0.00	0.06	1.27	1.91
Sexes								
	Male	7,911	0.44	49.2	0.00	0.00	1.22	1.84
	Female	7,426	0.50	51.9	0.00	0.10	1.32	1.98
	Unknown	30	0.41	48.0	0.00	0.00	1.41	2.38

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)								
					Percentiles			
State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
Florida (continued)								
Age (years)-Sex Category								
	Child 1 to 5	1,102	0.89	37.8	0.00	0.00	2.75	3.97
	Child 6 to 10	938	0.44	39.4	0.00	0.00	1.37	2.03
	Child 11 to 15	864	0.37	42.9	0.00	0.00	1.02	1.44
	Female 16 to 29	1,537	0.44	49.1	0.00	0.00	1.10	1.75
	Female 30 to 49	2,264	0.53	56.6	0.00	0.20	1.38	1.98
	Female 50+	2,080	0.41	56.5	0.00	0.20	1.14	1.62
	Male 16 to 29	1,638	0.44	46.1	0.00	0.00	1.11	1.72
	Male 30 to 49	2,540	0.43	53.0	0.00	0.11	1.17	1.77
	Male 50+	2,206	0.38	54.5	0.00	0.15	0.98	1.46
	Unknown	198	0.35	54.7	0.00	0.20	0.88	1.22
Race/Ethnicity								
	White, Non-Hispanic	11,607	0.46	51.6	0.00	0.09	1.24	1.84
	Black, Non-Hispanic	1,603	0.54	48.3	0.00	0.00	1.49	2.24
	Hispanic	1,556	0.46	45.9	0.00	0.00	1.20	1.96
	Asian	223	0.58	49.5	0.00	0.00	1.33	1.78
	American Indian	104	0.63	53.4	0.00	0.15	1.95	3.61
	Unknown	274	0.43	45.9	0.00	0.00	1.17	1.71
Respondent Education								
	0 to 11 years	1,481	0.40	41.5	0.00	0.00	1.16	1.69
	High School	4,992	0.46	48.5	0.00	0.00	1.26	1.96
	Some College	4,791	0.49	52.3	0.00	0.11	1.30	1.98
	College Grad	4,012	0.47	54.2	0.00	0.15	1.30	1.85
	Unknown	91	0.46	41.2	0.00	0.00	1.57	2.61
Household Income ($)								
	0 to 20,000	3,314	0.47	45.9	0.00	0.00	1.21	2.11
	20,000 to 50,000	6,678	0.48	50.4	0.00	0.06	1.28	1.92
	>50,000	3,136	0.51	57.5	0.00	0.21	1.38	1.99
	Unknown	2,239	0.35	47.6	0.00	0.00	1.09	1.57
Minnesota								
All		837	0.31	94.4	0.02	0.18	0.62	1.07
Sexes								
	Male	419	0.26	95.3	0.02	0.16	0.58	1.06
	Female	418	0.36	93.4	0.02	0.21	0.65	1.10
Age (years)-Sex Category								
	Child 1 to 5	47	0.57	97.4	0.05	0.45	1.09	1.74
	Child 6 to 10	46	0.33	88.4	0.00	0.21	0.82	1.34
	Child 11 to 15	68	0.22	92.8	0.02	0.19	0.54	0.59
	Female 16 to 29	47	0.67	96.0	0.02	0.15	0.61	4.48
	Female 30 to 49	132	0.24	95.0	0.02	0.22	0.50	0.58

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Age (years)-Sex Category								
	Female 50+	162	0.34	94.9	0.03	0.21	0.90	1.35
	Male 16 to 29	55	0.10	92.3	0.01	0.07	0.26	0.33
	Male 30 to 49	120	0.24	96.0	0.04	0.16	0.42	0.64
	Male 50+	155	0.24	99.8	0.05	0.19	0.53	0.68
	Unknown	5	0.00	1.6	0.00	0.00	0.00	0.00
Race/Ethnicity								
	White, Non-Hispanic	775	0.27	93.8	0.02	0.17	0.59	0.90
	Black, Non-Hispanic	1	0.00	*	*	*	*	*
	Hispanic	3	0.65	100.0	*	0.27	*	*
	Asian	7	0.53	100.0	0.13	0.47	*	*
	American Indian	12	2.08	100.0	0.09	0.16	*	*
	Unknown	39	0.32	100.0	0.10	0.24	0.79	1.02
Respondent Education								
	0 to 11 years	46	0.34	86.2	0.00	0.19	1.23	1.56
	High School	234	0.29	92.9	0.02	0.17	0.65	1.11
	Some College	259	0.41	95.3	0.03	0.20	0.65	0.95
	College Grad	255	0.26	95.0	0.02	0.17	0.57	1.05
	Unknown	43	0.24	99.7	0.09	0.23	0.41	0.51
Household Income ($)								
	0 to 20,000	87	0.40	91.0	0.03	0.20	1.20	1.61
	20,000 to 50,000	326	0.34	91.3	0.01	0.17	0.62	0.90
	>50,000	327	0.29	97.9	0.03	0.18	0.62	1.09
	Unknown	97	0.24	92.9	0.03	0.21	0.56	0.68
North Dakota								
All		575	0.32	95.2	0.03	0.18	0.71	1.18
Sexes								
	Male	276	0.32	96.2	0.04	0.19	0.68	1.20
	Female	299	0.32	94.2	0.03	0.17	0.73	1.16
Age (years)-Sex Category								
	Child 1 to 5	30	0.67	94.4	0.04	0.22	1.56	3.83
	Child 6 to 10	44	0.51	92.0	0.07	0.29	1.14	1.49
	Child 11 to 15	55	0.40	97.1	0.06	0.21	1.01	1.24
	Female 16 to 29	42	0.18	89.9	0.00	0.11	0.39	0.63
	Female 30 to 49	95	0.28	98.3	0.04	0.18	0.55	0.86
	Female 50+	99	0.38	93.4	0.02	0.16	0.99	1.47
	Male 16 to 29	36	0.22	100.0	0.04	0.13	0.45	0.56
	Male 30 to 49	90	0.22	97.8	0.04	0.18	0.45	0.54
	Male 50+	81	0.29	94.0	0.01	0.18	0.67	1.16
	Unknown	3	0.11	31.5	0.00	0.00	*	*

Table 10-37. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Race/Ethnicity								
	White, Non-Hispanic	528	0.33	95.1	0.03	0.18	0.72	1.21
	Black, Non-Hispanic	2	0.25	100.0	*	0.25	*	*
	Asian	4	0.20	100.0	*	0.18	*	*
	American Indian	9	0.30	100.0	0.08	0.25	0.69	*
	Unknown	32	0.30	93.5	0.05	0.13	0.71	0.94
Respondent Education								
	0 to 11 years	29	0.23	86.6	0.00	0.11	0.65	0.86
	High School	138	0.42	97.3	0.04	0.20	0.89	1.56
	Some College	183	0.28	95.2	0.03	0.18	0.63	0.99
	College Grad	188	0.31	96.7	0.04	0.18	0.69	1.26
	Unknown	37	0.35	87.2	0.00	0.10	0.73	1.32
Household Income ($)								
	0 to 20,000	51	0.52	93.7	0.02	0.17	1.79	2.55
	20,000 to 50,000	235	0.27	94.2	0.02	0.14	0.70	1.13
	>50,000	233	0.31	97.1	0.05	0.22	0.63	1.02
	Unknown	56	0.42	92.7	0.04	0.18	0.79	1.21

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		362	0.48	100	0.07	0.32	1.09	1.37
Sex								
	Male	175	0.45	100	0.08	0.29	1.11	1.40
	Female	187	0.52	100	0.05	0.34	1.03	1.35
Age (years)-Sex Category								
	Child 1 to 5	14	0.61	100	0.16	0.55	1.42	1.56
	Child 6 to 10	22	0.59	100	0.14	0.47	1.15	1.30
	Child 11 to 15	18	0.32	100	0.07	0.19	0.52	0.84
	Female 16 to 29	14	0.84	100	0.11	0.35	1.12	3.10
	Female 30 to 49	74	0.53	100	0.05	0.34	1.12	1.48
	Female 50+	70	0.48	100	0.05	0.37	1.03	1.36
	Male 16 to 29	10	0.23	100	0.08	0.21	0.47	0.56
	Male 30 to 49	74	0.51	100	0.11	0.35	1.15	1.46
	Male 50+	57	0.38	100	0.10	0.26	0.93	1.12
	Unknown	9	0.12	100	0.01	0.04	0.39	*
Race/Ethnicity								
	White, Non-Hispanic	331	0.46	100	0.07	0.32	1.05	1.31
	Black, Non-Hispanic	3	0.15	100	*	0.15	*	*
	Hispanic	15	0.68	100	0.12	0.30	1.86	2.47
	Asian	12	1.03	100	0.09	0.48	1.95	4.78
	Unknown	1	0.01	100	*	*	*	*
Respondent Education								
	0 to 11 years	13	0.32	100	0.05	0.15	0.97	1.37
	High School	76	0.44	100	0.05	0.27	1.04	1.15
	Some College	56	0.46	100	0.10	0.34	0.85	1.43
	College Grad	217	0.51	100	0.08	0.33	1.12	1.39
Household Income ($)								
	0 to 20,000	35	0.45	100	0.08	0.32	1.13	1.47
	20,000 to 50,000	133	0.54	100	0.07	0.33	1.12	1.45
	>50,000	182	0.45	100	0.07	0.30	1.06	1.31
	Unknown	12	0.44	100	0.10	0.41	0.84	1.03
Florida								
All		7,757	0.93	100	0.19	0.58	1.89	2.73
Sexes								
	Male	3,880	0.90	100	0.18	0.55	1.85	2.65
	Female	3,861	0.95	100	0.19	0.62	1.94	2.78
	Unknown	16	0.85	100	0.12	0.69	2.37	2.61

Table 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida (continued)								
Age (years)-Sex Category								
	Child 1 to 5	420	2.34	100	0.50	1.74	4.67	6.80
	Child 6 to 10	375	1.10	100	0.28	0.81	2.23	2.97
	Child 11 to 15	365	0.85	100	0.20	0.63	1.62	2.16
	Female 16 to 29	753	0.89	100	0.16	0.55	1.77	2.42
	Female 30 to 49	1,287	0.94	100	0.18	0.63	1.86	2.68
	Female 50+	1,171	0.73	100	0.19	0.52	1.52	2.05
	Male 16 to 29	754	0.96	100	0.16	0.52	1.77	2.65
	Male 30 to 49	1,334	0.81	100	0.17	0.53	1.69	2.44
	Male 50+	1,192	0.70	100	0.17	0.50	1.41	1.93
	Unknown	106	0.64	100	0.21	0.49	1.15	1.55
Race/Ethnicity								
	White, Non-Hispanic	5,957	0.88	100	0.18	0.56	1.82	2.61
	Black, Non-Hispanic	785	1.11	100	0.23	0.73	2.27	3.21
	Hispanic	721	1.01	100	0.17	0.60	2.08	2.81
	Asian	110	1.16	100	0.27	0.67	1.78	3.29
	American Indian	57	1.17	100	0.21	0.69	3.13	4.70
	Unknown	127	0.94	100	0.19	0.67	1.73	2.43
Respondent Education								
	0 to 11 years	613	0.96	100	0.22	0.60	1.86	2.81
	High School	2,405	0.96	100	0.18	0.58	1.98	2.83
	Some College	2,511	0.93	100	0.18	0.58	1.91	2.70
	College Grad	2,190	0.87	100	0.19	0.57	1.79	2.47
	Unknown	38	1.13	100	0.25	0.85	2.69	2.74
Household Income ($)								
	0 to 20,000	1,534	1.03	100	0.19	0.61	2.22	2.99
	20,000 to 50,000	3,370	0.95	100	0.19	0.60	1.91	2.78
	>50,000	1,806	0.89	100	0.17	0.56	1.87	2.73
	Unknown	1,047	0.74	100	0.17	0.51	1.61	2.09
Minnesota								
All Sexes		793	0.33	100	0.04	0.2	0.65	1.08
	Male	401	0.28	100	0.04	0.17	0.62	1.07
	Female	392	0.38	100	0.05	0.22	0.7	1.22
Age (years)-Sex Category								
	Child 1 to 5	46	0.58	100	0.07	0.46	1.1	1.75
	Child 6 to 10	42	0.38	100	0.05	0.25	1.01	1.36
	Child 11 to 15	63	0.24	100	0.03	0.21	0.55	0.59

Table 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Age (years)-Sex Category								
	Female 16 to 29	44	0.69	100	0.02	0.16	0.66	2.95
	Female 30 to 49	127	0.25	100	0.04	0.23	0.51	0.58
	Female 50+	150	0.36	100	0.05	0.22	0.93	1.37
	Male 16 to 29	52	0.11	100	0.02	0.08	0.27	0.33
	Male 30 to 49	115	0.25	100	0.07	0.17	0.42	0.64
	Male 50+	153	0.24	100	0.05	0.19	0.53	0.68
	Unknown	1	0.18	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	732	0.29	100	0.04	0.19	0.60	0.98
	Black, Non-Hispanic	*	*	100	*	*	*	*
	Hispanic	3	0.65	100	*	0.27	*	*
	Asian	7	0.53	100	0.13	0.46	*	*
	American Indian	12	2.08	100	0.09	0.15	*	*
	Unknown	39	0.32	100	0.10	0.24	0.79	1.01
Respondent Education								
	0 to 11 years	41	0.39	100	0.07	0.20	1.37	1.56
	High School	219	0.31	100	0.04	0.18	0.68	1.13
	Some College	249	0.43	100	0.04	0.22	0.65	0.98
	College Grad	242	0.27	100	0.04	0.19	0.58	1.05
	Unknown	42	0.24	100	0.09	0.23	0.41	0.50
Household Income ($)								
	0 to 20,000	77	0.44	100	0.09	0.20	1.30	1.63
	20,000 to 50,000	301	0.37	100	0.05	0.18	0.65	0.96
	>50,000	321	0.29	100	0.03	0.19	0.62	1.10
	Unknown	94	0.26	100	0.05	0.23	0.57	0.69
North Dakota								
All Sexes		546	0.34	100	0.05	0.19	0.74	1.21
	Male	265	0.33	100	0.04	0.20	0.74	1.22
	Female	281	0.34	100	0.05	0.18	0.74	1.20
Age (years)-Sex Category								
	Child 1 to 5	28	0.70	100	0.05	0.23	1.58	3.82
	Child 6 to 10	41	0.56	100	0.11	0.30	1.17	1.51
	Child 11 to 15	53	0.41	100	0.06	0.22	1.04	1.26
	Female 16 to 29	38	0.20	100	0.04	0.15	0.41	0.67
	Female 30 to 49	93	0.29	100	0.05	0.18	0.56	0.87
	Female 50+	92	0.40	100	0.06	0.17	1.14	1.52
	Male 16 to 29	36	0.22	100	0.04	0.13	0.45	0.56

Table 10-38. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics (g/kg-day, as-consumed) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
North Dakota (continued)								
Age (years)-Sex Category								
	Male 30 to 49	88	0.22	100	0.05	0.18	0.45	0.54
	Male 50+	76	0.31	100	0.04	0.19	0.74	1.20
	Unknown	1	0.34	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	501	0.34	100	0.05	0.19	0.74	1.23
	Black, Non-Hispanic	2	0.25	100	*	0.25	*	*
	Asian	4	0.20	100	*	0.14	*	*
	American Indian	9	0.30	100	0.08	0.25	0.61	*
	Unknown	30	0.32	100	0.05	0.16	0.73	0.95
Respondent Education								
	0 to 11 years	25	0.26	100	0.07	0.12	0.73	0.90
	High School	134	0.43	100	0.05	0.20	0.98	1.62
	Some College	174	0.29	100	0.05	0.20	0.65	1.02
	College Grad	181	0.32	100	0.05	0.19	0.72	1.30
	Unknown	32	0.40	100	0.04	0.13	0.84	1.43
Household Income ($)								
	0 to 20,000	48	0.55	100	0.07	0.19	1.80	2.62
	20,000 to 50,000	221	0.29	100	0.04	0.15	0.73	1.17
	>50,000	225	0.32	100	0.06	0.23	0.64	1.04
	Unknown	52	0.45	100	0.05	0.20	0.82	1.28

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-39. Fish Consumption per kg Body Weight, all Respondents by State, Acquisition Method, (g/kg-day, as-consumed)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.41	85.1	0.00	0.25	1.00	1.32
Acquisition Method								
	Bought	420	0.40	84.8	0.00	0.25	0.96	1.30
	Caught	420	0.01	16.3	0.00	0.00	0.01	0.03
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	40	0.38	86.4	0.00	0.26	0.96	1.45
	Bought; 20,000 to 50,000	150	0.46	86.6	0.00	0.27	0.93	1.42
	Bought; >50,000	214	0.38	84.1	0.00	0.24	0.99	1.27
	Bought; Unknown	16	0.32	73.4	0.00	0.30	0.75	1.00
	Caught; 0 to 20,000	40	0.01	11.0	0.00	0.00	0.00	0.05
	Caught; 20,000 to 50,000	150	0.01	18.1	0.00	0.00	0.02	0.06
	Caught; >50,000	214	0.01	16.8	0.00	0.00	0.01	0.02
	Caught; Unknown	16	0.00	6.2	0.00	0.00	0.00	0.01
Habitat								
	Freshwater	420	0.01	36.4	0.00	0.00	0.03	0.07
	Estuarine	420	0.10	76.0	0.00	0.04	0.23	0.43
	Marine	420	0.29	84.8	0.00	0.17	0.67	0.97
Fish/Shellfish Type								
	Shellfish	420	0.13	74.6	0.00	0.06	0.30	0.55
	Finfish	420	0.27	82.7	0.00	0.14	0.69	0.95
Florida								
All		15,367	0.47	50.5	0.00	0.06	1.27	1.91
Acquisition Method								
	Bought	15,367	0.41	47.5	0.00	0.00	1.12	1.70
	Caught	15,367	0.06	7.4	0.00	0.00	0.00	0.34
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	3,314	0.41	42.5	0.00	0.00	1.10	1.84
	Bought; 20,000 to 50,000	6,678	0.41	47.4	0.00	0.00	1.11	1.68
	Bought; >50,000	3,136	0.45	54.2	0.00	0.14	1.27	1.79
	Bought; Unknown	2,239	0.32	45.3	0.00	0.00	0.99	1.45
	Caught; 0 to 20,000	3,314	0.06	6.7	0.00	0.00	0.00	0.32
	Caught; 20,000 to 50,000	6,678	0.07	7.8	0.00	0.00	0.00	0.38
	Caught; >50,000	3,136	0.06	8.4	0.00	0.00	0.00	0.42
	Caught; Unknown	2,239	0.03	5.5	0.00	0.00	0.00	0.16
Habitat								
	Freshwater	15,367	0.04	9.1	0.00	0.00	0.00	0.26
	Estuarine	15,367	0.10	26.5	0.00	0.00	0.32	0.54
	Marine	15,367	0.33	40.3	0.00	0.00	0.90	1.43
Fish/Shellfish Type								
	Shellfish	15,367	0.07	21.1	0.00	0.00	0.22	0.43
	Finfish	15,367	0.39	41.9	0.00	0.00	1.10	1.67

Table 10-39. Fish Consumption per kg Body Weight, all Respondents by State, Acquisition Method, (g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota								
All		837	0.31	94.4	0.02	0.18	0.62	1.07
Acquisition Method								
	Bought	837	0.20	89.9	0.00	0.10	0.51	0.76
	Caught	837	0.11	60.6	0.00	0.03	0.22	0.37
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	87	0.26	90.7	0.02	0.12	0.61	1.06
	Bought; 20,000 to 50,000	326	0.18	84.4	0.00	0.10	0.45	0.58
	Bought; >50,000	327	0.20	93.9	0.02	0.10	0.55	0.86
	Bought; Unknown	97	0.21	91.3	0.01	0.18	0.54	0.65
	Caught; 0 to 20,000	87	0.14	70.4	0.00	0.03	0.28	1.00
	Caught; 20,000 to 50,000	326	0.15	66.0	0.00	0.04	0.25	0.36
	Caught; >50,000	327	0.09	55.5	0.00	0.02	0.24	0.39
	Caught; Unknown	97	0.04	56.7	0.00	0.02	0.12	0.14
Habitat								
	Freshwater	837	0.11	60.6	0.00	0.03	0.22	0.37
	Estuarine	837	0.02	67.5	0.00	0.01	0.05	0.09
	Marine	837	0.18	89.9	0.00	0.09	0.46	0.68
Fish/Shellfish Type								
	Shellfish	837	0.04	67.5	0.00	0.01	0.10	0.18
	Finfish	837	0.27	94.0	0.01	0.15	0.57	0.83
North Dakota								
All		575	0.32	95.2	0.03	0.18	0.71	1.18
Acquisition Method								
	Bought	575	0.23	89.9	0.00	0.10	0.52	0.93
	Caught	575	0.09	68.3	0.00	0.04	0.24	0.40
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	51	0.41	88.0	0.00	0.12	1.34	2.03
	Bought; 20,000 to 50,000	235	0.21	90.6	0.01	0.09	0.48	1.01
	Bought; >50,000	233	0.19	90.7	0.01	0.10	0.48	0.77
	Bought; Unknown	56	0.30	85.5	0.00	0.10	0.66	0.91
	Caught; 0 to 20,000	51	0.10	53.9	0.00	0.01	0.23	0.45
	Caught; 20,000 to 50,000	235	0.07	59.4	0.00	0.02	0.18	0.30
	Caught; >50,000	233	0.12	76.2	0.00	0.06	0.34	0.46
	Caught; Unknown	56	0.11	85.7	0.00	0.05	0.22	0.23
Habitat								
	Freshwater	575	0.09	68.3	0.00	0.04	0.24	0.40
	Estuarine	575	0.02	71.3	0.00	0.01	0.05	0.08
	Marine	575	0.21	89.9	0.00	0.09	0.45	0.80

Table 10-39. Fish Consumption per kg Body Weight, all Respondents by State, Acquisition Method,g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Fish/Shellfish Type								
	Shellfish	575	0.04	71.3	0.00	0.02	0.09	0.15
	Finfish	575	0.28	94.3	0.02	0.14	0.63	1.01

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.
A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-40. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method (g/kg-day, as-consumed)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		362	0.48	100	0.07	0.32	1.09	1.37
Acquisition Method								
	Bought	361	0.47	100	0.07	0.31	1.05	1.38
	Caught	71	0.05	100	0.00	0.02	0.13	0.18
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	35	0.44	100	0.08	0.30	1.13	1.47
	Bought; 20,000 to 50,000	132	0.53	100	0.07	0.32	1.03	1.46
	Bought; >50,000	182	0.45	100	0.06	0.30	1.04	1.29
	Bought; Unknown	12	0.44	100	0.10	0.41	0.84	1.03
	Caught; 0 to 20,000	4	0.05	100	*	0.01	*	*
	Caught; 20,000 to 50,000	30	0.08	100	0.00	0.02	0.23	0.46
	Caught; >50,000	36	0.03	100	0.00	0.02	0.08	0.11
	Caught; Unknown	1	0.01	100	*	*	*	*
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	1	0.01	100	*	*	*	*
	Eats Caught and Bought	70	0.49	100	0.10	0.34	1.10	1.33
	Eats Bought Only	291	0.48	100	0.06	0.32	1.06	1.39
Habitat								
	Freshwater	157	0.04	100	0.00	0.02	0.07	0.15
	Estuarine	327	0.14	100	0.01	0.06	0.30	0.51
	Marine	361	0.34	100	0.04	0.23	0.78	1.09
Eats Freshwater/Estuarine Caught Fish								
	Sometimes	50	0.46	100	0.09	0.29	1.10	1.25
	Never	312	0.49	100	0.07	0.32	1.06	1.41
Fish/Shellfish Type								
	Shellfish	320	0.18	100	0.02	0.09	0.37	0.68
	Finfish	353	0.32	100	0.02	0.20	0.77	1.08
Florida								
All		7,757	0.93	100	0.19	0.58	1.89	2.73
Acquisition Method								
	Bought	7,246	0.86	100	0.17	0.54	1.77	2.55
	Caught	1,212	0.83	100	0.15	0.52	1.74	2.36
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	1,418	0.97	100	0.19	0.58	2.10	2.78
	Bought; 20,000 to 50,000	3,141	0.87	100	0.18	0.56	1.74	2.50
	Bought; >50,000	1,695	0.83	100	0.16	0.53	1.75	2.54
	Bought; Unknown	992	0.71	100	0.16	0.48	1.55	2.06
	Caught; 0 to 20,000	246	0.89	100	0.19	0.60	1.94	2.77
	Caught; 20,000 to 50,000	563	0.90	100	0.15	0.53	1.79	2.38
	Caught; >50,000	274	0.76	100	0.11	0.49	1.63	2.42
	Caught; Unknown	129	0.58	100	0.16	0.41	1.07	1.52

Table 10-40. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method,(g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Florida (continued)								
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	511	0.76	100	0.15	0.50	1.67	2.34
	Eats Caught and Bought	701	1.81	100	0.50	1.15	3.35	5.09
	Eats Bought Only	6,545	0.85	100	0.18	0.54	1.75	2.49
Habitat								
	Freshwater	1,426	0.47	100	0.07	0.30	1.09	1.51
	Estuarine	4,124	0.37	100	0.07	0.23	0.80	1.14
	Marine	6,124	0.81	100	0.15	0.50	1.64	2.40
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	235	0.71	100	0.10	0.42	1.60	2.16
	Sometimes	458	1.73	100	0.43	1.10	3.44	4.96
	Never	7,064	0.88	100	0.18	0.56	1.81	2.60
Fish/Shellfish Type								
	Shellfish	3,260	0.35	100	0.07	0.21	0.74	1.02
	Finfish	6,428	0.94	100	0.24	0.60	1.85	2.72
Minnesota								
All		793	0.33	100	0.04	0.20	0.65	1.08
Acquisition Method								
	Bought	755	0.22	100	0.03	0.12	0.55	0.83
	Caught	593	0.18	100	0.02	0.07	0.30	0.57
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	76	0.29	100	0.04	0.13	0.64	1.08
	Bought; 20,000 to 50,000	284	0.22	100	0.03	0.13	0.47	0.74
	Bought; >50,000	312	0.21	100	0.03	0.11	0.57	0.97
	Bought; Unknown	83	0.23	100	0.02	0.2	0.54	0.65
	Caught; 0 to 20,000	56	0.19	100	0.02	0.05	0.49	1.09
	Caught; 20,000 to 50,000	232	0.23	100	0.02	0.08	0.30	0.46
	Caught; >50,000	235	0.16	100	0.02	0.08	0.37	0.65
	Caught; Unknown	70	0.07	100	0.02	0.03	0.14	0.16
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	38	0.16	100	0.02	0.08	0.37	0.51
	Eats Caught and Bought	555	0.40	100	0.08	0.23	0.70	1.32
	Eats Bought Only	200	0.23	100	0.02	0.14	0.56	0.91
Habitat								
	Freshwater	593	0.18	100	0.02	0.07	0.30	0.57
	Estuarine	559	0.03	100	0.00	0.01	0.07	0.12
	Marine	755	0.20	100	0.02	0.10	0.50	0.73
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	38	0.16	100	0.02	0.08	0.37	0.51
	Sometimes	555	0.40	100	0.08	0.23	0.70	1.32
	Never	200	0.23	100	0.02	0.14	0.56	0.91
					10th	50th	90th	95th

Table 10-40. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method,(g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Fish/Shellfish Type								
	Shellfish	559	0.06	100	0.01	0.02	0.14	0.24
	Finfish	791	0.28	100	0.03	0.16	0.57	0.86
North Dakota								
All		546	0.34	100	0.05	0.19	0.74	1.21
Acquisition Method								
	Bought	516	0.25	100	0.03	0.12	0.61	1.02
	Caught	389	0.14	100	0.02	0.07	0.34	0.46
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	45	0.47	100	0.05	0.14	1.54	2.22
	Bought; 20,000 to 50,000	213	0.23	100	0.03	0.11	0.52	1.03
	Bought; >50,000	210	0.21	100	0.03	0.11	0.48	0.79
	Bought; Unknown	48	0.35	100	0.03	0.14	0.70	1.08
	Caught; 0 to 20,000	27	0.19	100	0.01	0.08	0.42	0.64
	Caught; 20,000 to 50,000	142	0.11	100	0.02	0.05	0.25	0.40
	Caught; >50,000	173	0.15	100	0.02	0.08	0.38	0.53
	Caught; Unknown	47	0.13	100	0.03	0.06	0.23	0.24
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	30	0.21	100	0.05	0.14	0.33	0.51
	Eats Caught and Bought	359	0.39	100	0.07	0.23	0.82	1.25
	Eats Bought Only	157	0.25	100	0.03	0.10	0.53	0.97
Habitat								
	Freshwater	389	0.14	100	0.02	0.07	0.34	0.46
	Estuarine	407	0.03	100	0.00	0.01	0.06	0.10
	Marine	516	0.23	100	0.02	0.10	0.54	0.86
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	30	0.21	100	0.05	0.14	0.33	0.51
	Sometimes	359	0.39	100	0.07	0.23	0.82	1.25
	Never	157	0.25	100	0.03	0.10	0.53	0.97
Fish/Shellfish Type								
	Shellfish	407	0.05	100	0.01	0.02	0.13	0.21
	Finfish	541	0.30	100	0.04	0.16	0.67	1.08

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.
A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-41. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics, Uncooked (g/kg-day)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.56	85.1	0.00	0.35	1.37	1.76
Sex								
	Male	201	0.53	86.2	0.00	0.34	1.48	1.78
	Female	219	0.59	84.0	0.00	0.39	1.29	1.73
Age (years)-Sex Category								
	Child 1 to 5	26	0.43	51.7	0.00	0.07	1.25	1.95
	Child 6 to 10	26	0.71	86.7	0.00	0.48	1.55	1.74
	Child 11 to 15	21	0.37	85.6	0.00	0.25	0.71	1.20
	Female 16 to 29	17	0.88	79.9	0.00	0.43	1.41	5.25
	Female 30 to 49	85	0.64	86.7	0.00	0.39	1.39	1.80
	Female 50+	77	0.59	90.6	0.01	0.45	1.28	1.74
	Male 16 to 29	14	0.23	70.5	0.00	0.21	0.55	0.74
	Male 30 to 49	80	0.64	92.8	0.04	0.43	1.56	1.97
	Male 50+	63	0.47	90.5	0.03	0.36	1.15	1.55
	Unknown	11	0.12	76.1	0.00	0.03	0.52	0.62
Race/Ethnicity								
	White, Non-Hispanic	370	0.56	88.7	0.00	0.38	1.32	1.69
	Black, Non-Hispanic	9	0.07	33.5	0.00	0.00	0.23	*
	Hispanic	20	0.67	70.9	0.00	0.29	2.14	3.43
	Asian	19	0.81	59.2	0.00	0.18	1.74	4.96
	Unknown	2	0.01	43.4	0.00	0.00	*	*
Respondent Education								
	0 to 11 years	13	0.43	100.0	0.07	0.20	1.34	1.74
	High School	87	0.51	85.3	0.00	0.30	1.40	1.55
	Some College	62	0.56	88.7	0.00	0.41	1.09	1.87
	College Grad	258	0.58	83.4	0.00	0.36	1.40	1.78
Household Income ($)								
	0 to 20,000	40	0.52	86.4	0.00	0.34	1.28	1.86
	20,000 to 50,000	150	0.64	87.4	0.00	0.39	1.40	1.93
	>50,000	214	0.52	84.1	0.00	0.34	1.37	1.69
	Unknown	16	0.45	73.4	0.00	0.42	1.02	1.36
Florida								
All		15,367	0.59	50.5	0.00	0.08	1.59	2.39
Sexes								
	Male	7,911	0.55	49.2	0.00	0.00	1.51	2.32
	Female	7,426	0.62	51.9	0.00	0.14	1.66	2.48
	Unknown	30	0.51	48.0	0.00	0.00	1.73	2.90

Table 10-41. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics, Uncooked (g/kg-day) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Florida (continued)								
Age (years)-Sex Category								
	Child 1 to 5	1,102	1.10	37.8	0.00	0.00	3.41	4.85
	Child 6 to 10	938	0.54	39.4	0.00	0.00	1.69	2.55
	Child 11 to 15	864	0.46	42.9	0.00	0.00	1.27	1.92
	Female 16 to 29	1,537	0.55	49.1	0.00	0.00	1.42	2.20
	Female 30 to 49	2,264	0.67	56.6	0.00	0.27	1.73	2.56
	Female 50+	2,080	0.52	56.5	0.00	0.27	1.44	2.04
	Male 16 to 29	1,638	0.55	46.1	0.00	0.00	1.41	2.20
	Male 30 to 49	2,540	0.54	53.0	0.00	0.16	1.49	2.21
	Male 50+	2,206	0.49	54.5	0.00	0.20	1.24	1.86
	Unknown	198	0.45	54.7	0.00	0.27	1.07	1.53
Race/Ethnicity								
	White, Non-Hispanic	11,607	0.57	51.6	0.00	0.12	1.56	2.33
	Black, Non-Hispanic	1,603	0.67	48.3	0.00	0.00	1.87	2.77
	Hispanic	1,556	0.57	45.9	0.00	0.00	1.52	2.46
	Asian	223	0.72	49.5	0.00	0.00	1.65	2.34
	American Indian	104	0.78	53.4	0.00	0.20	2.46	4.52
	Unknown	274	0.53	45.9	0.00	0.00	1.45	2.14
Respondent Education								
	0 to 11 years	1,481	0.50	41.5	0.00	0.00	1.45	2.16
	High School	4,992	0.58	48.5	0.00	0.00	1.59	2.45
	Some College	4,791	0.61	52.3	0.00	0.15	1.59	2.47
	College Grad	4,012	0.60	54.2	0.00	0.20	1.64	2.34
	Unknown	91	0.58	41.2	0.00	0.00	2.04	3.05
Household Income ($)								
	0 to 20,000	3,314	0.59	45.9	0.00	0.00	1.55	2.61
	20,000 to 50,000	6,678	0.61	50.4	0.00	0.08	1.61	2.42
	>50,000	3,136	0.65	57.5	0.00	0.27	1.77	2.53
	Unknown	2,239	0.45	47.6	0.00	0.00	1.36	1.99
Minnesota								
All		837	0.41	94.4	0.03	0.24	0.83	1.43
Sexes								
	Male	419	0.35	95.3	0.03	0.22	0.77	1.41
	Female	418	0.48	93.4	0.02	0.27	0.87	1.46

Table 10-41. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics, Uncooked (g/kg-day) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Age (years)-Sex Category								
	Child 1 to 5	47	0.76	97.4	0.06	0.60	1.46	2.32
	Child 6 to 10	46	0.44	88.4	0.00	0.28	1.09	1.79
	Child 11 to 15	68	0.29	92.8	0.02	0.25	0.72	0.78
	Female 16 to 29	47	0.89	96.0	0.03	0.20	0.81	5.97
	Female 30 to 49	132	0.32	95.0	0.03	0.29	0.67	0.77
	Female 50+	162	0.46	94.9	0.04	0.28	1.19	1.80
	Male 16 to 29	55	0.13	92.3	0.01	0.09	0.35	0.44
	Male 30 to 49	120	0.32	96.0	0.06	0.22	0.56	0.85
	Male 50+	155	0.32	99.8	0.06	0.25	0.70	0.91
	Unknown	5	0.00	1.6	0.00	0.00	0.00	0.00
Race/Ethnicity								
	White, Non-Hispanic	775	0.36	93.8	0.02	0.23	0.79	1.19
	Black, Non-Hispanic	1	0.00	*	*	*	*	*
	Hispanic	3	0.86	100	*	0.36	*	*
	Asian	7	0.71	100	0.18	0.63	*	*
	American Indian	12	2.77	100	0.12	0.21	*	*
	Unknown	39	0.43	100	0.14	0.31	1.05	1.36
Respondent Education								
	0 to 11 years	46	0.45	86.2	0.00	0.25	1.64	2.08
	High School	234	0.39	92.9	0.02	0.22	0.86	1.48
	Some College	259	0.54	95.3	0.04	0.27	0.86	1.27
	College Grad	255	0.34	95.0	0.03	0.23	0.76	1.40
	Unknown	43	0.32	99.7	0.12	0.30	0.55	0.68
Household Income ($)								
	0 to 20,000	87	0.53	91.0	0.04	0.27	1.60	2.14
	20,000 to 50,000	326	0.45	91.3	0.02	0.23	0.83	1.20
	>50,000	327	0.38	97.9	0.04	0.24	0.82	1.46
	Unknown	97	0.33	92.9	0.04	0.29	0.74	0.91
North Dakota								
All		575	0.43	95.2	0.05	0.24	0.95	1.58
Sexes								
	Male	276	0.43	96.2	0.05	0.25	0.91	1.60
	Female	299	0.43	94.2	0.04	0.23	0.97	1.55

Table 10-41. Fish Consumption per kg Body Weight, All Respondents, by Selected Demographic Characteristics, Uncooked (g/kg-day) (continued)								
					Percentiles			
State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	10th	50th	90th	95th
North Dakota (continued)								
Age (years)-Sex Category								
	Child 1 to 5	30	0.89	94.4	0.05	0.30	2.08	5.10
	Child 6 to 10	44	0.68	92.0	0.09	0.39	1.52	1.99
	Child 11 to 15	55	0.53	97.1	0.07	0.28	1.35	1.65
	Female 16 to 29	42	0.24	89.9	0.00	0.15	0.52	0.84
	Female 30 to 49	95	0.38	98.3	0.05	0.24	0.74	1.14
	Female 50+	99	0.50	93.4	0.03	0.21	1.32	1.95
	Male 16 to 29	36	0.29	100.0	0.05	0.17	0.61	0.75
	Male 30 to 49	90	0.29	97.8	0.05	0.23	0.59	0.71
	Male 50+	81	0.38	94.0	0.02	0.23	0.90	1.54
	Unknown	3	0.14	31.5	0.00	0.00	*	*
Race/Ethnicity								
	White, Non-Hispanic	528	0.43	95.1	0.04	0.24	0.96	1.62
	Black, Non-Hispanic	2	0.33	100.0	*	0.33	*	*
	Asian	4	0.26	100.0	*	0.24	*	*
	American Indian	9	0.40	100.0	0.11	0.33	0.92	*
	Unknown	32	0.40	93.5	0.06	0.18	0.95	1.25
Respondent Education								
	0 to 11 years	29	0.30	86.6	0.00	0.15	0.86	1.15
	High School	138	0.56	97.3	0.06	0.26	1.19	2.08
	Some College	183	0.37	95.2	0.04	0.25	0.84	1.32
	College Grad	188	0.41	96.7	0.05	0.25	0.92	1.69
	Unknown	37	0.46	87.2	0.00	0.13	0.98	1.76
Household Income ($)								
	0 to 20,000	51	0.69	93.7	0.03	0.23	2.39	3.40
	20,000 to 50,000	235	0.36	94.2	0.03	0.18	0.93	1.51
	>50,000	233	0.41	97.1	0.06	0.30	0.84	1.36
	Unknown	56	0.55	92.7	0.05	0.24	1.05	1.62

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-42. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics, Uncooked (g/kg-day)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
All		362	0.66	100	0.10	0.43	1.51	1.80
Sex								
	Male	175	0.61	100	0.11	0.41	1.54	1.85
	Female	187	0.70	100	0.09	0.47	1.40	1.77
Age (years)-Sex Category								
	Child 1 to 5	14	0.83	100	0.21	0.74	1.88	2.07
	Child 6 to 10	22	0.81	100	0.21	0.74	1.57	1.76
	Child 11 to 15	18	0.43	100	0.12	0.30	0.72	1.14
	Female 16 to 29	14	1.10	100	0.15	0.47	1.50	4.07
	Female 30 to 49	74	0.73	100	0.08	0.47	1.60	1.97
	Female 50+	70	0.65	100	0.07	0.50	1.39	1.76
	Male 16 to 29	10	0.32	100	0.11	0.30	0.63	0.78
	Male 30 to 49	74	0.69	100	0.15	0.48	1.58	1.98
	Male 50+	57	0.52	100	0.14	0.38	1.25	1.55
	Unknown	9	0.16	100	0.01	0.05	0.54	*
Race/Ethnicity								
	White, Non-Hispanic	331	0.63	100	0.10	0.43	1.41	1.75
	Black, Non-Hispanic	3	0.20	100	*	0.20	*	*
	Hispanic	15	0.95	100	0.16	0.39	2.95	3.52
	Asian	12	1.36	100	0.12	0.69	2.57	6.24
	Unknown	1	0.03	100	*	*	*	*
Respondent Education								
	0 to 11 years	13	0.43	100	0.07	0.20	1.27	1.72
	High School	76	0.60	100	0.06	0.37	1.47	1.56
	Some College	56	0.63	100	0.16	0.46	1.16	1.89
	College Grad	217	0.70	100	0.11	0.45	1.53	1.85
Household Income ($)								
	0 to 20,000	35	0.60	100	0.10	0.43	1.53	1.90
	20,000 to 50,000	133	0.73	100	0.12	0.46	1.55	1.98
	>50,000	182	0.62	100	0.09	0.41	1.49	1.75
	Unknown	12	0.61	100	0.13	0.57	1.14	1.41
Florida								
All		7,757	1.16	100	0.24	0.73	2.39	3.37
Sexes								
	Male	3,880	1.12	100	0.23	0.69	2.33	3.32
	Female	3,861	1.20	100	0.25	0.77	2.42	3.48
	Unknown	16	1.05	100	0.15	0.91	2.90	3.19

Table 10-42. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics, Uncooked (g/kg-day) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Florida (continued)								
Age (years)-Sex Category								
	Child 1 to 5	420	2.92	100	0.63	2.16	5.73	8.37
	Child 6 to 10	375	1.37	100	0.38	1.01	2.72	3.45
	Child 11 to 15	365	1.06	100	0.28	0.79	2.02	2.78
	Female 16 to 29	753	1.12	100	0.23	0.71	2.22	3.10
	Female 30 to 49	1,287	1.18	100	0.24	0.78	2.39	3.31
	Female 50+	1,171	0.91	100	0.24	0.66	1.92	2.53
	Male 16 to 29	754	1.19	100	0.22	0.66	2.26	3.30
	Male 30 to 49	1,334	1.02	100	0.22	0.67	2.18	3.05
	Male 50+	1,192	0.89	100	0.22	0.62	1.75	2.51
	Unknown	106	0.81	100	0.27	0.61	1.50	2.02
Race/Ethnicity								
	White, Non-Hispanic	5,957	1.11	100	0.24	0.71	2.30	3.28
	Black, Non-Hispanic	785	1.39	100	0.30	0.91	2.81	3.92
	Hispanic	721	1.25	100	0.23	0.75	2.53	3.57
	Asian	110	1.46	100	0.35	0.84	2.34	4.08
	American Indian	57	1.45	100	0.28	0.90	4.02	5.73
	Unknown	127	1.16	100	0.24	0.81	2.23	3.10
Respondent Education								
	0 to 11 years	613	1.20	100	0.27	0.74	2.38	3.53
	High School	2,405	1.20	100	0.23	0.73	2.49	3.58
	Some College	2,511	1.16	100	0.24	0.72	2.39	3.39
	College Grad	2,190	1.10	100	0.24	0.73	2.25	3.17
	Unknown	38	1.40	100	0.32	1.06	3.08	3.17
Household Income ($)								
	0 to 20,000	1,534	1.28	100	0.25	0.77	2.77	3.66
	20,000 to 50,000	3,370	1.20	100	0.25	0.75	2.41	3.45
	>50,000	1,806	1.13	100	0.22	0.71	2.39	3.37
	Unknown	1,047	0.93	100	0.23	0.64	2.06	2.52
Minnesota								
All		793	0.44	100	0.06	0.26	0.86	1.44
Sexes								
	Male	401	0.37	100	0.05	0.23	0.82	1.43
	Female	392	0.51	100	0.06	0.29	0.93	1.62

Table 10-42. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics, Uncooked (g/kg-day) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Age (years)-Sex Category								
	Child 1 to 5	46	0.78	100	0.09	0.62	1.47	2.33
	Child 6 to 10	42	0.50	100	0.06	0.33	1.35	1.81
	Child 11 to 15	63	0.32	100	0.04	0.28	0.73	0.78
	Female 16 to 29	44	0.92	100	0.03	0.21	0.88	3.93
	Female 30 to 49	127	0.34	100	0.05	0.30	0.68	0.78
	Female 50+	150	0.48	100	0.07	0.29	1.24	1.82
	Male 16 to 29	52	0.14	100	0.02	0.11	0.36	0.44
	Male 30 to 49	115	0.33	100	0.09	0.23	0.56	0.86
	Male 50+	153	0.33	100	0.06	0.25	0.70	0.91
	Unknown	1	0.24	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	732	0.38	100	0.05	0.25	0.81	1.31
	Black, Non-Hispanic	*	*	100	*	*	*	*
	Hispanic	3	0.86	100	*	0.36	*	*
	Asian	7	0.71	100	0.18	0.62	*	*
	American Indian	12	2.77	100	0.12	0.21	*	*
	Unknown	39	0.43	100	0.14	0.31	1.05	1.34
Respondent Education								
	0 to 11 years	41	0.53	100	0.10	0.26	1.83	2.08
	High School	219	0.42	100	0.06	0.24	0.90	1.51
	Some College	249	0.57	100	0.05	0.29	0.86	1.31
	College Grad	242	0.36	100	0.05	0.25	0.78	1.41
	Unknown	42	0.32	100	0.12	0.31	0.55	0.67
Household Income ($)								
	0 to 20,000	77	0.59	100	0.12	0.27	1.73	2.17
	20,000 to 50,000	301	0.49	100	0.07	0.24	0.86	1.28
	>50,000	321	0.39	100	0.04	0.25	0.83	1.46
	Unknown	94	0.35	100	0.07	0.30	0.76	0.92
North Dakota								
All		546	0.45	100	0.07	0.25	0.99	1.62
Sexes								
	Male	265	0.44	100	0.06	0.27	0.99	1.62
	Female	281	0.46	100	0.07	0.24	0.99	1.60

Table 10-42. Fish Consumption per kg Body Weight, Consumers Only, by Selected Demographic Characteristics, Uncooked (g/kg-day) (continued)

State	Demographic Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
North Dakota (continued)								
Age (years)-Sex Category								
	Child 1 to 5	28	0.94	100	0.07	0.31	2.11	5.09
	Child 6 to 10	41	0.74	100	0.14	0.40	1.56	2.02
	Child 11 to 15	53	0.54	100	0.08	0.29	1.39	1.68
	Female 16 to 29	38	0.27	100	0.05	0.19	0.54	0.89
	Female 30 to 49	93	0.38	100	0.06	0.24	0.75	1.16
	Female 50+	92	0.54	100	0.08	0.23	1.53	2.02
	Male 16 to 29	36	0.29	100	0.05	0.17	0.60	0.75
	Male 30 to 49	88	0.29	100	0.06	0.25	0.60	0.72
	Male 50+	76	0.41	100	0.05	0.25	0.99	1.60
	Unknown	1	0.45	100	*	*	*	*
Race/Ethnicity								
	White, Non-Hispanic	501	0.45	100	0.06	0.25	0.99	1.64
	Black, Non-Hispanic	2	0.33	100	*	0.33	*	*
	Asian	4	0.26	100	*	0.18	*	*
	American Indian	9	0.40	100	0.11	0.33	0.82	*
	Unknown	30	0.42	100	0.07	0.21	0.98	1.27
Respondent Education								
	0 to 11 years	25	0.35	100	0.09	0.16	0.97	1.20
	High School	134	0.57	100	0.07	0.27	1.30	2.16
	Some College	174	0.38	100	0.06	0.26	0.87	1.36
	College Grad	181	0.43	100	0.07	0.25	0.95	1.73
	Unknown	32	0.53	100	0.05	0.17	1.12	1.91
Household Income ($)								
	0 to 20,000	48	0.74	100	0.09	0.25	2.40	3.49
	20,000 to 50,000	221	0.39	100	0.05	0.20	0.97	1.55
	>50,000	225	0.42	100	0.08	0.31	0.85	1.39
	Unknown	52	0.60	100	0.06	0.27	1.10	1.71

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.

Source: Westat, 2006.

Table 10-43. Fish Consumption per kg Body Weight, All Respondents, by State, Acquisition Method, Uncooked (g/kg-day)

State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		420	0.56	85.1	0.00	0.35	1.37	1.76
Acquisition Method								
	Bought	420	0.55	84.8	0.00	0.34	1.30	1.76
	Caught	420	0.01	16.3	0.00	0.00	0.02	0.04
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	40	0.51	86.4	0.00	0.34	1.28	1.86
	Bought; 20,000 to 50,000	150	0.62	86.6	0.00	0.37	1.22	1.93
	Bought; >50,000	214	0.52	84.1	0.00	0.33	1.34	1.64
	Bought; Unknown	16	0.45	73.4	0.00	0.42	1.02	1.36
	Caught; 0 to 20,000	40	0.01	11.0	0.00	0.00	0.00	0.06
	Caught; 20,000 to 50,000	150	0.02	18.1	0.00	0.00	0.03	0.08
	Caught; >50,000	214	0.01	16.8	0.00	0.00	0.01	0.03
	Caught; Unknown	16	0.00	6.2	0.00	0.00	0.00	0.01
Habitat								
	Freshwater	420	0.02	36.4	0.00	0.00	0.05	0.09
	Estuarine	420	0.15	76.0	0.00	0.06	0.36	0.59
	Marine	420	0.40	84.8	0.00	0.23	0.90	1.29
Fish/Shellfish Type								
	Shellfish	420	0.19	74.6	0.00	0.09	0.43	0.76
	Finfish	420	0.36	82.7	0.00	0.19	0.94	1.28
Florida								
All		15,367	0.59	50.5	0.00	0.08	1.59	2.39
Acquisition Method								
	Bought	15,367	0.51	47.5	0.00	0.00	1.41	2.16
	Caught	15,367	0.08	7.40	0.00	0.00	0.00	0.45
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	3,314	0.51	42.5	0.00	0.00	1.34	2.32
	Bought; 20,000 to 50,000	6,678	0.52	47.4	0.00	0.00	1.40	2.12
	Bought; >50,000	3,136	0.57	54.2	0.00	0.19	1.58	2.27
	Bought; Unknown	2,239	0.40	45.3	0.00	0.00	1.21	1.82
	Caught; 0 to 20,000	3,314	0.08	6.7	0.00	0.00	0.00	0.42
	Caught; 20,000 to 50,000	6,678	0.09	7.8	0.00	0.00	0.00	0.48
	Caught; >50,000	3,136	0.08	8.4	0.00	0.00	0.00	0.53
	Caught; Unknown	2,239	0.04	5.5	0.00	0.00	0.00	0.21
Habitat								
	Freshwater	15,367	0.05	9.1	0.00	0.00	0.00	0.33
	Estuarine	15,367	0.13	26.5	0.00	0.00	0.43	0.73
	Marine	15,367	0.40	40.3	0.00	0.00	1.11	1.76
Fish/Shellfish Type								
	Shellfish	15,367	0.11	21.1	0.00	0.00	0.32	0.61
	Finfish	15,367	0.48	41.9	0.00	0.00	1.35	2.08

Table 10-43. Fish Consumption per kg Body Weight, All Respondents, by State, Acquisition MethodUncooked (g/kg-day) (continued)

State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota								
All		837	0.41	94.4	0.03	0.24	0.83	1.43
Acquisition Method								
	Bought	837	0.27	89.9	0.00	0.14	0.68	1.01
	Caught	837	0.15	60.6	0.00	0.03	0.30	0.49
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	87	0.35	90.7	0.02	0.15	0.82	1.42
	Bought; 20,000 to 50,000	326	0.25	84.4	0.00	0.13	0.60	0.77
	Bought; >50,000	327	0.27	93.9	0.02	0.14	0.74	1.15
	Bought; Unknown	97	0.28	91.3	0.02	0.23	0.72	0.86
	Caught; 0 to 20,000	87	0.18	70.4	0.00	0.04	0.38	1.33
	Caught; 20,000 to 50,000	326	0.20	66.0	0.00	0.06	0.33	0.48
	Caught; >50,000	327	0.12	55.5	0.00	0.03	0.31	0.53
	Caught; Unknown	97	0.05	56.7	0.00	0.02	0.16	0.19
Habitat								
	Freshwater	837	0.15	60.6	0.00	0.03	0.30	0.49
	Estuarine	837	0.03	67.5	0.00	0.01	0.06	0.12
	Marine	837	0.24	89.9	0.00	0.12	0.61	0.91
Fish/Shellfish Type								
	Shellfish	837	0.06	67.5	0.00	0.02	0.13	0.24
	Finfish	837	0.36	94.0	0.02	0.19	0.76	1.11
North Dakota								
All		575	0.43	95.2	0.05	0.24	0.95	1.58
Acquisition Method								
	Bought	575	0.30	89.9	0.00	0.13	0.69	1.24
	Caught	575	0.13	68.3	0.00	0.05	0.31	0.53
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	51	0.55	88.0	0.00	0.15	1.79	2.71
	Bought; 20,000 to 50,000	235	0.28	90.6	0.01	0.13	0.65	1.35
	Bought; >50,000	233	0.26	90.7	0.01	0.13	0.64	1.02
	Bought; Unknown	56	0.41	85.5	0.00	0.14	0.88	1.21
	Caught; 0 to 20,000	51	0.14	53.9	0.00	0.01	0.31	0.61
	Caught; 20,000 to 50,000	235	0.09	59.4	0.00	0.03	0.23	0.40
	Caught; >50,000	233	0.15	76.2	0.00	0.08	0.45	0.61
	Caught; Unknown	56	0.15	85.7	0.00	0.07	0.29	0.31
Habitat								
	Freshwater	575	0.13	68.3	0.00	0.05	0.31	0.53
	Estuarine	575	0.03	71.3	0.00	0.01	0.06	0.10
	Marine	575	0.28	89.9	0.00	0.11	0.60	1.07

Table 10-43. Fish Consumption per kg Body Weight, All Respondents, by State, Acquisition MethodUncooked (g/kg-day) (continued)

State	Characteristic	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
North Dakota (continued)								
Fish/Shellfish Type								
	Shellfish	575	0.05	71.3	0.00	0.02	0.12	0.20
	Finfish	575	0.38	94.3	0.03	0.19	0.84	1.35

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.
A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-44. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method, Uncooked (g/kg-day)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
All		362	0.66	100	0.10	0.43	1.51	1.80
Acquisition Method								
	Bought	361	0.65	100	0.10	0.43	1.43	1.80
	Caught	71	0.07	100	0.00	0.02	0.17	0.23
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	35	0.59	100	0.10	0.41	1.53	1.90
	Bought; 20,000 to 50,000	132	0.71	100	0.11	0.45	1.40	1.98
	Bought; >50,000	182	0.62	100	0.08	0.41	1.45	1.75
	Bought; Unknown	12	0.61	100	0.13	0.57	1.14	1.41
	Caught; 0 to 20,000	4	0.07	100	*	0.02	*	*
	Caught; 20,000 to 50,000	30	0.11	100	0.01	0.03	0.30	0.62
	Caught; >50,000	36	0.04	100	0.00	0.02	0.11	3.15
	Caught; Unknown	1	0.01	100	*	*	*	*
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	1	0.03	100	*	*	*	*
	Eats Caught and Bought	70	0.67	100	0.13	0.46	1.54	1.71
	Eats Bought Only	291	0.66	100	0.09	0.43	1.50	1.82
Habitat								
	Freshwater	157	0.05	100	0.00	0.03	0.10	0.21
	Estuarine	327	0.19	100	0.01	0.09	0.40	0.69
	Marine	361	0.47	100	0.06	0.31	1.03	1.45
Eats Freshwater/Estuarine Caught Fish								
	Sometimes	50	0.64	100	0.12	0.39	1.53	1.68
	Never	312	0.66	100	0.10	0.44	1.50	1.83
Fish/Shellfish Type								
	Shellfish	320	0.26	100	0.03	0.14	0.56	0.91
	Finfish	353	0.43	100	0.03	0.26	1.03	1.45
Florida								
All		7,757	1.16	100	0.24	0.73	2.39	3.37
Acquisition Method								
	Bought	7,246	1.07	100	0.23	0.68	2.22	3.18
	Caught	1,212	1.05	100	0.20	0.64	2.18	3.03
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	1,418	1.20	100	0.24	0.72	2.54	3.44
	Bought; 20,000 to 50,000	3,141	1.09	100	0.24	0.70	2.18	3.21
	Bought; >50,000	1,695	1.05	100	0.22	0.67	2.18	3.17
	Bought; Unknown	992	0.89	100	0.22	0.60	1.96	2.50
	Caught; 0 to 20,000	246	1.14	100	0.26	0.76	2.40	3.72
	Caught; 20,000 to 50,000	563	1.14	100	0.20	0.67	2.31	3.13
	Caught; >50,000	274	0.95	100	0.16	0.61	2.09	3.06
	Caught; Unknown	129	0.74	100	0.22	0.54	1.36	2.03

Table 10-44. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method, Uncooked (g/kg-day) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Florida (continued)								
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	511	0.97	100	0.20	0.64	2.14	2.89
	Eats Caught and Bought	701	2.28	100	0.65	1.48	4.38	6.37
	Eats Bought Only	6,545	1.06	100	0.23	0.68	2.20	3.08
Habitat								
	Freshwater	1,426	0.59	100	0.09	0.37	1.36	1.89
	Estuarine	4,124	0.50	100	0.10	0.31	1.05	1.46
	Marine	6,124	0.99	100	0.20	0.62	2.01	2.94
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	235	0.91	100	0.13	0.56	2.14	2.7
	Sometimes	458	2.21	100	0.56	1.40	4.54	6.17
	Never	7,064	1.11	100	0.24	0.71	2.27	3.24
Fish/Shellfish Type								
	Shellfish	3,260	0.50	100	0.10	0.30	1.07	1.42
	Finfish	6,428	1.15	100	0.29	0.73	2.28	3.32
Minnesota								
All		793	0.44	100	0.06	0.26	0.86	1.44
Acquisition Method								
	Bought	755	0.30	100	0.04	0.16	0.73	1.10
	Caught	593	0.24	100	0.02	0.09	0.40	0.76
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	76	0.39	100	0.05	0.18	0.85	1.44
	Bought; 20,000 to 50,000	284	0.29	100	0.04	0.17	0.63	0.99
	Bought; >50,000	312	0.28	100	0.03	0.15	0.76	1.30
	Bought; Unknown	83	0.30	100	0.03	0.26	0.73	0.87
	Caught; 0 to 20,000	56	0.26	100	0.02	0.07	0.65	1.45
	Caught; 20,000 to 50,000	232	0.31	100	0.03	0.10	0.41	0.61
	Caught; >50,000	235	0.21	100	0.03	0.11	0.5	0.86
	Caught; Unknown	70	0.09	100	0.02	0.04	0.19	0.21
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	38	0.21	100	0.02	0.11	0.49	0.68
	Eats Caught and Bought	555	0.53	100	0.11	0.31	0.93	1.76
	Eats Bought Only	200	0.31	100	0.03	0.18	0.75	1.21
Habitat								
	Freshwater	593	0.24	100	0.02	0.09	0.4	0.76
	Estuarine	559	0.04	100	0.00	0.02	0.09	0.16
	Marine	755	0.26	100	0.03	0.14	0.67	0.97
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	38	0.21	100	0.02	0.11	0.49	0.68
	Sometimes	555	0.53	100	0.11	0.31	0.93	1.76
	Never	200	0.31	100	0.03	0.18	0.75	1.21

Table 10-44. Fish Consumption per kg Body Weight, Consumers Only, by State, Acquisition Method, Uncooked (g/kg-day) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Minnesota (continued)								
Fish/Shellfish Type								
	Shellfish	559	0.08	100	0.01	0.03	0.19	0.32
	Finfish	791	0.38	100	0.04	0.21	0.77	1.15
North Dakota								
All		546	0.45	100	0.07	0.25	0.99	1.62
Acquisition Method								
	Bought	516	0.34	100	0.04	0.15	0.81	1.36
	Caught	389	0.18	100	0.02	0.09	0.46	0.61
Acquisition Method-Household Income ($) Group								
	Bought; 0 to 20,000	45	0.63	100	0.06	0.19	2.06	2.97
	Bought; 20,000 to 50,000	213	0.30	100	0.04	0.15	0.69	1.37
	Bought; >50,000	210	0.28	100	0.04	0.15	0.64	1.05
	Bought; Unknown	48	0.47	100	0.04	0.19	0.93	1.44
	Caught; 0 to 20,000	27	0.25	100	0.02	0.10	0.56	0.86
	Caught; 20,000 to 50,000	142	0.15	100	0.02	0.07	0.33	0.54
	Caught; >50,000	173	0.20	100	0.03	0.11	0.51	0.71
	Caught; Unknown	47	0.17	100	0.04	0.08	0.30	0.32
Acquisition Method of Fish/Shellfish Eaten								
	Eats Caught Only	30	0.28	100	0.07	0.18	0.43	0.68
	Eats Caught and Bought	359	0.52	100	0.10	0.31	1.10	1.66
	Eats Bought Only	157	0.33	100	0.03	0.13	0.71	1.29
Habitat								
	Freshwater	389	0.18	100	0.02	0.09	0.46	0.61
	Estuarine	407	0.04	100	0.01	0.01	0.08	0.14
	Marine	516	0.31	100	0.03	0.13	0.72	1.15
Eats Freshwater/Estuarine Caught Fish								
	Exclusively	30	0.28	100	0.07	0.18	0.43	0.68
	Sometimes	359	0.52	100	0.10	0.31	1.10	1.66
	Never	157	0.33	100	0.03	0.13	0.71	1.29
Fish/Shellfish Type								
	Shellfish	407	0.07	100	0.01	0.03	0.17	0.27
	Finfish	541	0.40	100	0.05	0.21	0.89	1.44

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states.
A respondent can be represented in more than one row.

Source: Westat, 2006.

Table 10-45. Fish Consumption per kg Body Weight, All Respondents, by State, Subpopulation, and Sex (g/kg-day, as-consumed)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Connecticut								
Population for Sample Selection								
	Anglers	250	0.64	97.6	0.08	0.40	1.51	2.07
	Aquaculture Students	25	0.22	76.0	0.00	0.07	0.65	0.89
	Asians	396	1.15	99.2	0.30	0.91	2.28	3.15
	Commercial Fishermen	173	0.65	96.0	0.05	0.44	1.51	1.63
	EFNEP Participants	67	1.00	86.6	0.00	0.31	2.46	3.50
	General	420	0.41	85.1	0.00	0.25	1.00	1.32
	WIC Participants	699	0.80	79.1	0.00	0.42	1.93	3.02
Population for Sample Selection and Sex Group								
	Angler; Males	197	0.68	97.5	0.08	0.41	1.68	2.16
	Angler; Females	53	0.49	98.1	0.10	0.30	1.06	1.45
	Aquaculture Students; Males	10	0.21	90.0	0.00	0.09	0.75	0.85
	Aquaculture Students; Females	15	0.24	66.7	0.00	0.03	0.62	0.91
	Asians; Males	188	1.06	99.5	0.27	0.88	1.99	2.44
	Asians; Females	208	1.24	99.0	0.36	0.92	2.85	3.33
	Commercial Fishermen; Males	94	0.67	92.6	0.05	0.46	1.54	1.62
	Commercial Fishermen; Females	79	0.63	100	0.06	0.42	1.40	1.93
	EFNEP Participants; Males	25	1.05	88.0	0.00	0.33	2.83	3.80
	EFNEP Participants; Females	42	0.96	85.7	0.00	0.26	2.02	3.95
	General; Males	201	0.39	86.2	0.00	0.24	1.05	1.34
	General; Females	219	0.43	84.0	0.00	0.28	0.95	1.30
	WIC Participants; Males	312	0.94	79.2	0.00	0.45	2.30	3.52
	WIC Participants; Females	387	0.69	79.1	0.00	0.40	1.64	2.43
Florida								
Population for Sample Selection								
	General	15,367	0.47	50.5	0.00	0.06	1.27	1.91
Population for Sample Selection and Sex Group								
	General; Males	7,911	0.44	49.2	0.00	0.00	1.22	1.84
	General; Females	7,426	0.50	51.9	0.00	0.10	1.32	1.98
	Unknown	30	0.41	48.0	0.00	0.00	1.41	2.38
Minnesota								
Population for Sample Selection								
	American Indians	216	0.21	88.9	0.00	0.13	0.52	0.64
	Anglers	1,152	0.31	96.3	0.04	0.17	0.66	0.97
	General	837	0.31	94.4	0.02	0.18	0.62	1.07
	New Mothers	401	0.33	85.0	0.00	0.15	0.80	1.21

Table 10-45. Fish Consumption per kg Body Weight, All Respondents, by State, Subpopulation, and Sex (g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles			
					10th	50th	90th	95th
Minnesota (continued)								
Population for Sample Selection and Sex Group								
	American Indians; Males	108	0.19	89.8	0.00	0.14	0.46	0.55
	American Indians; Females	108	0.23	88.0	0.00	0.12	0.57	0.93
	Anglers; Males	606	0.30	96.9	0.04	0.18	0.63	0.93
	Anglers; Females	546	0.31	95.6	0.04	0.17	0.70	1.04
	General; Males	419	0.26	95.3	0.02	0.16	0.58	1.06
	General; Females	418	0.36	93.4	0.02	0.21	0.65	1.10
	New Mothers; Males	205	0.27	86.3	0.00	0.15	0.67	0.93
	New Mothers; Females	196	0.39	83.7	0.00	0.14	0.95	1.42
North Dakota								
Population for Sample Selection								
	American Indians	106	0.35	60.4	0.00	0.04	1.10	2.27
	Anglers	854	0.32	94.6	0.04	0.19	0.77	1.14
	General	575	0.32	95.2	0.03	0.18	0.71	1.18
Population for Sample Selection and Sex Group								
	American Indians; Males	50	0.35	58.0	0.00	0.04	0.76	1.39
	American Indians; Females	56	0.36	62.5	0.00	0.05	1.34	2.32
	Anglers; Males	467	0.32	95.3	0.04	0.19	0.77	1.14
	Anglers; Females	387	0.33	93.8	0.03	0.19	0.77	1.18
	General; Males	276	0.32	96.2	0.04	0.19	0.68	1.20
	General; Females	299	0.32	94.2	0.03	0.17	0.73	1.16

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.
FL consumption excludes away-from-home consumption by children <18.
Statistics are weighted to represent the general population in the states. Subpopulations statistics are unweighted.
EFNEP = Expanded Food and Nutrition Education Program.
WIC = USDA's Women, Infants, and Children Program.

Source: Westat, 2006.

Table 10-46. Fish Consumption per kg, Consumers Only, by State, Subpopulation, and Sex (g/kg-day, as-consumed)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Connecticut								
Population for Sample Selection								
	Angler	244	0.66	100	0.10	0.40	1.55	2.07
	Aquaculture Students	19	0.30	100	0.02	0.14	0.75	0.91
	Asians	393	1.16	100	0.31	0.91	2.28	3.16
	Commercial Fisherman	166	0.68	100	0.09	0.46	1.53	1.65
	EFNEP Participants	58	1.15	100	0.11	0.39	2.69	4.51
	General	362	0.48	100	0.07	0.32	1.09	1.37
	WIC Participants	553	1.01	100	0.12	0.61	2.30	3.39
Population for Sample Selection and Sex Group								
	Angler; Male	192	0.70	100	0.10	0.42	1.69	2.17
	Angler; Female	52	0.50	100	0.11	0.33	1.07	1.45
	Aquaculture Students; Male	9	0.23	100	0.01	0.11	0.74	*
	Aquaculture Students; Female	10	0.36	100	0.03	0.31	0.75	1.00
	Asians; Male	187	1.06	100	0.28	0.88	1.99	2.44
	Asians; Female	206	1.25	100	0.37	0.93	2.86	3.34
	Commercial Fishermen; Male	87	0.72	100	0.12	0.54	1.57	1.63
	Commercial Fishermen; Female	79	0.63	100	0.06	0.42	1.40	1.91
	EFNEP Participants; Male	22	1.20	100	0.14	0.42	2.89	3.75
	EFNEP Participants; Female	36	1.12	100	0.07	0.39	2.38	4.50
	General; Male	175	0.45	100	0.08	0.29	1.11	1.40
	General; Female	187	0.52	100	0.05	0.34	1.03	1.35
	WIC Participants; Male	247	1.18	100	0.12	0.69	2.89	3.78
	WIC Participants; Female	306	0.87	100	0.12	0.59	1.87	2.73
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	Angler; Exclusively	1	0.04	100	*	*	*	*
	Angler; Sometimes	190	0.74	100	0.14	0.44	1.69	2.18
	Angler; Never	53	0.38	100	0.05	0.27	0.89	1.00
	Aquaculture Students; Sometimes	2	0.34	100	*	0.21	*	*
	Aquaculture Students; Never	17	0.29	100	0.02	0.14	0.80	0.93
	Asians; Sometimes	199	1.23	100	0.30	0.93	2.94	3.50
	Asians; Never	194	1.09	100	0.34	0.87	2.03	2.39
	Commercial Fishermen; Sometimes	120	0.78	100	0.18	0.54	1.58	1.98
	Commercial Fishermen; Never	46	0.41	100	0.03	0.30	0.89	1.36
	EFNEP Participants; Sometimes	8	0.25	100	0.14	0.22	0.40	*
	EFNEP Participants; Never	50	1.29	100	0.09	0.52	2.82	6.09
	General; Sometimes	50	0.46	100	0.09	0.29	1.10	1.25
	General; Never	312	0.49	100	0.07	0.32	1.06	1.41
	WIC Participants; Sometimes	67	1.49	100	0.28	0.91	3.43	5.12
	WIC Participants; Never	486	0.95	100	0.10	0.60	2.02	3.12

Table 10-46. Fish Consumption per kg, Consumers Only, by State, Subpopulation, and Sex (g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
Florida								
Population for Sample Selection								
	General	7,757	0.93	100	0.19	0.58	1.89	2.73
Population for Sample Selection and Sex Group								
	General; Male	3,880	0.90	100	0.18	0.55	1.85	2.65
	General; Female	3,861	0.95	100	0.19	0.62	1.94	2.78
	Unknown	16	0.85	100	0.12	0.69	2.37	2.61
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	General; Exclusively	235	0.71	100	0.10	0.42	1.60	2.16
	General; Sometimes	458	1.73	100	0.43	1.10	3.44	4.96
	General; Never	7,064	0.88	100	0.18	0.56	1.81	2.60
Minnesota								
Population for Sample Selection								
	American Indian	192	0.24	100	0.02	0.15	0.53	0.70
	Anglers	1,109	0.32	100	0.05	0.18	0.67	0.99
	General	793	0.33	100	0.04	0.20	0.65	1.08
	New Mothers	341	0.38	100	0.04	0.20	0.89	1.30
Population for Sample Selection and Sex Group								
	American Indians; Male	97	0.21	100	0.03	0.15	0.49	0.55
	American Indians; Female	95	0.26	100	0.02	0.16	0.59	0.95
	Anglers; Male	587	0.31	100	0.05	0.18	0.63	0.93
	Anglers; Female	522	0.33	100	0.05	0.18	0.72	1.05
	General; Male	401	0.28	100	0.04	0.17	0.62	1.07
	General; Female	392	0.38	100	0.05	0.22	0.70	1.22
	New Mothers; Male	177	0.31	100	0.04	0.19	0.75	1.06
	New Mothers; Female	164	0.46	100	0.05	0.21	1.04	1.83
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	American Indians; Exclusively	31	0.18	100	0.01	0.07	0.42	0.55
	American Indians; Sometimes	136	0.28	100	0.05	0.18	0.57	0.92
	American Indians; Never	25	0.05	100	0.01	0.04	0.12	0.15
	Anglers; Exclusively	57	0.35	100	0.02	0.16	0.89	1.93
	Anglers; Sometimes	879	0.34	100	0.07	0.20	0.71	1.05
	Anglers; Never	173	0.20	100	0.03	0.10	0.46	0.66
	General; Exclusively	38	0.16	100	0.02	0.08	0.37	0.51
	General; Sometimes	555	0.40	100	0.08	0.23	0.70	1.32
	General; Never	200	0.23	100	0.02	0.14	0.56	0.91
	New Mothers; Exclusively	17	0.06	100	0.02	0.09	0.20	0.25
	New Mothers; Sometimes	189	0.47	100	0.07	0.27	1.00	1.32
	New Mothers; Never	135	0.30	100	0.03	0.12	0.74	1.35

Table 10-46. Fish Consumption per kg, Consumers Only, by State, Subpopulation, and Sex (g/kg-day, as-consumed) (continued)

State	Category	Sample Size	Arithmetic Mean	Percent Eating Fish	Percentiles 10th	50th	90th	95th
North Dakota								
Population for Sample Selection								
	American Indians	64	0.58	100	0.03	0.19	1.75	2.65
	Anglers	808	0.34	100	0.05	0.20	0.81	1.17
	General	546	0.34	100	0.05	0.19	0.74	1.21
Population for Sample Selection and Sex Group								
	American Indians; Male	29	0.60	100	0.03	0.18	1.31	3.67
	American Indians; Female	35	0.57	100	0.02	0.19	2.25	2.55
	Anglers; Male	445	0.33	100	0.05	0.20	0.78	1.14
	Anglers; Female	363	0.35	100	0.05	0.21	0.83	1.29
	General; Male	265	0.33	100	0.04	0.20	0.74	1.22
	General; Female	281	0.34	100	0.05	0.18	0.74	1.20
Population for Sample Selection and Eats Freshwater/Estuarine Caught Fish Group								
	American Indians; Exclusively	4	0.05	100	*	0.05	*	*
	American Indians; Sometimes	30	1.08	100	0.13	0.60	2.65	3.62
	American Indians; Never	30	0.16	100	0.02	0.07	0.36	0.66
	Anglers; Exclusively	47	0.19	100	0.01	0.07	0.61	1.02
	Anglers; Sometimes	660	0.38	100	0.07	0.23	0.84	1.29
	Anglers; Never	101	0.18	100	0.02	0.10	0.41	0.53
	General; Exclusively	30	0.21	100	0.05	0.14	0.33	0.51
	General; Sometimes	359	0.39	100	0.07	0.23	0.82	1.25
	General; Never	157	0.25	100	0.03	0.10	0.53	0.97

* Percentiles cannot be estimated due to small sample size.

Notes: FL consumption is based on a 7-day recall; CT, MN, and ND consumptions are based on rate of consumption.

FL consumption excludes away-from-home consumption by children <18.

Statistics are weighted to represent the general population in the states. Subpopulations statistics are unweighted.

Source: Westat, 2006.

Table 10-47. Fish Consumption Among General Population in Four States, Consumers Only (g/kg-day, as-consumed)

	N	Mean	CI	Percentiles						Maximum
				10th	25th	50th	75th	90th	95th	
Connecticut										
1 to <6 years	14	0.61	0.42–0.81	0.16	0.26	0.55	0.83	1.4	1.6	1.6
6 to <11 years	22	0.59	0.040–0.77	0.14	0.23	0.47	0.96	1.2	1.3	1.5
11 to <16 years	18	0.32	0.17–0.46	0.07	0.14	0.19	0.38	0.52	0.84	1.3
16 to <30 years										
Females	14	0.84	0.10–1.58	0.11	0.30	0.35	0.87	1.1	3.1	7.0
Males	10	0.23	0.14–0.32	0.08	0.13	0.21	0.25	0.47	0.56	0.58
30 to <50 years										
Females	74	0.53	0.37–0.70	0.05	0.15	0.34	0.67	1.1	1.5	4.5
Males	74	0.51	0.40–0.61	0.11	0.18	0.35	0.70	1.2	1.5	2.2
>50 years										
Females	70	0.48	0.37–0.59	0.05	0.13	0.37	0.72	1.0	1.4	2.7
Males	57	0.38	0.30–0.46	0.10	0.17	0.26	0.50	0.93	1.1	1.4
Eats Caught Only	1	0.01	-	-	-	-	-	-	-	0.01
Eats Caught and Bought	70	0.49	0.36–0.61	0.10	0.17	0.34	0.75	1.1	1.3	2.2
Eats Bought Only	291	0.48	0.40–0.57	0.06	0.16	0.32	0.61	1.1	1.4	7.0
Anglers	244	0.66	-	0.10	0.20	0.40	0.80	1.6	2.1	3.5
General Population	362	0.48	-	0.07	0.16	0.32	0.63	1.1	1.4	2.4
Florida										
1 to <6 years	420	2.3	2.05–2.63	0.5	1.0	1.7	2.8	4.7	6.8	14.6
6 to <11 years	375	1.1	0.98–1.22	0.28	0.52	0.81	1.4	2.2	3.0	9.4
11 to <16 years	365	0.85	0.73–0.98	0.20	0.36	0.63	0.99	1.6	2.2	11.0
16 to <30 years										
Females	753	0.89	0.74–1.04	0.16	0.31	0.55	0.95	1.8	2.4	25
Males	754	0.96	0.80–1.12	0.16	0.28	0.52	0.99	1.8	2.7	34
30 to <50 years										
Females	1,287	0.94	0.87–1.00	0.18	0.33	0.63	1.0	1.9	2.7	20
Males	1,334	0.81	0.74–0.88	0.17	0.28	0.53	0.95	1.7	2.4	23
>50 years										
Females	1,171	0.73	0.69–0.77	0.19	0.31	0.52	0.94	1.5	2.1	7.4
Males	1,192	0.70	0.66–0.75	0.17	0.27	0.50	0.84	1.4	1.9	14
Eats Caught Only	511	0.76	0.66–0.86	0.15	0.30	0.50	0.90	1.7	2.3	7.4
Eats Caught and Bought	701	1.8	1.6–2.1	0.50	0.76	1.2	2.0	3.4	5.1	34
Eats Bought Only	6,545	0.85	0.81–0.89	0.18	0.30	0.54	0.98	1.8	2.5	24

Table 10-47. Fish Consumption Among General Population Children in Four States, Consumers Only (g/kg-day, as-consumed) (continued)										
	N	Mean	CI	Percentiles						Maximum
				10th	25th	50th	75th	90th	95th	
Minnesota										
1 to <6 years	46	0.58	0.32–0.85	0.07	0.15	0.46	0.73	1.1	1.8	8.0
6 to <11 years	42	0.38	0.21–0.54	0.05	0.07	0.25	0.47	1.0	1.4	5.3
11 to <16 years	63	0.24	0.16–0.31	0.03	0.06	0.21	0.32	0.55	0.59	1.4
16 to <30 years										
Females	44	0.69	–0.21–1.59	0.02	0.08	0.16	0.29	0.66	3.0	9.2
Males	52	0.11	0.07–0.15	0.02	0.02	0.08	0.14	0.27	0.33	0.74
30 to <50 years										
Females	127	0.25	0.21–0.30	0.04	0.10	0.23	0.32	0.51	0.58	1.3
Males	115	0.25	0.17–0.32	0.07	0.11	0.17	0.30	0.42	0.64	1.9
>50 years										
Females	150	0.36	0.26–0.46	0.05	0.11	0.22	0.38	0.93	1.4	1.9
Males	153	0.24	0.20–0.29	0.05	0.11	0.19	0.28	0.53	0.68	1.3
Eats Caught Only	38	0.16	0.05–0.26	0.02	0.03	0.08	0.25	0.37	0.51	0.57
Eats Caught and Bought	555	0.40	0.27–0.52	0.08	0.11	0.23	0.49	0.70	1.3	9.2
Eats Bought Only	200	0.23	0.18–0.28	0.02	0.05	0.14	0.26	0.56	0.91	8.0
Anglers	1,109	0.32	-	0.05	0.10	0.18	0.34	0.67	0.99	2.2
General Population	793	0.33	-	0.04	0.10	0.20	0.34	0.65	1.1	1.8
North Dakota										
1 to <6 years	28	0.70	0.24–1.17	0.05	0.12	0.23	0.68	1.6	3.8	6.8
6 to <11 years	41	0.56	0.31–0.81	0.11	0.21	0.30	0.66	1.2	1.5	4.3
11 to <16 years	53	0.41	0.23–0.59	0.06	0.12	0.22	0.54	1.0	1.3	2.3
16 to <30 years										
Females	38	0.20	0.14–0.26	0.04	0.06	0.15	0.26	0.41	0.67	0.80
Males	36	0.22	0.13–0.31	0.04	0.07	0.13	0.23	0.45	0.56	1.9
30 to <50 years										
Females	93	0.29	0.22–0.36	0.05	0.10	0.18	0.36	0.56	0.87	2.6
Males	88	0.22	0.17–0.27	0.05	0.08	0.18	0.26	0.45	0.54	1.3
>50 years										
Females	92	0.40	0.27–0.54	0.06	0.10	0.17	0.52	1.1	1.5	4.2
Males	76	0.31	0.20–0.41	0.04	0.08	0.19	0.33	0.74	1.2	1.8
Eats Caught Only	30	0.21	0.09–0.32	0.05	0.09	0.14	0.22	0.33	0.51	1.8
Eats Caught and Bought	359	0.39	0.29–0.49	0.07	0.13	0.23	0.43	0.82	1.3	4.3
Eats Bought Only	157	0.25	0.13–0.36	0.03	0.05	0.10	0.24	0.53	0.97	6.8
Anglers	808	0.34	-	0.05	0.10	0.20	0.39	0.81	1.2	2.0
General Population	546	0.34	-	0.05	0.09	0.19	0.35	0.74	1.2	2.2

N = Sample size.
CI = Confidence interval.

Source: Moya et al., 2008.

Table 10-48. Estimated Number of Participants in Marine Recreational Fishing by State and Subregion

Subregion	State	Coastal Participants	Non-Coastal Participants	Out of State[a]	Total Participants[a]
Pacific	Southern California	902	8	159	910
	Northern California	534	99	63	633
	Oregon	265	19	78	284
	TOTAL	1,701	126		
North Atlantic	Connecticut	186	*[b]	47	186
	Maine	93	9	100	102
	Massachusetts	377	69	273	446
	New Hampshire	34	10	32	44
	Rhode Island	97	*	157	97
	TOTAL	787	88		
Mid-Atlantic	Delaware	90	*	159	90
	Maryland	540	32	268	572
	New Jersey	583	9	433	592
	New York	539	13	70	552
	Virginia	294	29	131	323
	TOTAL	1,046	83		
South Atlantic	Florida	1,201	*	741	1,201
	Georgia	89	61	29	150
	North Carolina	398	224	745	622
	South Carolina	131	77	304	208
	TOTAL	1,819	362		
Gulf of Mexico	Alabama	95	9	101	104
	Florida	1,053	*	1,349	1,053
	Louisiana	394	48	63	442
	Mississippi	157	42	51	200
	TOTAL	1,699	99		
	GRAND TOTAL	8,053	760		

[a] Not additive across states. One person can be counted as "OUT OF STATE" for more than one state.
[b] An asterisk (*) denotes no non-coastal counties in state.

Source: NMFS, 1993.

Table 10-49. Estimated Weight of Fish Caught (Catch Type A and B1) by Marine Recreational Fishermen, by Wave and Subregion

	Atlantic and Gulf		Pacific	
	Region	Weight (1,000 kg)	Region	Weight (1,000 kg)
Jan/Feb	South Atlantic	1,060	So. California	418
	Gulf	3,683	N. California	101
	TOTAL	4,743	Oregon	165
			TOTAL	684
Mar/Apr	North Atlantic	310	So. California	590
	Mid-Atlantic	1,030	N. California	346
	South Atlantic	1,913	Oregon	144
	Gulf	3,703	TOTAL	1,080
	TOTAL	6,956		
May/Jun	North Atlantic	3,272	So. California	1,195
	Mid-Atlantic	4,815	N. California	563
	South Atlantic	4,234	Oregon	581
	Gulf	5,936	TOTAL	2,339
	TOTAL	18,257		
Jul/Aug	North Atlantic	4,003	So. California	1,566
	Mid-Atlantic	9,693	N. California	1,101
	South Atlantic	4,032	Oregon	39
	Gulf	5,964	TOTAL	2,706
	TOTAL	23,692		
Sep/Oct	North Atlantic	2,980	So. California	859
	Mid-Atlantic	7,798	N. California	1,032
	South Atlantic	3,296	Oregon	724
	Gulf	7,516	TOTAL	2,615
	TOTAL	21,590		
Nov/Dec	North Atlantic	456	So. California	447
	Mid-Atlantic	1,649	N. California	417
	South Atlantic	2,404	Oregon	65
	Gulf	4,278	TOTAL	929
	TOTAL	8,787		
	GRAND TOTAL	84,025	GRAND TOTAL	10,353

Source: NMFS, 1993.

Table 10-50. Average Daily Intake (g/day) of Marine Finfish, by Region and Coastal Status

	Intake Among Anglers	
Region[a]	Mean	95th Percentile
North Atlantic	6.2	20.1
Mid-Atlantic	6.3	18.9
South Atlantic	4.7	15.9
All Atlantic	5.6	18.0
Gulf	7.2	26.1
Southern California	2.0	5.5
Northern California	2.0	5.7
Oregon	2.2	8.9
All Pacific	2.0	6.8

[a] North Atlantic—ME, NH, MA, RI, and CT; Mid-Atlantic—NY, NJ, MD, DE, and VA; South Atlantic—NC, SC, GA, and FL (Atlantic Coast); Gulf—AL, MS, LA, and FL (Gulf Coast).

Source: NMFS, 1993.

Table 10-51. Estimated Weight of Fish Caught (Catch Type A and B1)[a] by Marine Recreational Fishermen, by Species Group and Subregion

	North Atlantic (1,000 kg)	Mid-Atlantic (1,000 kg)	South Atlantic (1,000 kg)	Gulf (1,000 kg)	All Atlantic and Gulf (1,000 kg)
Cartilaginous Fishes	66	1,673	162	318	2,219
Eels	14	9	*[b]	0[c]	23
Herrings	118	69	1	89	177
Catfishes	0	306	138	535	979
Toadfishes	0	7	0	*	7
Cods and Hakes	2,404	988	4	0	1,396
Searobins	2	68	*	*	70
Sculpins	1	*	0	0	1
Temperate Basses	837	2,166	22	4	2,229
Sea Basses	22	2,166	644	2,477	5,309
Bluefish	4,177	3,962	1,065	158	5,362
Jacks	0	138	760	2,477	3,375
Dolphins	65	809	2,435	1,599	4,908
Snappers	0	*	508	3,219	3,727
Grunts	0	9	239	816	1,064
Porgies	132	417	1,082	2,629	4,160
Drums	3	2,458	2,953	9,866	15,280
Mullets	1	43	382	658	1,084
Barracudas	0	*	356	244	600
Wrasses	783	1,953	46	113	2,895
Mackerels and Tunas	878	3,348	4,738	4,036	13,000
Flounders	512	4,259	532	377	5,680
Triggerfishes/Filefishes	0	48	109	544	701
Puffers	*	16	56	4	76
Other fishes	105	72	709	915	1,801

Species Group	Southern California (1,000 kg)	Northern California (1,000 kg)	Oregon (1,000 kg)	All Pacific
Cartilaginous fish	35	162	1	198
Sturgeons	0[b]	89	13	102
Herrings	10	15	40	65
Anchovies	*[c]	7	0	7
Smelts	0	71	0	71
Cods and Hakes	0	0	0	0
Silversides	58	148	0	206
Striped Bass	0	51	0	51
Sea Basses	1,319	17	0	1,336
Jacks	469	17	1	487
Croakers	141	136	0	277
Sea Chubs	53	1	0	54
Surfperches	74	221	47	342
Pacific Barracuda	866	10	0	876
Wrasses	73	5	0	78
Tunas and Mackerels	1,260	36	1	1,297
Rockfishes	409	1,713	890	3,012
California Scorpionfish	86	0	0	86
Sablefishes	0	0	5	5
Greenlings	22	492	363	877
Sculpins	6	81	44	131
Flatfishes	106	251	5	362
Other fishes	89	36	307	432

[a] For Catch Type A and B1, the fish were not thrown back.
[b] An asterisk (*) denotes data not reported.
[c] Zero (0) = <1,000 kg.

Source: NMFS, 1993.

Table 10-52. Percent of Fishing Frequency During the Summer and Fall Seasons in Commencement Bay, Washington

Fishing Frequency	Frequency Percent in the Summer[a]	Frequency Percent in the Fall[b]	Frequency Percent in the Fall[c]
Daily	10.4	8.3	5.8
Weekly	50.3	52.3	51.0
Monthly	20.1	15.9	21.1
Bimonthly	6.7	3.8	4.2
Biyearly	4.4	6.1	6.3
Yearly	8.1	13.6	11.6

[a] Summer—July through September, includes 5 survey days and 4 survey areas (i.e., Areas #1, #2, #3, and #4)

[b] Fall—September through November, includes 4 survey days and 4 survey areas (i.e., Areas #1, #2, #3, and #4)

[c] Fall—September through November, includes 4 survey days described in footnote b plus an additional survey area (5 survey areas) (i.e., Areas #1, #2, #3, #4, and #5)

Source: Pierce et al., 1981.

Table 10-53. Selected Percentile Consumption Estimates (g/day) for the Survey and Total Angler Populations Based on the Re-Analysis of the Puffer et al. (1981) and Pierce et al. (1981) Data

	50th Percentile	90th Percentile
Survey Population		
Puffer et al. (1981)	37	225
Pierce et al. (1981)	19	155
Average	28	190
Total Angler Population		
Puffer et al. (1981)	2.9[a]	35[b]
Pierce et al. (1981)	1.0	13
Average	2.0	24

[a] Estimated based on the average intake for the 0–90th percentile anglers.

[b] Estimated based on the average intake for the 91st–96th percentile anglers.

Source: Price et al., 1994.

Table 10-54. Median Intake Rates Based on Demographic Data of Sport Fishermen and Their Family/Living Group

	Percent of total interviewed	Median intake rates (g/person-day)
Ethnic Group		
Caucasian	42	46.0
Black	24	24.2
Mexican American	16	33.0
Asian/Samoan	13	70.6
Other	5	-[a]
Age (years)		
<17	11	27.2
18 to 40	52	32.5
41 to 65	28	39.0
>65	9	113.0

[a] Not reported.

Source: Puffer et al., 1981.

Table 10-55. Cumulative Distribution of Total Fish/Shellfish Consumption by Surveyed Sport Fishermen in the Metropolitan Los Angeles Area

Percentile	Intake rate (g/person-day)
5	2.3
10	4.0
20	8.3
30	15.5
40	23.9
50	36.9
60	53.2
70	79.8
80	120.8
90	224.8
95	338.8

Source: Puffer et al., 1981.

Table 10-56. Catch Information for Primary Fish Species Kept by Sport Fishermen (*N* = 1,059)

Species	Average Weight (Grams)	Percent of Fishermen who Caught
White Croaker	153	34
Pacific Mackerel	334	25
Pacific Bonito	717	18
Queenfish	143	17
Jacksmelt	223	13
Walleye Perch	115	10
Shiner Perch	54	7
Opaleye	307	6
Black Perch	196	5
Kelp Bass	440	5
California Halibut	1,752	4
Shellfish[a]	421	3

[a] Crab, mussels, lobster, abalone.

Source: Modified from Puffer et al., 1981.

Table 10-57. Fishing and Crabbing Behavior of Fishermen at Humacao, Puerto Rico

	Mean ± Standard Error
Crabbing	
Number of interviews	20
Number of people in group	3.5 ± 0.4
Number of adults (>21 years)	2.3 ± 0.3
Visits to site/month	3.8 ± 0.7
No. crabs caught per season	21.4 ± 4.7
Crabs/hour	21.6 ± 4.9
Crabs eaten/week	13.3 ± 2.3
Range in no. eaten/week	0–25
Fishing	
Number of interviews	25
Number of people in group	2.9 ± 0.3
Number of adults (>21 years)	2.3 ± 0.2
Visits to site/month	2.8 ± 0.4
No. fish caught per season	16.9 ± 3.5
Fish/hour	11.3 ± 2.5
Fish eaten/week	6.8 ± 0.7
Range in no. eaten/week	3–30

Source: Burger and Gochfeld, 1991.

Table 10-58. Fish Consumption of Delaware Recreational Fishermen and Their Households

	N	Mean consumption (g/day)	SE (%)
All respondents	867	17.5	5.3
Sex			
Males	496	18.6	6.6
Females	369	15.9	8.7
Age (years)			
0 to 9	73	6.0	13.4
10 to 19	102	11.4	16.8
20 to 29	95	11.7	10.9
30 to 39	148	18.1	13.9
40 to 49	144	12.6	8.5
50 to 59	149	28.6	11.1
60 to 69	124	23.0	12.4
70 to 79	28	21.8	33.4
80 to 89	4	53.9	68.3
Race			
African American	81	14.9	27.1
Asian	12	5.6	31.2
Hispanic	12	3.0	35.2
Caucasian	748	18.2	5.3

N = Sample size.
SE = Standard error.

Source: KCA Research Division, 1994.

Table 10-59. Seafood Consumption Rates of All Fish by Ethnic and Income Groups of Santa Monica Bay

		Consumption (g/day)			
Category	*N*	Mean	95% CI	50th	90th
All respondents	555	49.6	9.3	21.4	107.1
Ethnicity					
White	217	58.1	19.1	21.4	112.5
Hispanic	137	28.2	5.9	16.1	64.3
Black	57	48.6	18.9	24.1	85.7
Asian	122	51.1	18.7	21.4	115.7
Other	14	137.3	92.2	85.7	173.6
Income					
<$5,000	20	42.1	18.0	32.1	64.3
$5,000 to $10,000	27	40.5	29.1	21.4	48.2
$10,000 to $25,000	90	40.4	9.3	21.4	80.4
$25,000 to $50,000	149	46.9	10.5	21.4	113.0
>$50,000	130	58.9	20.6	21.4	128.6

N = Sample size.
CI = Confidence interval.

Source: Santa Monica Bay Restoration Project, 1994.

Table 10-60. Means and Standard Deviations of Selected Characteristics by Population Groups in Everglades, Florida

Variables (N[a] = 330)	Mean ± SD[b]	Range
Age (years)	38.6 ± 18.8	2 to 81
Sex		
Female	38%	-
Male	62%	-
Race/ethnicity		
Black	46%	-
White	43%	-
Hispanic	11%	-
Number of Years Fished	15.8 ± 15.8	0–70
Number Per Week Fished in Past 6 Months of Survey Period	1.8 ± 2.5	0–20
Number Per Week Fished in Last Month of Survey Period	1.5 ± 1.4	0–12
Aware of Health Advisories	71%	-

[a] *N* = Number of respondents who reported consuming fish.
[b] SD = Standard deviation.

Source: U.S. DHHS, 1995.

Table 10-61. Grams per Day of Self-Caught Fish Consumed by Recreational Anglers—Alcoa/Lavaca Bay

Cohort	Mean	95% Upper Confidence Limit on Mean	90th or 95th Percentile of Distribution[a]
Finfish			
Adult men	24.8	27.7	68.1
Adult women	17.9	19.7	47.8
Women of childbearing age	18.8	22.1	45.4
Small children	11.4	14.2	30.3
Youths	15.6	17.8	45.4
Shellfish			
Adult men	1.2	1.6	5.1
Adult women	0.8	1.1	2.4
Women of childbearing age	0.9	1.2	4.0
Small children	0.4	0.6	2.0
Youths	0.7	1.0	4.5

[a] For shellfish, the 95th percentile value is provided because less than 90% of the individuals consumed shellfish, resulting in a 90th percentile of zero.

Source: Alcoa, 1998.

Table 10-62. Number of Meals and Portion Sizes of Self-Caught Fish Consumed by Recreational Anglers Lavaca Bay, Texas

Age Group	Number of Meals		Portion Size (ounces)[a]	
	Mean	95% Upper Confidence Limit on Mean	Mean	95% Upper Confidence Limit on Mean
Finfish				
Adult Men	3.2	3.5	8.0	8.2
Adult Women	2.6	3.0	6.8	7.1
Women of Childbearing Age	2.8	3.2	6.8	7.3
Small children (<6 years)	2.6	3.1	4.5	4.7
Youths (6 to 19 years)	2.4	2.7	6.6	6.9
Shellfish				
Adult Men	0.3	0.4	3.7	4.3
Adult Women	0.3	0.4	2.9	3.4
Women of Childbearing Age	0.3	0.5	3.3	4.3
Small children (<6 years)	0.3	0.5	2.0	2.4
Youths (6 to 19 years)	0.3	0.4	2.5	2.9

[a] Converted from ounces; 1 ounce = 28.35 grams.

Source: Alcoa, 1998.

Table 10-63. Consumption Patterns of People Fishing and Crabbing in Barnegat Bay, New Jersey

	Males	Females
N	434	81
% Eat fish	84.1	78.05
% Give away fish	55.0	41.2
% Eat crabs	87.9	94.7
% Give away crabs	48.2	53.1
Number of times fish eaten/month	5.21 ± 0.33	5.21 ± 0.33
% Eaten that are self-caught	48.7 ± 2.15	48.7 ± 2.15
Number of times crabs eaten/month	2.14 ± 0.32	2.14 ± 0.32
Average serving size (ounces)	10.12 ± 0.32	10.12 ± 0.32
Average consumption (males and females) (g/day)	48.3	

N = Sample size.

Source: Burger et al., 1998.

Table 10-64. Fish Intake Rates of Members of the Laotian Community of West Contra Costa County, California

Group	Sample Size	Consumption (g/day)					
		Mean	Percentile			Max	Min
			50th	90th	95th		
All respondents	229	18.3	9.1	42.5	85.1	182.3	--
Fish consumers[a]	199	21.4	9.1	42.5	85.1	--	1.5

[a] "Fish consumers" were those who reported consumption of fish at least once a month.

Max = Maximum.

Min = Minimum.

Source: Chiang, 1998.

Table 10-65. Consumption Rates (g/day) Among Recent Consumers[a] by Demographic Factor

				Percentiles			
	N	Mean	SD	10th	50th	90th	95th
Overall	465	23.0	32.1	4.0	16.0	48.0	80.0
Sex							
Male	410	22.7	32.3	4.0	16.0	48.0	72.0
Female	35	22.3	26.8	6.0	16.0	53.2	84.0
Age (years)							
18 to 45	256	24.2	32.2	5.3	12.0	48.0	84.0
46 to 65	148	21.0	32.9	4.0	16.0	32.0	64.0
65 and older	43	21.8	24.4	4.0	16.0	64.0	72.0
Ethnicity							
African American	41	26.7	38.3	8.0	16.0	48.0	6.04
Asian-Chinese	26	27.8	34.8	4.0	12.0	80.0	128.0
Asian-Filipino	70	32.7	48.8	5.3	16.0	72.0	176.0
Asian-Other	31	22.0	27.6	4.0	8.0	72.0	72.0
Asian-Pacific Islander	12	38.0	44.2	4.0	24.0	96.0	184.0
Asian-Vietnamese	51	21.8	20.7	4.0	16.0	48.0	72.0
Hispanic	52	22.0	29.5	4.0	16.0	48.0	84.0
Caucasian	158	18.9	27.0	4.0	10.7	36.0	56.0
Education							
<12th Grade	73	24.2	28.7	4.0	16.0	48.0	64.0
HS/GED	142	21.5	28.0	4.0	12.0	48.0	72.0
Some college	126	22.7	29.0	5.3	16.0	45.0	84.0
>4 years college	94	25.0	42.1	4.0	12.0	53.2	96.0
Annual income							
<$20,000	101	21.9	27.8	4.0	8.0	48.0	72.0
$20,000 to $45,000	119	21.7	32.9	4.0	8.0	40.0	56.0
>$45,000	180	25.3	35.3	5.3	8.0	56.0	108.0
Season							
Winter	70	19.4	28.2	4.0	8.0	48.0	80.0
Spring	76	22.1	37.6	4.0	8.0	40.0	144.0
Summer	189	23.9	30.6	7.9	16.0	48.0	72.0
Fall	130	24.4	32.1	5.4	16.0	64.0	96.0

[a] Recent consumers are defined in the study as anglers who report consuming fish caught from San Francisco Bay in the 4 weeks prior to the date they were interviewed. Recent consumers are a subset of the overall consumer group.

N = Sample size.

SD = Standard deviation.

HS/GED= High school/general education development.

Source: SFEI, 2000.

Table 10-66. Mean ± SD Consumption Rates for Individuals Who Fish or Crab in the Newark Bay Area				
	People that crab	People that fish	People that both crab and fish	
			Crab values	Fish values
Sample size	110	111	33	33
Number of times per month consuming	3.39 ± 0.42	4.06 ± 0.76	2.96 ± 0.45	3.56 ± 0.66
Serving size				
Number of crabs	6.15 ± 0.85	-	7.27 ± 0.91	-
Fish or crabs (grams) (crabs assumed to weigh 70 grams each)	439 ± 61.2	331 ± 42.1	509 ± 63.8	428 ± 57.6
Monthly consumption (g/month)	1,980 ± 561	1,410 ± 266	1,620 ± 330	1,630 ± 358
Number of months per year fishing and/or crabbing	3.31 ± 0.13	4.92 ± 0.33	3.5 ± 0.37	7.24 ± 0.74
Yearly consumption (g/year)	5,760 ± 1,360	8,120 ± 2,040	6,230 ± 1,790	13,600 ± 3,480
Average daily consumption (g/day)[a]	15.8 ± 3.7	22.2 ± 5.6	17.1 ± 4.9	37.3 ± 9.5

[a] Estimated by U.S. EPA by dividing yearly consumption rate by 365 days/year.
SD = Standard deviation.
Note: Sample size is slightly different from that reported in the text of Burger (2002a).

Source: Burger, 2002a.

Table 10-67. Consumption Rates (g/day) for Marine Recreational Anglers in King County, WA							
Location	Sample Size	Mean	SD	SE	Percentiles		
					50th	90th	95th
Marine Fish Consumption							
Duwamish River[a]	50	8	13	2	2	23	42
Elliott Bay	377	63	91	5	31	145	221
North King County	67	32	40	5	17	85	102
All Locations	494	53	83	4	21	121	181
Shellfish Consumption							
Duwamish River[a]	16	20	33	8	4	77	123
Elliott Bay	49	28	33	5	14	74	119
North King County	31	22	33	6	12	62	132
All Locations	96	25	33	3	11	60	119

[a] The Duwamish River is tidally influenced by Elliott Bay, and anglers caught marine species; therefore, data for these locations were considered to represent marine locations.
SD = Standard deviation.
SE = Standard error.

Source: Mayfield et al., 2007.

Table 10-68. Percentile and Mean Intake Rates for Wisconsin Sport Anglers (all respondents)		
Percentile	Annual Number of Sport-Caught Meals	Intake Rate of Sport-Caught Meals (g/day)
25th	4	2.6
50th	10	6.2
75th	25	15.5
90th	50	31.3
95th	60	37.2
98th	100	62.1
100th	365	227
Mean	18	11.2

Source: Raw data on sport-caught meals from Fiore et al., 1989. U.S. EPA calculated distributions of intake rates using a value of 227 grams per fish meal.

Table 10-69. Mean Fish Intake Among Individuals Who Eat Fish and Reside in Households with Recreational Fish Consumption

Group	All Fish meals/week	Recreational Fish meals/week	*N*	Total Fish g/day	Recreational Fish g/day	Total Fish g/kg-day	Recreational Fish g/kg-day
All household members	0.686	0.332	2,196	21.9	11.0	0.356	0.178
Respondents (i.e., licensed anglers)	0.873	0.398	748	29.4	14.0	0.364	0.168
Age groups (years)							
1 to 5	0.463	0.223	121	11.4	5.63	0.737	0.369
6 to 10	0.49	0.278	151	13.6	7.94	0.481	0.276
11 to 20	0.407	0.229	349	12.3	7.27	0.219	0.123
21 to 40	0.651	0.291	793	22	10.2	0.306	0.139
41 to 60	0.923	0.42	547	29.3	14.2	0.387	0.186
61 to 70	0.856	0.431	160	28.2	14.5	0.377	0.193
71 to 80	1.0	0.622	45	32.3	20.1	0.441	0.271
80+	0.8	0.6	10	26.5	20	0.437	0.345

N = Sample size.

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-70. Comparison of 7-Day Recall and Estimated Seasonal Frequency for Fish Consumption

Usual Fish Consumption Frequency Category	Mean Fish Meals/Week 7-day Recall Data	Usual Frequency Value Selected for Data Analysis (times/week)
Almost daily	no data	4 (if needed)
2 to 4 times a week	1.96	2
Once a week	1.19	1.2
2 to 3 times a month	0.840 (3.6 times/month)	0.7 (3 times/month)
Once a month	0.459 (1.9 times/month)	0.4 (1.7 times/month)
Less often	0.306 (1.3 times/month)	0.2 (0.9 times/month)

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-71. Distribution of Usual Fish Intake Among Survey Main Respondents Who Fished and Consumed Recreationally Caught Fish

	All Fish Meals/Week	Recreational Fish Meals/Week	All Fish Intake g/day	Recreational Fish Intake g/day	All Fish Intake g/kg-day	Recreational Fish Intake g/kg-day
N	738	738	738	738	726	726
Mean	0.859	0.447	27.74	14.42	0.353	0.1806
10%	0.300	0.040	9.69	1.29	0.119	0.0159
25%	0.475	0.125	15.34	4.04	0.187	0.0504
50%	0.750	0.338	24.21	10.90	0.315	0.1357
75%	1.200	0.672	38.74	21.71	0.478	0.2676
90%	1.400	1.050	45.20	33.90	0.634	0.4146
95%	1.800	1.200	58.11	38.74	0.747	0.4920

N = Sample size.

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-72. Estimates of Fish Intake Rates of Licensed Sport Anglers in Maine During the 1989–1990 Ice Fishing or 1990 Open-Water Seasons[a]

	Intake Rates (g/day)			
	All Waters[b]		Rivers and Streams	
Percentile Rankings	All Anglers[c] (N = 1,369)	Consuming Anglers[d] (N = 1,053)	River Anglers[e] (N = 741)	Consuming Anglers[d] (N = 464)
50th (median)	1.1	2.0	0.19	0.99
66th	2.6	4.0	0.71	1.8
75th	4.2	5.8	1.3	2.5
90th	11.0	13.0	3.7	6.1
95th	21.0	26.0	6.2	12.0
Arithmetic Mean[f]	5.0 [79]	6.4 [77]	1.9 [82]	3.7 [81]

a Estimates are based on rank except for those of arithmetic mean.
b All waters based on fish obtained from all lakes, ponds, streams, and rivers in Maine, from other household sources, and from other non-household sources.
c Licensed anglers who fished during the seasons studied and did or did not consume freshwater fish, and licensed anglers who did not fish but ate freshwater fish caught in Maine during those seasons.
d Licensed anglers who consumed freshwater fish caught in Maine during the seasons studied.
e Those of the "all anglers" who fished on rivers or streams (consumers and nonconsumers).
f Values in brackets [ ] are percentiles at the mean consumption rates.

Source: Chemrisk, 1992; Ebert et al., 1993.

Table 10-73. Analysis of Fish Consumption by Ethnic Groups for "All Waters" (g/day)[a]

	Consuming Anglers[b]					
	French Canadian Heritage	Irish Heritage	Italian Heritage	Native American Heritage	Other White Non-Hispanic Heritage	Scandinavian Heritage
N of Cases	201	138	27	96	533	37
Median (50th percentile)[c,d]	2.3	2.4	1.8	2.3	1.9	1.3
66th percentile[c,d]	4.1	4.4	2.6	4.7	3.8	2.6
75th percentile[c,d]	6.2	6.0	5.0	6.2	5.7	4.9
Arithmetic mean[c]	7.4	5.2	4.5	10	6.0	5.3
Percentile at the mean[d]	80	70	74	83	76	78
90th percentile[c,d]	15	12	12	16	13	9.4
95th percentile[c,d]	27	20	21	51	24	25
Percentile at 6.5 g/day[d,e]	77	75	81	77	77	84

[a] "All Waters" based on fish obtained from all lakes, ponds, streams, and rivers in Maine, from other household sources, and from other non-household sources.
[b] "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989–1990 ice fishing or 1990 open water fishing seasons.
[c] The average consumption per day by freshwater fish consumers in the household.
[d] Calculated by rank without any assumption of statistical distribution.
[e] Fish consumption rate recommended by U.S. EPA (1984) for use in establishing ambient water quality standards.

Source: Chemrisk, 1992.

Table 10-74. Total Consumption of Freshwater Fish Caught by All Survey Respondents During the 1990 Season

	Ice Fishing		Lakes and Ponds		Rivers and Streams	
Species	Quantity Consumed (#)	Grams ($\times10^3$) Consumed	Quantity Consumed (#)	Grams ($\times10^3$) Consumed	Quantity Consumed (#)	Grams ($\times10^3$) Consumed
Landlocked salmon	832	290	928	340	305	120
Atlantic salmon	3	1.1	33	9.9	17	11
Togue (lake trout)	483	200	459	160	33	2.7
Brook trout	1,309	100	3,294	210	10,185	420
Brown trout	275	54	375	56	338	23
Yellow perch	235	9.1	1,649	52	188	7.4
White perch	2,544	160	6,540	380	3,013	180
Bass (smallmouth and largemouth)	474	120	73	5.9	787	130
Pickerel	1,091	180	553	91	303	45
Lake whitefish	111	20	558	13	55	2.7
Hornpout (catfish and bullheads)	47	8.2	1,291	100	180	7.8
Bottom fish (suckers, carp, and sturgeon)	50	81	62	22	100	6.7
Chub	0	0	252	35	219	130
Smelt	7,808	150	428	4.9	4,269	37
Other	201	210	90	110	54	45
TOTALS	15,463	1,583.4	16,587	1,590	20,046	1,168

Source: Chemrisk, 1992.

Table 10-75. Socio-Demographic Characteristics of Respondents

Category	Subcategory	Percent of Total[a]
Geographic Distribution	Upper Hudson	18%
	Mid Hudson	35%
	Lower Hudson	48%
Age Distribution (years)	<14	3%
	15 to 29	26%
	30 to 44	35%
	45 to 59	23%
	>60	12%
Annual Household Income	<$10,000	16%
	$10,000 to 29,999	41%
	$30,000 to 49,999	29%
	$50,000 to 69,999	10%
	$70,000 to 89,999	2%
	>$90,000	3%
Ethnic Background	Caucasian American	67%
	African American	21%
	Hispanic American	10%
	Asian American	1%
	Native American	1%

[a] A total of 336 shore-based anglers were interviewed.

Source: Hudson River Sloop Clearwater, Inc., 1993.

Table 10-76. Mean Sport-Fish Consumption by Demographic Variables, Michigan Sport Anglers Fish Consumption Study, 1991–1992			
	N	Mean (g/day)	95% CI
Income[a]			
<$15,000	290	21.0	16.3–25.8
$15,000 to $24,999	369	20.6	15.5–25.7
$25,000 to $39,999	662	17.5	15.0–20.1
>$40,000	871	14.7	12.8–16.7
Education			
Some High School	299	16.5	12.9–20.1
High School Degree	1,074	17.0	14.9–19.1
Some College-College Degree	825	17.6	14.9–20.2
Post-Graduate	231	14.5	10.5–18.6
Residence Size[b]			
Large City/Suburb (>100,000)	487	14.6	11.8–17.3
Small City (20,000 to 100,000)	464	12.9	10.7–15.0
Town (2,000 to 20,000)	475	19.4	15.5–23.3
Small Town (100 to 2,000)	272	22.8	16.8–28.8
Rural, Non-Farm	598	17.7	15.1–20.3
Farm	140	15.1	10.3–20.0
Age (years)			
16 to 29	266	18.9	13.9–23.9
30 to 39	583	16.6	13.5–19.7
40 to 49	556	16.5	13.4–19.6
50 to 59	419	16.5	13.6–19.4
60+	596	16.2	13.8–18.6
Sex[a]			
Male	299	17.5	15.8–19.1
Female	1,074	13.7	11.2–16.3
Race/Ethnicity[b]			
Minority	160	23.2	13.4–33.1
White	2,289	16.3	14.9–17.6

a $p < 0.01$, F test.
b $p < 0.05$, F test.
N = Sample size.
CI = Confidence interval.

Source: West et al., 1993.

Table 10-77. Mean Per Capita Freshwater Fish Intake of Alabama Anglers

	Mean Consumption (g/day)					
	Harvest Method[a]			4-ounce Serving Method[b]		
	N	Site meals	All meals	*N*	Site Meals	All Meals
All respondents	563	32.6	43.1	1,303	30.3	45.8
All respondents; all meals; 4-ounce serving method	-	-	-	-	-	44.8
Age (years)						16
20 to 30	-	-	-	-	-	39
31 to 50	-	-	-	-	-	76
51 and over	-	-	-	-	-	
Race/Ethnicity						
African American	113	35.4	49.6	232	33.4	50.7
Native American	0	0	0	2	22.7	22.7
Asian	2	74.7	74.7	3	44.1	44.1
Hispanic	2	0	0	2	0	0
Caucasian	413	33.9	48.6	925	29.4	49.7
Seasons						
Fall	130	29.7	43.4	303	32.0	49.4
Winter	56	26.2	34.2	177	30.8	43.9
Spring	185	21.5	29.3	414	20.5	33.6[c]
Summer	192	46.7	57.0	417	36.4	53.0[c]

[a] The Harvest Method used the actual harvest of fish and dressing method reported to calculate consumption rates.
[b] The 4-ounce Serving Method estimated consumption based on a typical 4-ounce serving size.
[c] Statistical difference at $p < 0.05$.
N = Number of respondents.

Source: Alabama Department of Environmental Management (ADEM), 1994.

Table 10-78. Distribution of Fish Intake Rates (from all sources and from sport-caught sources) for 1992 Lake Ontario Anglers

Percentile of Lake Ontario Anglers	Fish from All Sources (g/day)	Sport-Caught Fish (g/day)
25%	8.8	0.6
50%	14.1	2.2
75%	23.2	6.6
90%	34.2	13.2
95%	42.3	17.9
99%	56.6	39.8

Source. Connelly et al., 1996.

Table 10-79. Mean Annual Fish Consumption (g/day) for Lake Ontario Anglers, 1992, by Socio-Demographic Characteristics

Demographic Group	Mean Consumption: Fish from all Sources	Mean Consumption: Sport-Caught Fish
Overall	17.9	4.9
Residence		
Rural	17.6	5.1
Small City	20.8	6.3
City (25 to 100,000)	19.8	5.8
City (>100,000)	13.1	2.2
Income		
<$20,000	20.5	4.9
$21,000 to 34,000	17.5	4.7
$35,000 to 50,000	16.5	4.8
>$50,000	20.7	6.1
Age (years)		
<30	13.0	4.1
30 to 39	16.6	4.3
40 to 49	18.6	5.1
50+	21.9	6.4
Education		
<High School	17.3	7.1
High School Graduate	17.8	4.7
Some College	18.8	5.5
College Graduate	17.4	4.2
Some Post-Grad.	20.5	5.9

Note Scheffe's test showed statistically significant differences between residence types (for all sources and sport caught) and age groups (all sources).
Source: Connelly et al., 1996.

Table 10-80. Seafood Consumption Rates of Nine Connecticut Population Groups (cooked, edible meat, g/day)

	N	Mean	SD	Minimum	Maximum
General population	437	27.7	42.7	0	494.8
Sport-fishing households	502	51.1	66.1	0	586.0
Commercial fishing households	178	47.4	58.5	0	504.3
Minority	861	50.3	57.5	0	430.0
South East Asians	329	59.2	49.3	0.13	245.6
Non-Asians	532	44.8	61.5	0	430.0
Limited income households	937	43.1	60.4	0	571.9
Women aged 15 to 45 years	497	46.5	57.4	0	494.8
Children ≤15 years old	559	18.3	29.8	0	324.8

N = Sample size.
SD = Standard deviation.
Source: Balcom et al., 1999.

Table 10-81. Fishing Patterns and Consumption Rates of People Fishing Along the Savannah River (Mean ± SE)

	N	Age (years)	Years fished	Years fished Savannah River	Distance traveled (km)	How often eat fish/month	Serving size (grams)	Fish/month (kg)	Fish/year (kg)
Ethnicity									
White	180	42 ± 1	31 ± 1	24 ± 1	42 ± 9	2.88 ± 0.30	370 ± 6.60	1.17 ± 0.14	14.0 ± 1.70
Black	72	47 ± 2	34 ± 2	24 ± 2	15 ± 1	5.37 ± 0.57	387 ± 10.2	2.13 ± 0.24	25.6 ± 2.92
Income									
≤$20,000	138	43 ± 1	32± 2	24 ± 2	31 ± 4	3.39 ± 0.52	379 ± 7.27	1.44 ± 0.24	17.3 ± 2.82
>$20,000	99	42 ± 1	30± 1	22 ± 2	32 ± 9	3.97 ± 0.36	375 ± 8.10	1.58 ± 0.16	18.9 ± 1.88
Education									
Not high school graduate	45	49 ± 2	36 ± 2	23 ± 3	24 ± 4	5.93 ± 0.85	383 ± 13.3	2.61 ± 0.44	31.3 ± 5.26
High school graduate	154	43 ± 1	31 ± 1	26 ± 1	36 ± 9	3.02 ± 0.27	366 ± 6.81	1.15 ± 0.11	13.8 ± 1.36
College or technical training	59	41 ± 2	28 ± 2	17 ± 2	54 ± 24	3.36 ± 0.67	398 ± 11.8	1.52 ± 0.31	18.2 ± 3.66
Overall mean (all respondents)									48.7 g/day

N = Sample size.
SE = Standard error.

Source: Burger et al., 1999.

Table 10-82. Fish Consumption Rates for Indiana Anglers—Mail Survey (g/day)						
			Percentile			
	N	Mean	50th	80th	90th	95th
Active Consumers	1,045	19.8	9.5	28.4	37.8	60.5
Potential and Active Consumers	1,261	16.4	7.6	23.6	37.8	60.5

N = Sample size.

Source: Williams et al., 1999.

Table 10-83. Fish Consumption Rates for Indiana Anglers—On-Site Survey (g/day)						
			Percentile			
	N	Mean	50th	80th	90th	95th
Active Consumers						
White	177	20.0	7.6	23.6	37.8	113.4
Minority	143	27.2	7.6	30.2	90.7	136.1
Income						
<$25,000	101	18.9	7.5	18.9	37.8	136.1
$25,000 to $34,999	62	18.8	7.6	23.6	60.5	90.7
$35,000 to $49,999	55	15.2	5.7	23.6	23.6	45.4
>$50,000	60	48.9	11.3	113.4	181.4	181.4
Potential and Active Consumers						
White	361	6.8	0	5.7	15.1	37.8
Minority	217	15.3	3.8	13.2	37.8	90.7
Income						
<$25,000	180	10.2	3.8	9.5	23.6	37.8
$25,000 to $34,999	117	7.4	0	7.6	15.1	37.8
$35,000 to $49,999	91	6.8	0	5.7	22.7	23.6
>$50,000	126	13.6	0	7.6	37.8	113.4

N = Sample size.

Source: Williams et al., 2000.

Table 10-84. Consumption of Sport-Caught and Purchased Fish by Minnesota and North Dakota Residents (g/day)

		Percentile				
	N	50th	75th	90th	95th	99th
Minnesota						
Sport-caught fish only						
Age in years (sex)						
0 to 14	582	1.2	4.2	9.0	13.7	26.7
14 and over (males)	996	4.5	10.6	23.7	39.8	113.9
15 to 44 (females)	505	2.1	5.8	14.0	24.9	75.9
44 and over (females)	460	3.6	8.2	20.8	37.2	101.3
General population	2,312	2.8	7.9	17.3	28.9	78.0
Bois Forte Tribe	232	2.8	6.6	12.0	19.6	120.6
With fishing license	2,020	3.9	9.2	18.9	30.4	94.5
Without fishing license	490	0.0	2.0	4.5	7.0	51.1
Purchased Fish Only						
Age in years (sex)						
0 to 14	582	3.6	9.3	18.0	31.3	61.2
14 and over (males)	996	7.4	15.4	30.3	47.5	91.6
15 to 44 (females)	505	6.1	14.0	29.2	50.3	103.7
44 and over (females)	460	7.1	14.6	25.3	42.5	89.4
General population	2,312	6.6	14.4	27.7	43.2	91.3
Bois Forte Tribe	232	3.4	9.0	14.4	24.1	71.9
With fishing license	2,020	6.4	14.0	25.9	39.7	88.7
Without fishing license	490	5.6	12.7	29.6	55.4	98.7
Total						
Age in years (sex)						
0 to 14	582	6.9	14.0	25.6	38.1	78.2
14 and over (males)	996	15.1	27.2	50.3	72.3	155.6
15 to 44 (females)	505	10.1	19.1	39.5	69.2	147.7
44 and over (females)	460	13.8	22.8	45.2	64.1	139.3
General population	2,312	12.3	22.6	42.8	64.5	128.7
Bois Forte Tribe	232	9.3	14.5	26.0	38.4	123.0
With fishing license	2,020	13.2	23.1	42.3	64.5	133.5
Without fishing license	490	7.5	15.2	30.4	58.7	110.0
North Dakota						
Sport-Caught Fish Only						
Age in years (sex)						
0 to 14	343	1.7	6.0	13.3	21.6	44.3
14 and over (males)	579	2.3	6.8	15.1	24.6	79.8
15 to 44 (females)	311	4.3	10.7	23.8	30.1	89.8
44 and over (females)	278	4.2	11.5	21.8	32.5	87.5
General population	1,406	3.0	9.2	16.4	27.4	80.9
Spirit Lake Nation Tribes	105	0.0	2.9	20.3	36.3	97.6
With fishing license	1,101	4.5	11.2	21.2	30.8	87.2
Without fishing license	391	0.0	1.5	4.8	7.9	23.1

Table 10-84. Consumption of Sport-Caught and Purchased Fish by Minnesota and North Dakota Residents (g/day) (continued)

		Percentile				
	N	50th	75th	90th	95th	99th
Purchased Fish Only						
Age in years (sex)						
0 to 14	343	4.7	14.3	23.1	32.9	90.7
14 and over (males)	579	7.4	15.4	30.3	47.5	91.6
15 to 44 (females)	311	7.1	16.1	33.5	50.6	90.9
44 and over (females)	278	6.1	15.4	30.3	47.0	90.7
General population	1,406	6.4	15.4	29.1	47.8	95.6
Spirit Lake Nation Tribes	105	1.2	16.5	30.0	40.7	143.5
With fishing license	1,101	6.8	15.9	29.5	47.0	95.6
Without fishing license	391	5.7	15.1	30.2	52.8	112.2
Total						
Age in years (sex)						
0 to 14	343	9.2	20.4	35.7	57.1	97.4
14 and over (males)	579	7.4	15.4	30.3	47.5	91.6
15 to 44 (females)	311	14.1	27.3	49.8	80.5	137.5
44 and over (females)	278	13.5	25.4	49.3	78.8	144.5
General population	1,406	12.6	24.1	46.7	71.4	126.3
Spirit Lake Nation Tribes	105	1.4	21.2	50.7	80.8	179.8
With fishing license	1,101	14.0	25.3	49.2	76.2	131.4
Without fishing license	391	7.2	15.9	33.5	54.1	116.1

N = Sample size.

Source: Benson et al., 2001.

Table 10-85. Fishing Patterns and Consumption Rates of Anglers Along the Clinch River Arm of Watts Bar Reservoir (Mean ± SE)

	N	Age (years)	Years fished	Years fished, Clinch River	Distance traveled (km)	How often eat fish/month	Serving size (grams)	Fish/month (kg)	Fish/year (kg)
All anglers	202	39.2± 1	31 ± 1	11 ± 1	61 ± 5	1.28 ± 0.12	283 ± 20.9	0.62 ± 0.08	7.40 ± 1.01
Anglers who catch and eat fish from study area	77	41.8 ± 2	34 ± 2	12 ± 2	57 ± 6	2.06 ± 0.22	486 ± 32.7	1.14 ± 0.19	13.7 ± 2.17
Ethnicity									
White	71	42 ± 2	34 ± 2	12 ± 2	59 ± 6	2.14 ± 0.23	501 ± 33.6	1.21 ± 0.20	14.5 ± 2.36
Black	6	43 ± 6	33 ± 7	20 ± 5	44 ± 20	0.94 ± 0.78	307 ± 116	0.34 ± 0.68	4.14 ± 8.11
Income									
≤$20,000	22	42 ± 3	33 ± 4	16 ± 3	49 ± 10	1.37 ±0.40	392 ± 41.7	0.52 ± 0.29	6.29 ± 3.58
$20,000 to $29,000	19	35 ± 3	29 ± 4	8.8 ± 3	37 ± 12	1.84 ± 0.44	548 ± 44.9	1.19 ± 0.32	14.3 ± 3.85
$30,000 to $39,000	18	43 ± 3	37 ± 4	8.9 ± 3	69 ± 11	2.13 ± 0.45	482 ± 46.1	1.11 ± 0.33	13.3 ± 3.95
>$40,000	15	47 ± 4	38 ± 4	13.9 ± 3	81 ± 12	3.01 ± 0.49	452 ± 50.5	1.56 ± 0.36	18.8 ± 4.33
Education									
Not high school graduate	18	44 ± 4	35 ± 4	13 ± 3	57 ± 12	1.67 ± 0.46	439 ± 67.7	0.83 ± 0.39	9.99 ± 4.77
High school graduate	28	40 ± 3	32 ± 3	14 ± 3	55 ± 10	2.12 ± 0.37	551 ± 54.2	1.45 ± 0.32	17.4 ± 3.82
Some college, associates, trade school	20	40 ± 3	35 ± 4	9.0 ± 3	61 ± 11	2.05 ± 0.44	486 ± 64.2	1.11 ± 0.38	13.4 ± 4.52
College, at least a bachelors degree	10	42 ± 5	36 ± 5	10 ± 4	59 ± 16	2.33 ± 0.62	414 ± 90.8	0.92 ± 0.53	11.0 ± 6.39

N = Sample size.

Source: Campbell et al., 2002.

Table 10-86. Daily Consumption of Wild-Caught Fish, Consumers Only (g/kg-day, as-consumed)

			g/person/day						
Population	*N*	Consumers (%)	Mean	Range	Median	75th	90th	95th	99th
Ethnicity									
Black	39	79	171.0	1.88–590.0	137.0	240.0	446.0	557.0	590.0
White	415	78	38.8	0.35–902.0	15.3	37.6	93.0	129.0	286.0
All	458	78	50.2	0.35–902.0	17.6	47.8	123.0	216.0	538.0
Sex									
Female	149	72	39.1	0.35–412.0	11.6	32.8	123.0	172.0	373.0
Male	308	80	55.2	0.63–902.0	21.3	56.4	127.0	235.0	557.0
All	458	73	50.2	0.35–902.0	17.6	47.8	123.0	216.0	538.0
Age (years)									
<32	145	77	32.6	0.63–412.0	14.2	37.6	66.5	123.0	216.0
33 to 45	159	77	71.3	7.52–902.0	18.8	67.6	177.0	354.0	590.0
>45	150	78	44.0	0.35–538.0	20.0	44.4	100.0	164.0	286.0
Income									
$0 to <20K	98	82	104.0	31.9–590.0	31.9	151.0	285.0	429.0	590.0
$20 to 30K	95	82	32.7	0.35–460.0	15.0	37.2	93.0	120.0	460.0
>$30K	172	76	40.9	0.47–902.0	19.4	45.8	87.9	127.0	216.0

N = Sample size.

Source: Burger, 2002b.

Table 10-87. Consumption Rates (g/day) for Freshwater Recreational Anglers in King County, WA							
Location	Sample Size	Mean	SD	SE	Percentiles		
					50th	90th	95th
Freshwater Fish Consumption							
King County Lakes (all respondents)	128	10	24	2	0	23	42
King County Lakes (children of respondents)	81	7	20	2	0	17	29

SD = Standard deviation.
SE = Standard error.

Source: Mayfield et al., 2007.

Table 10-88. Number of Grams per Day of Fish Consumed by All Adult Respondents (consumers and non-consumers combined)—Throughout the Year

Number of g/day	Cumulative Percent	Number of g/Day	Cumulative Percent
0.00	8.9%	64.8	80.6%
1.6	9.0%	72.9	81.2%
3.2	10.4%	77.0	81.4%
4.0	10.8%	81.0	83.3%
4.9	10.9%	97.2	89.3%
6.5	12.8%	130	92.2%
7.3	12.9%	146	93.7%
8.1	13.7%	162	94.4%
9.7	14.4%	170	94.8%
12.2	14.9%	194	97.2%
13.0	16.3%	243	97.3%
16.2	22.8%	259	97.4%
19.4	24.0%	292	97.6%
20.2	24.1%	324	98.3%
24.3	27.9%	340	98.7%
29.2	28.1%	389	99.0%
32.4	52.5%	486	99.6%
38.9	52.9%	648	99.7%
40.5	56.5%	778	99.9%
48.6	67.6%	972	100%

N = 500; *N* = sample size.
Weighted Mean = 58.7 g/day.
Weighted SE = 3.64; SE = standard error.
90^{th} Percentile 97.2 g/day < (90^{th}) < 130 g/day.
95^{th} Percentile = 170 g/day.
99^{th} Percentile = 389 g/day.

Source: CRITFC, 1994.

Table 10-89. Fish Intake Throughout the Year by Sex, Age, and Location by All Adult Respondents

	N	Weighted Mean (g/day)	Weighted SE
Sex			
Female	278	55.8	4.78
Male	222	62.6	5.60
Total	500	58.7	3.64
Age (years)			
18 to 39	287	57.6	4.87
40 to 59	155	55.8	4.88
60 and Older	58	74.4	15.3
Total	500	58.7	3.64
Location			
On Reservation	440	60.2	3.98
Off Reservation	60	47.9	8.25
Total	500	58.7	3.64

Source: CRITFC, 1994.

Table 10-90. Fish Consumption Rates Among Native American Children (Age 5 Years and Under)[a]

g/day	Unweighted Cumulative Percent
0.0	21.1
0.4	21.6
0.8	22.2
1.6	24.7
2.4	25.3
3.2	28.4
4.1	32.0
4.9	33.5
6.5	35.6
8.1	47.4
9.7	48.5
12.2	51.0
13.0	51.5
16.2	72.7
19.4	73.2
20.3	74.2
24.3	76.3
32.4	87.1
48.6	91.2
64.8	94.3
72.9	96.4
81.0	97.4
97.2	98.5
162.0	100

[a] Sample size = 194; unweighted mean = 19.6 g/day; unweighted standard error = 1.94.

Note: Data are compiled from the Umatilla, Nez Perce, Yakama, and Warm Springs tribes of the Columbia River Basin.

Source: CRITFC, 1994.

Table 10-91. Number of Fish Meal Eaten per Month and Fish Intake Among Native American Children Who Consume Particular Species

Species	N	Fish Meals/Month		Intake (g/day)	
		Unweighted Mean	Unweighted SE	Unweighted Mean	Unweighted SE
Salmon	164	2.3	0.16	19	1.5
Lamprey	37	0.89	0.27	8.1	2.8
Trout	89	0.96	0.12	8.8	1.4
Smelt	39	0.40	0.09	3.8	0.99
Whitefish	21	3.5	2.83	21	16
Sturgeon	21	0.43	0.12	4.0	1.3
Walleye	5	0.22	0.20	2.0	1.5
Squawfish	2	0.00	-	0.0	-
Sucker	4	0.35	0.22	2.6	1.7
Shad	3	0.10	0.06	1.1	0.57

- Not applicable.
SE = Standard error.

Source: CRITFC, 1994.

Table 10-92. Socio-Demographic Factors and Recent Fish Consumption

	Peak Consumption[a]		Recent Consumption[b]			
	Average meals/week[c]	≥3 meals/week[d] (%)	Walleye	N. Pike	Muskellunge	Bass
All participants (N = 323)	1.7	20	4.2	0.3	0.3	0.5
Sex						
Male (N = 148)	1.9	26	5.1	0.5[a]	0.5	0.7[a]
Female (N = 175)	1.5	15	3.4	0.2	0.1	0.3
Age (years)						
<35 (N = 150)	1.8	23	5.3[a]	0.3	0.2	0.7
≥35 (N = 173)	1.6	17	3.2	0.4	0.3	0.3
High School Graduate						
No (N = 105)	1.6	18	3.6	0.2	0.4	0.7
Yes (N = 218)	1.7	21	4.4	0.4	0.2	0.4
Unemployed						
Yes (N = 78)	1.9	27	4.8	0.6	0.6	1.1
No (N = 245)	1.6	18	4.0	0.3	0.2	0.3

[a] Highest number of fish meals consumed/week.
[b] Number of meals of each species in the previous 2 months.
[c] Average peak fish consumption.
[d] Percentage of population reporting peak fish consumption of ≥3 fish meals/week.

Source: Peterson et al., 1994.

Table 10-93. Number of Local Fish Meals Consumed per Year by Time Period for All Respondents

Number of Local Fish Meals Consumed Per Year	Time Period: During Pregnancy				≤1 Year Before Pregnancy[a]				>1 Year Before Pregnancy[b]			
	Mohawk		Control		Mohawk		Control		Mohawk		Control	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
None	63	64.9	109	70.8	42	43.3	99	64.3	20	20.6	93	60.4
1 to 9	24	24.7	24	15.6	40	41.2	31	20.1	42	43.3	35	22.7
10 to 19	5	5.2	7	4.5	4	4.1	6	3.9	6	6.2	8	5.2
20 to 29	1	1.0	5	3.3	3	3.1	3	1.9	9	9.3	5	3.3
30 to 39	0	0.0	2	1.3	0	0.0	3	1.9	1	1.0	1	0.6
40 to 49	0	0.0	1	0.6	1	1.0	1	0.6	1	1.0	1	0.6
50+	4	4.1	6	3.9	7	7.2	11	7.1	18	18.6	11	7.1
Total	97	100.0	154	100.0	97	100.0	154	100.0	97	100.0	154	100.0

[a] $p < 0.05$ for Mohawk vs. Control.
[b] $p < 0.001$ for Mohawk vs. Control.
N = Number of respondents.

Source: Fitzgerald et al., 1995.

Table 10-94. Mean Number of Local Fish Meals Consumed per Year by Time Period for All Respondents and Consumers Only

	All Respondents (N = 97 Mohawks and 154 Controls)			Consumers Only (N = 82 Mohawks and 72 Controls)		
	During Pregnancy	≤1 Year Before Pregnancy	>1 Year Before Pregnancy	During Pregnancy	≤1 Year Before Pregnancy	>1 Year Before Pregnancy
Mohawk	3.9 (1.2)	9.2 (2.3)	23.4 (4.3)[a]	4.6 (1.3)	10.9 (2.7)	27.6 (4.9)
Control	7.3 (2.1)	10.7 (2.6)	10.9 (2.7)	15.5 (4.2)[a]	23.0 (5.1)[b]	23.0 (5.5)

[a] $p < 0.001$ for Mohawk vs. Controls.
[b] $p < 0.05$ for Mohawk vs. Controls.
( ) = Standard error.

Test for linear trend:
$p < 0.001$ for Mohawk (All participants and consumers only);
$p = 0.07$ for Controls (All participants and consumers only).

Source: Fitzgerald et al., 1995.

Table 10-95. Mean Number of Local Fish Meals Consumed per Year by Time Period and Selected Characteristics for All Respondents (Mohawk, *N* = 97; Control, *N* = 154)

	Time Period					
	During Pregnancy		≤1 Year Before Pregnancy		>1 Year Before Pregnancy	
Variable	Mohawk	Control	Mohawk	Control	Mohawk	Control
Age (years)						
<20	7.7	0.8	13.5	13.9	27.4	10.4
20 to 24	1.3	5.9	5.7	14.5	20.4	15.9
25 to 29	3.9	9.9	15.5	6.2	25.1	5.4
30 to 34	12.0	7.6	9.5	2.9	12.0	5.6
>34	1.8	11.2	1.8	26.2	52.3	22.1[a]
Education (Years)						
<12	6.3	7.9	14.8	12.4	24.7	8.6
12	7.3	5.4	8.1	8.4	15.3	11.4
13 to 15	1.7	10.1	8.0	15.4	29.2	13.3
>15	0.9	6.8	10.7	0.8	18.7	2.1
Cigarette Smoking						
Yes	3.8	8.8	10.4	13.0	31.6	10.9
No	3.9	6.4	8.4	8.3	18.1	10.8
Alcohol Consumption						
Yes	4.2	9.9	6.8	13.8	18.0	14.8
No	3.8	6.3[b]	12.1	4.7[c]	29.8	2.9[d]

a F (4,149) = 2.66, *p* = 0.035 for Age Among Controls.
b F (1,152) = 3.77, *p* = 0.054 for Alcohol Among Controls.
c F (1,152) = 5.20, *p* = 0.024 for Alcohol Among Controls.
d F (1,152) = 6.42, *p* = 0.012 for Alcohol Among Controls.
Note: F (r1, r2) = F statistic with r1 and r2 degrees of freedom.

Source: Fitzgerald et al., 1995.

Table 10-96. Fish Consumption Rates for Mohawk Native Americans (g/day)

Population Group	Sample Size	Fish Intake Rate		% Consuming
		Mean	95th Percentile	
Adults—all[a]				
All fish	1,092	28	132	90%
Local fish	1,092	25	131	90%
Adults—consumers only[a]				
All fish	983	31	142	90%
Local fish	972	29	135	90%
Children—all[b]				
Local fish	--	10	54	--
Children—consumers only[b]				
Local fish	--	13	58	--

a Value based on assumption that 1 fish meal = 227 grams (1/2 pound) (based on data from Pao et al., [1982]).
b Value for 2-year old child, based on assumption that children consume fish at the same frequency as adults but have a smaller meal size (93 grams).

Source: Forti et al., 1995.

Table 10-97. Percentiles and Mean of Adult Tribal Member Consumption Rates (g/kg-day)

	5%	50%	90%	95%	SE	Mean	95% CI
Tulalip Tribes (*N* = 73)							
Anadromous fish	0.006	0.190	1.429	2.114	0.068	0.426	(0.297, 0.555)
Pelagic fish	0.000	0.004	0.156	0.234	0.008	0.036	(0.021, 0.051)
Bottom fish[a]	0.000	0.008	0.111	0.186	0.007	0.033	(0.020, 0.046)
Shellfish[a]	0.000	0.153	1.241	1.5296	0.059	0.362	(0.250, 0.474)
Total finfish	0.010	0.284	1.779	2.149	0.072	0.495	(0.359, 0.631)
Other fish[b]	0.000	0.000	0.113	0.264	0.008	0.031	(0.016, 0.046)
Total fish	0.046	0.552	2.466	2.876	0.111	0.889	(0.679, 1.099)
Squaxin Island Tribe (*N* = 117)							
Anadromous fish	0.016	0.308	1.639	2.182	0.069	0.590	(0.485, 0.695)
Pelagic fish	0.000	0.003	0.106	0.248	0.009	0.043	(0.029, 0.057)
Bottom fish[a]	0.000	0.026	0.176	0.345	0.010	0.063	(0.048, 0.078)
Shellfish[a]	0.000	0.065	0.579	0.849	0.027	0.181	(0.140, 0.222)
Total finfish	0.027	0.383	1.828	2.538	0.075	0.697	(0.583, 0.811)
Other fish[b]	0.000	0.000	0.037	0.123	0.003	0.014	(0.009, 0.019)
Total fish	0.045	0.524	2.348	3.016	0.088	0.891	(0.757, 1.025)
Both Tribes Combined (weighted)							
Anadromous fish	0.010	0.239	1.433	2.085	0.042	0.508	(0.425, 0.591)
Pelagic fish	0.000	0.004	0.112	0.226	0.005	0.040	(0.029, 0.050)
Bottom fish**	0.000	0.015	0.118	0.118	0.005	0.048	(0.038, 0.058)
Shellfish**	0.000	0.115	0.840	1.308	0.030	0.272	(0.212, 0.331)
Total finfish	0.017	0.317	1.751	2.188	0.045	0.596	(0.507, 0.685)
Other fish*	0.000	0.000	0.049	0.145	0.004	0.023	(0.015, 0.030)
Total fish	0.047	0.531	2.312	2.936	0.064	0.890	(0.765, 1.015)

[a] $p < 0.01$ comparing two tribes (Wilcoxon-Mann-Whitney test).
[b] $p < 0.05$
N = Sample size.
SE = Standard error.
CI = Confidence interval.

Source: Toy et al., 1996.

Table 10-98. Median and Mean Consumption Rates by Sex (g/kg-day) within Each Tribe

	Tulalip Tribe				Squaxin Island Tribe			
	N	Median	Mean	95% CI	*N*	Median	Mean	95% CI
Shellfish								
Male	42	0.158	0.370	(0.215, 0.525)	65	0.100	0.202	(0.149, 0.255)
Female	31	0.153	0.353	(0.192, 0.514)	52	0.038	0.155	(0.093, 0.217)
Total finfish								
Male	42	0.414	0.559	(0.370, 0.748)	65	0.500	0.707	(0.576, 0.838)
Female	31	0.236	0.409	(0.218, 0.600)	52	0.272	0.684	(0.486, 0.882)
Total fish[a]								
Male	42	0.623	0.959	(0.666, 1.252)	65	0.775[b]	0.926	(0.771, 1.081)
Female	31	0.472	0.794	(0.499, 1.089)	52	0.353	0.847	(0.614, 1.080)

[a] Total fish includes anadromous, pelagic, bottom shellfish, finfish, and other fish.
[b] $p < 0.05$ for difference in consumption rate by sex within a tribe (Wilcoxon-Mann-Whitney test).
N = Sample size.
CI = Confidence interval.

Source: Toy et al., 1996.

Table 10-99. Median Consumption Rate for Total Fish by Sex and Tribe (g/day)

	Tulalip Tribe	Squaxin Island Tribe
Male	53	66
Female	34	25

Source: Toy et al., 1996.

Table 10-100. Percentiles of Adult Consumption Rates by Age (g/kg-day)							
	Tulalip Tribes				Squaxin Island Tribe		
Ages (years)	5%	50%	90%	95%	50%	90%	95%
Shellfish							
18 to 34	0.00	0.181	1.163	1.676	0.073	0.690	1.141
35 to 49	0.00	0.161	1.827	1.836	0.073	0.547	1.094
50 to 64	0.00	0.173	0.549	0.549	0.000	0.671	0.671
65+	0.00	0.034	0.088	0.088	0.035	0.188	0.188
Total finfish							
18 to 34	0.013	0.156	1.129	1.956	0.289	1.618	2.963
35 to 49	0.002	0.533	2.188	2.388	0.383	2.052	2.495
50 to 64	0.156	0.301	1.211	1.211	0.909	3.439	3.439
65+	0.006	0.176	0.531	0.531	0.601	2.049	2.049
Total fish[a]							
18 to 34	0.044	0.571	2.034	2.615	0.500	2.385	3.147
35 to 49	0.006	0.968	3.666	4.204	0.483	2.577	3.053
50 to 64	0.190	0.476	11.586	1.586	1.106	3.589	3.589
65+	0.050	0.195	0.623	0.623	0.775	2.153	2.153

[a] Total fish includes anadromous, pelagic, bottom, shellfish, finfish, and other fish.

Source: Toy et al., 1996.

Table 10-101. Median Consumption Rates by Income (g/kg-day) within Each Tribe		
Income	Tulalip Tribes	Squaxin Island Tribe
Shellfish		
≤ $10,000	0.143	0.078
$10,001 to $15,000	0.071	0.121
$15,001 to $20,000	0.144	0.072
$20,001 to $25,000	0.202	0.000
$25,001 to $35,000	0.416	0.030
$35,001+	0.175	0.090
Total finfish		
≤ $10,000	0.235	0.272
$10,001 to $15,000	0.095	0.254
$15,001 to $20,000	0.490	0.915
$20,001 to $25,000	0.421	0.196
$25,001 to $35,000	0.236	0.387
$35,001+	0.286	0.785
Total fish		
≤$10,000	0.521	0.476
$10,001 to $15,000	0.266	0.432
$15,001 to $20,000	0.640	0.961
$20,001 to $25,000	0.921	0.233
$25,001 to $35,000	0.930	0.426
$35,001+	0.607	1.085

Source: Toy et al., 1996.

Table 10-102. Mean, 50th, and 90th Percentiles of Consumption Rates for Children Age Birth to 5 Years (g/kg-day)

	Mean (SE)	95% CI	50%	90%
Tulalip Tribes (*N* = 21)				
Shellfish	0.125 (0.056)	(0.014, 0.236)	0.000	0.597
Total finfish	0.114 (0.030)	(0.056, 0.173)	0.060	0.290
Total, all fish	0.239 (0.077)	(0.088, 0.390)	0.078	0.738
Squaxin Island Tribe (*N* = 48)				
Shellfish	0.228 (0.053)	(0.126, 0.374)	0.045	0.574
Total finfish	0.250 (0.063)	(0.126, 0.374)	0.061	0.826
Total, all fish	0.825 (0.143)	(0.546, 1.105)	0.508	2.056
Both Tribes Combined (weighted)				
Shellfish	0.177 (0.039)	(0.101, 0.253)	0.012	0.574
Total finfish	0.182 (0.035)	(0.104, 0.251)	0.064	0.615
Total, all fish	0.532 (0.081)	(0.373, 0.691)	0.173	1.357

N = Sample size.
SE = Standard error.
CI = Confidence interval.

Source: Toy et al., 1996.

Table 10-103. Adult Consumption Rate (g/kg-day): Individual Finfish and Shellfish and Fish Groups

Species/Group	All Adult Respondents (Including Non-Consumers)											Consumers Only			
	N	Mean	SE	95% LCL	95% UCL	Percentiles 5th	50th	75th	90th	95th	Max	*N*	%	GM	MSE
Group G															
Abalone	92	0.001	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.063	3	3	0.007	3.139
Lobster	92	0.022.	0.007	0.008	0.036	0.000	0.000	0.000	0.085	0.139	0.549	22	24	0.052	1.266
Octopus	92	0.019	0.006	0.008	0.030	0.000	0.000	0.015	0.069	0.128	0.407	25	27	0.042	1.231
Limpets	92	0.010	0.009	0.000	. 0.027	0.000	0.000	0.000	0.000	.0.000	0.795	2	2	0.261	3.047
Miscellaneous	92	0.0003	0.0003	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.023	1	1	0.023	
Group A	92	0.618	0.074.	0.473	0.763	0.021	0.350	1.002	1.680	2.177	3.469	92	100	0.274	1.167
Group B	92	0.051	0.016	0.019	0.082	0.000	0.003	0.019	0.128	0.270	1.149	49	53	0.025	1.262
Group C	92	0.136	0.025	0.087	0.185	0.000	0.055	0.141	0.369	0.526	1.716	87	95	0.064	1.147
Group D	92	0.097	0.021	0.056	0.138	0.000	0.029	0.076	0.206	0.613	1.069	76	.83	0.045	1.168
Group E	92	1.629	0.262	1.115	2.143	0.063	0.740	1.688	4.555	7.749	15.886	91	99	0.703	1.160
Group F	92	0.124	0.016	0.092	0.156	0.000	0.068	0.144	0.352	0.533	0.778	85	92	0.070	1.139
Group G	92	0.052	0.017	0.019	0.084	0.000	0.000	0.038	0.128	0.262	1.344	42	46	0.043	1.240
All Finfish	92	1.026	0.113	1.153	2.208	0.087	0.639	1.499	2.526	3.412	5.516	92	100	0.590	1.128
All Shellfish	92	1.680	0.269	2.049	3.364	0.063	0.796	1.825	4.590	7.754	15.976	91	99	0.727	1.160
All Seafood	92	2.707	0.336	0.000	0.000	0.236	1.672	3.598	6.190	10.087	18.400	92	100	1.530	1.123

N = Sample size.
SE = Standard error.
LCL = Lower confidence limit.
UCL = Upper confidence limit.
GM = Geometric mean.
MSE = Multiplicative standard error.
Note: The minimum consumption for all species and groups was zero, except for "Group A," "All Finfish," and "All Seafood". The minimum rate for "Group A" was 0.005, for "All Finfish" was 0.018, and for "All Seafood" was 0.080.

Source: Duncan, 2000.

Table 10-104. Adult Consumption Rate (g/kg-day) for Consumers Only

Group	Species	Consumers Only					
		N	Mean	SE	Median	75th Percentile	90th Percentile
Group A	King	63	0.200	0.031	0.092	0.322	0.581
	Sockeye	59	0.169	0.026	0.070	0.293	0.493
	Coho	50	0.191	0.033	0.084	0.247	0.584
	Chum	42	0.242	0.046	0.147	0.280	0.768
	Pink	17	0.035	0.007	0.034	0.057	0.077
	Other or Unspecified Salmon	32	0.159	0.070	0.043	0.172	0.261
	Steelhead	26	0.102	0.035	0.027	0.103	0.398
	Salmon (gatherings)	85	0.074	.0.012	0.031	0.079	0.205
Group B	Smelt	49	0.078	0.024	0.016	0.078	0.247
	Herring	14	0.059	0.020	0.034	0.093	0.197
Group C	Cod	78	0.126	0.024	0.051	0.140	0.319
	Perch	2	0.012	0.002	0.012	---	---
	Pollock	40	0.054	0.020	0.013	0.060	0.139
	Sturgeon	8	0.041	0.021	0.021	0.053	---
	Sable Fish	5	0.018	0.009	0.014	0.034	---
	Spiny Dogfish	1	0.004	---	---	---	---
	Greenling	2	0.013	0.002	0.013	---	---
	Bull Cod	1	0.016	---	---	---	---
Group D	Halibut	74	0.080	0.018	0.029	0.069	0.213
	Sole/Flounder	20	0.052	0.015	0.022	0.067	0.201
	Rock Fish	12	0.169	0.072	0.066	0.231	0.728
Group E	Manila/Littleneck Clams	84	0.481	0.154	0.088	0.284	1.190
	Horse Clams	52	0.073	0.016	0.025	0.070	0.261
	Butter Clams	72	0.263	0.062	0.123	0.184	0.599
	Geoduck	83	0.184	0.039	0.052	0.167	0.441
	Cockles	61	0.233	0.055	0.099	0.202	0.530
	Oysters	60	0.164	0.034	0.068	0.184	0.567
	Mussels	25	0.059	0.020	0.015	0.085	0.155
	Moon Snails	0	---	---	---	---	---
	Shrimp	86	0.174	0.027	0.088	0.196	0.549
	Dungeness Crab	81	0.164	0.028	0.071	0.185	0.425

Table 10-104. Adult Consumption Rate (g/kg-day) for Consumers Only (continued)							
		Consumers Only					
Group	Species	*N*	Mean	SE	Median	75th Percentile	90th Percentile
Group E (cont'd)	Red Rock Crab	19	0.037	0.010	0.012	0.057	0.117
	Scallops	54	0.037	0.009	0.011	0.040	0.110
	Squid	23	0.041	0.017	0.009	0:032	0.188
	Sea Urchin	6	0.025	0.008	0.019	0.048	---
	Sea Cucumber	5	0.056	0.031	0.008	0.130	---
	Oyster (gatherings)	40	0.061	0.014	0.031	0.088	0.152
	Clams (gatherings)	61	0.071	0.016	0.029	0.064	0.165
	Crab (gatherings)	43	0.056	0.019	0.027	0.042	0.100
	Clams (razor, unspecified)	35	0.124	0.036	0.062	0.138	0.284
	Crab (king/snow)	1	0.017	---	---	---	---
Group F	Cabazon	1	0.080	---	---	---	---
	Blue Back (sockeye)	2	0.006	0.004	0.006	---	---
	Trout/Cutthroat	3	0.112	0.035	0.129	---	---
	Tuna (fresh/canned)	83	0.129	0.017	0.071	0.145	0.346
	Groupers	1	0.025	---	---	---	---
	Sardine	1	0.049	---	---	---	---
	Grunter	4	0.056	0.026	0.047	0.110	---
	Mackerel	1	0.008	---	---	---	---
	Shark	1	0.002	---	---	---	---
Group G	Abalone	3	0.022	0.020	0.003	---	---
	Lobster	22	0.092	0.025	0.057	0.130	0.172
	Octopus	25	0.071	0.017	0.044	0.123	0.149
	Limpets	2	0.440	0.355	0.440	---	---
	Miscellaneous	1	0.023	---	---	---	---
	Group A	92	0.618	0.074	0.350	1.002	1.680
	Group B	49	0.095	0.029	0.017	0.098	0.261
	Group C	87	0.144	0.026	0.068	0.141	0.403
	Group D	76	0.118	0.025	0.042	0.091	0.392
	Group E	91	1.647	0.265	0.750	1.691	4.577
	Group F	85	0.134	0.017	0.076	0.163	0.372
	Group G	42	0.113	0.034	0.042	0.118	0.270
	All Finfish	92	1.026	0.113	0.639	1.499	2.526

Table 10-104. Adult Consumption Rate (g/kg-day) for Consumers Only (continued)

		Consumers Only					
Group	Species	*N*	Mean	SE	Median	75th Percentile	90th Percentile
	All Shellfish	91	1.699	0.271	0.819	1.837	4.600
	All Seafood	92	2.707	0.336	1.672	3.598	6.190

N = Sample size.
SE = Standard error.

Source: Duncan, 2000.

Table 10-105. Adult Consumption Rate (g/kg-day) by Sex

	All Adult Respondents (Including Non-Consumers)										Consumers Only			
						Percentiles								
Species/Group	*N*	Mean	SE	95% LCL	95% UCL	th	50th	75th	90th	95th	*N*	%	GM[a]	MSE[b]
Group A (*p* = 0.02)														
Male	46	0.817	0.120	0.582	1.052	0.021	0.459	1.463	2.033	2.236	46	100	0.385	1.245
Female	46	0.419	0.077	0.268	0.570	0.018	0.294	0.521	1.028	1.813	46	100	0.195	1.232
Group B (*p* = 0.04)														
Male	46	0.089	0.031	0.028	0.150	0.000	0.008	0.076	0.269	0.623	27	59	0.046	1.378
Female	46	0.013	0.004	0.005	0.021	0.000	0.000	0.013	0.044	0.099	22	48	0.012	1.309
Group C (*p* = 0.03)														
Male	46	0.170	0.043	0.086	0.254	0.007	0.078	0.148	0.432	0.847	46	100	0.075	1.210
Female	46	0.102	0.025	0.053	0.151	0.000	0.047	0.102	0.277	0.496	41	89	0.053	1.215
Group D (*p* = 0.08)														
Male	46	0.135	0.037	0.062	0.208	0.000	0.045	0.133	0.546	0.948	39	85	0.057	1.274
Female	46	0.060	0.018	0.025	0.095	0.000	0.026	0.056	0.105	0.453	37	80	0.035	1.204
Group E (*p* = 0.03)														
Male	46	1.865	0.316	1.246	2.484	0.068	1.101	2.608	4.980	7.453	46	100	0.879	1.238
Female	46	1.392	0.419	0.571	2.213	0.029	0.644	0.936	2.462	9.184	45	98	0.559	1.224
Group F (*p* = 0.6)														
Male	46	0.141	0.026	0.090	0.192	0.000	0.072	0.195	0.413	0.597	40	87	0.089	1.199
Female	46	0.107	0.020	0.068	0.146	0.005	0.052	0.126	0.322	0.451	45	98	0.056	1.198
Group G (*p* = 0.2)														
Male	46	0.081	0.032	0.018	0.144	0.000	0.001	0.070	0.261	0.476	23	50	0.057	1.395
Female	46	0.023	0.007	0.009	0.037	0.000	0.000	0.016	0.093	0.162	19	41	0.031	1.272
All Finfish (*p* = 0.007)														
5Male	46	1.351	0.193	0.973	1.729	0.115	0.905	1.871	3.341	4.540	46	100	0.800	1.191
Female	46	0.701	0.100	0.505	0.897	0.083	0.465	0.943	1.751	2.508	46	100	0.434	1.169
All Shellfish (*p* = 0.03)														
Male	46	1.946	0.335	1.289	2.603	0.068	1.121	2.628	5.146	7.453	46	100	0.909	1.240
Female	46	1.415	0.421	0.590	2.240	0.029	0.678	1.007	2.462	9.231	45	98	0.579	1.221
All Seafood (*p* = 0.008)														
Male	46	3.297	0.458	2.399	4.195	0.232	2.473	4.518	8.563	10.008	46	100	1.971	1.188
Female	46	2.116	0.480	1.175	3.057	0.236	0.965	2.219	4.898	10.400	46	100	1.188	1.158

N = Sample size.
SE = Standard error.
LCL = Lower confidence interval.
UCL = Upper confidence interval.
GM = Geometric mean.
MSE = Multiplicative standard error.
Note *p*-value is 2-sided and based upon Mann-Whitney test. The 95% CL is based on the normal distribution. The 5th and 95th percentile are not reported for groups with less than 20 respondents.

Source: Duncan, 2000.

Table 10-106. Adult Consumption Rate (g/kg-day) by Age

	All Adult Respondents (Including Non-Consumers)										Consumers Only			
						Percentiles								
Species/Age Group	*N*	Mean	SE	95% LCL	95% UCL	5th	50th	75th	90th	95th	*N*	%	GM[a]	MSE[b]
Group A (*p* = 0.04)														
16 to 42 Years	58	0.512	0.083	0.349	0.675	0.015	0.294	0.660	1.544	2.105	58	100	0.215	1.219
43 to 54 Years	15	1.021	0.233	0.564	1.478		1.020	1.596	2.468		15	100	0.645	1.337
55 Years and Over	19	0.623	0.159	0.311	0.935		0.394	0.868	2.170		19	100	0.294	1.402
Group B (*p* = 0.001)														
16 to 42 Years	58	0.042	0.022	0.000	0.085	0.000	0.000	0.009	0.098	0.295	22	38	0.023	1.447
43 to 54 Years	15	0.097	0.047	0.005	0.189		0.019	0.124	0.421		12	80	0.049	1.503
55 Years and Over	19	0.041	0.017	0.008	0.074		0.010	0.054	0.182		15	79	0.017	1.503
Group C (*p* = 0.6)														
16 to 42 Years	58	0.122	0.026	0.071	0.173	0.000	0.055	0.134	0.301	0.578	54	93	0.061	1.186
43 to 54 Years	15	0.117	0.029	0.060	0.174		0.078	0.146	0.339		15	100	0.072	1.335
55 Years and Over	19	0.193	0.091	0.015	0.371		0.050	0.141	0.503		18	95	0.066	1.429
Group D (*p* = 0.2)														
16 to 42 Years	58	0.079	0.023	0.034	0.124	0.000	0.026	0.072	0.164	0.610	44	76	0.043	1.218
43 to 54 Years	15	0.164	0.079	0.009	0.319		0.049	0.094	0.862		15	100	0.056	1.435
55 Years and Over	19	0.102	0.038	0.028	0.176		0.033	0.088	0.513		17	89	0.041	1.434
Group E (*p* = 0.1)														
16 to 42 Years	58	1.537	0.289	0.971	2.103	0.059	0.740	1.715	3.513	8.259	57	98	0.707	1.199
43 to 54 Years	15	2.241	0.571	1.122	3.360		1.679	4.403	6.115		15	100	1.188	1.419
55 Years and Over	19	1.425	0.811	0.000	3.015		0.678	1.159	1.662		19	100	0.456	1.415
Group F (*p* = 0.5)														
16 to 42 Years	58	0.119	0.021	0.078	0.160	0.000	0.044	0.123	0.387	0.563	53	91	0.065	1.180
43 to 54 Years	15	0.154	0.050	0.056	0.252		0.109	0.217	0.472		14	93	0.098	1.339
55 Years and Over	19	0.115	0.029	0.058	0.172		0.072	0.145	0.302		18	95	0.066	1.350
Group G (*p* = 0.6)														
16 to 42 Years	58	0.052	0.024	0.005	0.099	0.000	0.006	0.035	0.126	0.241	30	52	0.037	1.259
43 to 54 Years	15	0.088	0.043	0.004	0.172		0.000	0.116	0.420		5	33	0.207	1.447
55 Years and Over	19	0.023	0.011	0.001	0.045		0.000	0.018	0.091		7	37	0.028	1.875
All Finfish (*p* = 0.03)														
16 to 42 Years	58	0.874	0.136	0.607	1.141	0.087	0.536	1.062	2.471	2.754	58	100	0.489	1.163
43 to 54 Years	15	1.554	0.304	0.958	2.150		1.422	2.005	3.578		15	100	1.146	1.249
55 Years and Over	19	1.074	0.247	0.590	1.558		0.861	1.525	2.424		19	100	0.619	1.329
All Shellfish (*p* = 0.1)														
16 to 42 Years	58	1.589	0.301	3.626	2.179	0.059	0.799	1.834	3.626	8.305	57	98	0.736	1.197
43 to 54 Years	15	2.330	0.586	1.181	3.479		1.724	4.519	6.447		15	100	1.225	1.426
55 Years and Over	19	1.447	0.815	0.000	3.044		0.688	1.160	1.837		19	100	0.464	1.417

Table 10-106. Adult Consumption Rate (g/kg-day) by Age (continued)

	All Adult Respondents (Including Non-Consumers)										Consumers Only			
						Percentiles								
Species/Age Group	*N*	Mean	SE	95% LCL	95% UCL	5th	50th	75th	90th	95th	*N*	%	GM	MSE
All Seafood (p = 0.09)														
16 to 42 Years	58	2.463	0.387	1.704	3.222	0.247	1.270	3.410	6.206	9.954	58	100	1.384	1.156
43 to 54 Years	15	3.884	0.781	2.353	5.415		3.869	4.942	9.725		15	100	2.665	1.295
55 Years and Over	19	2.522	0.927	0.705	4.339		1.393	2.574	5.220		19	100	1.340	1.293

N = Sample size.
SE = Standard error.
LCL = Lower confidence interval.
UCL = Upper confidence interval.
GM = Geometric mean.
MSE = Multiplicative standard error.
Note: p-value is 2-sided and based upon Kruskul-Wallis test. The 95% CL is based on the normal distribution. The 5th and 95th percentiles are not reported for groups with less than 20 respondents.

Source: Duncan, 2000.

Table 10-107. Consumption Rates for Native American Children (g/kg-day), All Children (including non-consumers): Individual Finfish and Shellfish and Fish Groups

Group	Species	*N*	Mean	SE	95% LCL	95% UCL	p5	Median	p75	p90	p95	Maximum
Group E												
	Manila/Littleneck clams	31	0.095	0.051	0.000	0.195	0.000	0.031	0.063	0.181	0.763	1.597
	Horse clams	31	0.022	0.013	0.000	0.048	0.000	0.000	0.006	0.048	0.269	0.348
	Butter clams	31	0.021	0.014	0.000	0.048	0.000	0.000	0.000	0.041	0.247	0.422
	Geoduck	31	0.112	0.041	0.033	0.191	0.000	0.027	0.116	0.252	0.841	1.075
	Cockles	31	0.117	0.079	0.000	0.271	0.000	0.000	0.054	0.240	1.217	2.433
	Oysters	31	0.019	0.012	0.000	0.043	0.000	0.000	0.056	0.058	0.205	0.362
		31	0.001	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.011	0.026
	Moon snails	31	0.000	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
		31	0.093	0.038	0.019	0.168	0.000	0.004	0.059	0.394	0.712	0.982
	Dungeness crab	31	0.300	0.126	0.053	0.547	0.000	0.047	0.166	1.251	2.689	2.833
Mussels	Red rock crab	31	0.007	0.003	0.001	0.014	0.000	0.000	0.000	0.046	0.064	0.082
	Scallops	31	0.011	0.006	0.000	0.022	0.000	0.000	0.005	0.031	0.089	0.174
Shrimp		31	0.002	0.002	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.411
	Sea urchin	31	0.000	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
	Sea cucumber	31	0.000	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
Squid Group A[a]		31	0.271	0.117	0.043	0.499	0.000	0.063	0.216	0.532	2.064	3.559
Group B[b]		31	0.004	0.002	0.000	0.008	0.000	0.000	0.000	0.015	0.038	0.069
Group C[c]		31	0.131	0.040	0.052	0.210	0.000	0.036	0.205	0.339	0.838	1.014
Group D[d]		31	0.030	0.011	0.008	0.053	0.000	0.010	0.037	0.081	0.191	0.342
Group F[e]		31	0.240	0.075	0.094	0.387	0.000	0.092	0.254	0.684	1.571	1.901
All Finfish		31	0.677	0.168	0.346	1.007	0.026	0.306	0.740	2.110	3.549	4.101
All Shellfish		31	0.801	0.274	0.265	1.337	0.000	0.287	0.799	2.319	4.994	7.948
All Seafood		31	1.477	0.346	0.799	2.155	0.042	0.724	1.983	3.374	7.272	9.063

[a] Group A is salmon, including king, sockeye, coho, chum, pink, and steelhead.
[b] Group B is finfish, including smelt and herring.
[c] Group C is finfish, including cod, perch, pollock, sturgeon, sablefish, spiny dogfish, and greenling.
[d] Group D is finfish, including halibut, sole, flounder, and rockfish.
[e] Group F includes tuna, other finfish, and all others not included in Groups A, B, C, and D.
\- = Not applicable.
N = Sample size.
SE = Standard error
LCL = Lower confidence limit
UCL = Upper confidence limit
p5...p95 = Percentile value.
Note: The minimum consumption for all species and groups was zero, except for "All Finfish" and "All Seafood." The minimum rate for "All Finfish" was 0.023, and for "All Seafood" was 0.035.

Source: Duncan, 2000.

Table 10-108. Consumption Rates for Native American Children (g/kg-day), Consumers Only: Individual Finfish and Shellfish and Fish Groups

Group	Species	*N*	Mean	SE	Median	Percentiles	
						75th	90th
Group E	Manila/Littleneck clams	23	0.128	0.068	0.043	0.066	0.200
	Horse clams	12	0.058	0.032	0.009	0.046	0.308
	Butter clams	6	0.106	0.066	0.032	0.203	-
	Geoduck	22	0.158	0.054	0.053	0.230	0.554
	Cockles	10	0.361	0.233	0.078	0.291	2.230
	Oysters	10	0.060	0.035	0.015	0.074	0.336
	Mussels	1	0.026	-	-	-	-
	Moon snails	0	-	-	-	-	-
	Shrimp	17	0.170	0.064	0.035	0.299	0.621
	Dungeness crab	21	0.443	0.179	0.082	0.305	2.348
	Red rock crab	5	0.046	0.011	0.051	0.067	-
	Scallops	8	0.042	0.019	0.027	0.032	-
	Squid	2	0.033	0.008	0.033	-	-
	Sea urchin	0	-	-	-	-	-
	Sea cucumber	0	-	-	-	-	-
Group A[a]		28	0.300	0.128	0.112	0.246	0.599
Group B[b]		5	0.023	0.012	0.017	0.043	-
Group C[c]		25	0.163	0.048	0.048	0.236	0.493
Group D[d]		17	0.055	0.019	0.033	0.064	0.140
Group F[e] (tuna/other finfish)		24	0.311	0.092	0.177	0.336	1.035
All finfish		31	0.677	0.168	0.306	0.740	2.110
All shellfish		28	0.886	0.299	0.363	0.847	2.466
All seafood		31	1.477	0.346	0.724	1.983	3.374

[a] Group A is salmon, including king, sockeye, coho, chum, pink, and steelhead.
[b] Group B is finfish, including smelt and herring.
[c] Group C is finfish, including cod, perch, pollock, sturgeon, sablefish, spiny dogfish, and greenling.
[d] Group D is finfish, including halibut, sole, flounder, and rockfish.
[e] Group F includes tuna, other finfish, and all others not included in Groups A, B, C, and D.
N = Sample size.
SE = Standard error.
\- = No data.

Source: Duncan, 2000.

Table 10-109. Percentiles and Mean of Consumption Rates for Adult Consumers Only (g/kg-day)											
					Percentiles						
Species	*N*	Mean	SD	95% CI	5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe											
Anadromous fish	117	0.672	1.174	(0.522–1.034)	0.016	0.028	0.093	0.308	0.802	1.563	2.086
Pelagic fish	62	0.099	0.203	(0.064–0.181)	0.004	0.007	0.014	0.035	0.086	0.226	0.349
Bottom fish	94	0.093	0.180	(0.065–0.140)	0.006	0.007	0.016	0.037	0.079	0.223	0.370
Shellfish	86	0.282	0.511	(0.208–0.500)	0.006	0.015	0.051	0.126	0.291	0.659	1.020
Other fish	39	0.046	0.066	(0.031–0.073)	0.002	0.005	0.006	0.019	0.046	0.129	0.161
All finfish	117	0.799	1.263	(0.615–1.136	0.031	0.056	0.139	0.383	1.004	1.826	2.537
All fish	117	1.021	1.407	(0.826–1.368)	0.050	0.097	0.233	0.543	1.151	2.510	3.417
Tulalip Tribe											
Anadromous fish	72	0.451	0.671	(0.321–0.648)	0.010	0.020	0.065	0.194	0.529	1.372	1.990
Pelagic fish	38	0.077	0.100	(0.051–0.118)	0.005	0.011	0.015	0.030	0.088	0.216	0.266
Bottom fish	44	0.062	0.092	(0.043–0.107)	0.006	0.007	0.011	0.030	0.077	0.142	0.207
Shellfish	61	0.559	1.087	(0.382–1.037)	0.037	0.047	0.104	0.196	0.570	1.315	1.824
Other fish	36	0.075	0.119	(0.044–0.130)	0.004	0.004	0.011	0.022	0.054	0.239	0.372
All finfish	72	0.530	0.707	(0.391–0.724)	0.017	0.026	0.119	0.286	0.603	1.642	2.132
All fish	73	1.026	1.563	(0.772–1.635)	0.049	0.074	0.238	0.560	1.134	2.363	2.641

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.

Source: Polissar et al., 2006.

Table 10-110. Percentiles and Mean of Consumption Rates by Sex for Adult Consumers Only (g/kg-day)

Species	Sex	*N*	Mean	SD	95% CI	Percentiles						
						5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe												
Anadromous fish	Male	65	0.596	0.629	(0.465–0.770)	0.026	0.039	0.163	0.388	0.816	1.313	1.957
	Female	52	0.766	1.618	(0.463–1.458)	0.016	0.023	0.068	0.184	0.656	1.736	3.321
Pelagic fish	Male	39	0.104	0.235	(0.055–0.219)	0.003	0.008	0.013	0.037	0.074	0.181	0.299
	Female	23	0.091	0.136	(0.050–0.160)	0.005	0.007	0.017	0.030	0.096	0.322	0.349
Bottom fish	Male	55	0.091	0.185	(0.060–0.185)	0.005	0.007	0.017	0.041	0.077	0.180	0.365
	Female	39	0.096	0.175	(0.058–0.177)	0.006	0.007	0.014	0.034	0.089	0.226	0.330
Shellfish	Male	52	0.305	0.586	(0.215–0.645)	0.006	0.014	0.052	0.136	0.337	0.662	0.782
	Female	34	0.245	0.372	(0.149–0.407)	0.007	0.018	0.047	0.119	0.250	0.563	1.163
Other fish	Male	27	0.047	0.066	(0.029–0.085)	0.003	0.005	0.006	0.020	0.061	0.124	0.139
	Female	12	0.045	0.068	(0.016–0.100)	-	0.004	0.008	0.015	0.037	0.144	-
All finfish	Male	65	0.735	0.784	(0.586–0.980)	0.044	0.079	0.226	0.500	1.045	1.552	2.181
	Female	52	0.878	1.686	(0.546–1.652)	0.026	0.039	0.115	0.272	0.840	1.908	3.687
All fish	Male	65	0.999	0.991	(0.794–1.291)	0.082	0.157	0.335	0.775	1.196	2.036	2.994
	Female	52	1.049	1.808	(0.712–1.793)	0.041	0.061	0.183	0.353	1.083	2.918	4.410
Tulalip Tribe												
Anadromous fish	Male	41	0.546	0.754	(0.373–0.856)	0.011	0.020	0.066	0.408	0.570	1.433	2.085
	Female	31	0.327	0.528	(0.189–0.578)	0.014	0.028	0.066	0.134	0.290	0.625	1.543
Pelagic fish	Male	24	0.066	0.099	(0.037–0.119)	0.013	0.014	0.016	0.030	0.064	0.175	0.223
	Female	14	0.096	0.103	(0.046–0.153)	-	0.005	0.016	0.053	0.156	0.227	-
Bottom fish	Male	24	0.061	0.106	(0.035–0.147)	0.006	0.006	0.009	0.030	0.070	0.097	0.142
	Female	20	0.063	0.073	(0.039–0.103)	0.007	0.008	0.014	0.029	0.093	0.179	0.214

Table 10-110. Percentiles and Mean of Consumption Rates by Sex for Adult Consumers Only (g/kg-day) (continued)

						Percentiles						
Species	Sex	*N*	Mean	SD	95% CI	5th	10th	25th	50th	75th	90th	95th
Shellfish	Male	35	0.599	1.261	(0.343–1.499)	0.036	0.048	0.098	0.183	0.505	1.329	1.826
	Female	26	0.505	0.818	(0.292–1.018)	0.043	0.047	0.117	0.215	0.582	1.074	1.357
Other fish	Male	24	0.064	0.114	(0.029–0.134)	0.004	0.004	0.007	0.026	0.043	0.174	0.334
	Female	12	0.097	0.131	(0.041–0.190)	-	0.011	0.015	0.022	0.142	0.254	-
All finfish	Male	41	0.620	0.795	(0.438–0.966)	0.017	0.020	0.098	0.421	0.706	1.995	2.185
	Female	31	0.411	0.561	(0.265–0.678)	0.025	0.036	0.126	0.236	0.404	0.924	1.769
All fish	Male	42	1.140	1.805	(0.785–2.047)	0.049	0.068	0.208	0.623	1.142	2.496	2.638
	Female	31	0.872	1.168	(0.615–1.453)	0.066	0.144	0.305	0.510	0.963	1.938	2.317

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.
\- = No data.

Source: Polissar et al., 2006.

Table 10-111. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only—Squaxin Island Tribe (g/kg-day)												
						Percentiles						
Species	Age Group (years)	*N*	Mean	SD	95% CI	5th	10th	25th	50th	75th	90th	95th
Anadromous fish	18 to 34	54	0.664	1.392	(0.430–1.438)	0.019	0.026	0.078	0.233	0.863	1.236	1.969
	35 to 49	41	0.563	0.820	(0.376–0.914)	0.023	0.031	0.073	0.292	0.590	1.354	2.062
	50 to 64	11	1.126	1.511	(0.595–2.791)	-	0.212	0.278	0.771	0.948	2.160	-
	≥65	11	0.662	0.681	(0.321–1.097)	-	0.015	0.107	0.522	0.924	1.636	-
Pelagic fish	18 to 34	22	0.067	0.086	(0.040–0.114)	0.006	0.007	0.014	0.035	0.081	0.186	0.228
	35 to 49	30	0.128	0.269	(0.063–0.272)	0.003	0.005	0.014	0.029	0.101	0.248	0.626
	50 to 64	4	0.154	0.239	(0.027–0.396)	-	-	0.033	0.045	0.166	-	-
	≥65	6	0.036	0.023	(0.020–0.053)	-	-	0.017	0.038	0.047	-	-
Bottom fish	18 to 34	41	0.063	0.102	(0.043–0.120)	0.004	0.006	0.012	0.034	0.069	0.115	0.221
	35 to 49	35	0.126	0.225	(0.076–0.276)	0.010	0.013	0.023	0.051	0.111	0.273	0.446
	50 to 64	9	0.159	0.302	(0.029–0.460)	-	0.009	0.014	0.029	0.067	0.451	-
	≥65	9	0.035	0.031	(0.020–0.065)	-	0.006	0.018	0.034	0.043	0.060	-
Shellfish	18 to 34	44	0.335	0.657	(0.211–0.729)	0.014	0.019	0.041	0.127	0.327	0.698	1.046
	35 to 49	27	0.264	0.321	(0.171–0.422)	0.016	0.054	0.082	0.146	0.277	0.582	0.984
	50 to 64	5	0.321	0.275	(0.137–0.589)	-	-	0.100	0.335	0.364	-	-
	≥65	10	0.076	0.079	(0.033–0.124)	-	0.005	0.007	0.042	0.155	0.180	-
Other fish	18 to 34	20	0.079	0.079	(0.053–0.122)	0.004	0.005	0.025	0.046	0.124	0.161	0.218
	35 to 49	10	0.014	0.008	(0.009–0.019)	-	0.005	0.007	0.015	0.020	0.022	-
	50 to 64	2	0.007	0.003	(0.005–0.009)	-	-	-	0.007	-	-	-
	≥65	7	0.010	0.007	(0.006–0.015)	-	-	0.006	0.008	0.014	-	-

Table 10-111. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only—Squaxin Island Tribe (g/kg-day) (continued)

Species	Age Group (years)	*N*	Mean	SD	95% CI	Percentiles						
						5th	10th	25th	50th	75th	90th	95th
All finfish	18 to 34	54	0.739	1.417	(0.508–1.372)	0.025	0.039	0.105	0.289	0.887	1.466	2.296
	35 to 49	41	0.764	1.001	(0.527–1.173)	0.046	0.082	0.226	0.383	0.816	1.859	2.423
	50 to 64	11	1.312	1.744	(0.690–3.219)	-	0.212	0.297	0.909	1.119	2.188	-
	≥65	11	0.711	0.699	(0.386–1.259)	-	0.027	0.119	0.601	0.986	1.637	-
All fish	18 to 34	54	1.041	1.570	(0.729–1.741)	0.052	0.107	0.217	0.500	1.117	2.669	3.557
	35 to 49	41	0.941	1.217	(0.652–1.453)	0.051	0.136	0.248	0.483	0.975	2.227	3.009
	50 to 64	11	1.459	1.773	(0.770–3.258)	-	0.317	0.327	1.106	1.301	2.936	-
	≥65	11	0.786	0.727	(0.446–1.242)	-	0.058	0.122	0.775	1.091	1.687	-

N = Sample size.
SD = Standard deviation.
CI = Confidence interval.
\- = No data.

Source: Polissar et al., 2006.

Table 10-112. Percentiles and Mean of Consumption Rates by Age for Adult Consumers Only—Tulalip Tribe (g/kg-day)

Species	Age Group (years)	*N*	Mean	SD	95% CI	Percentiles						
						5th	10th	25th	50th	75th	90th	95th
Anadromous fish	18 to 34	27	0.298	0.456	(0.169–0.524)	0.011	0.016	0.061	0.120	0.315	0.713	1.281
	35 to 49	23	0.725	0.928	(0.436–1.202)	0.010	0.032	0.078	0.431	0.719	2.001	2.171
	50 to 64	16	0.393	0.550	(0.225–0.854)	-	0.059	0.164	0.228	0.420	0.599	-
	≥65	6	0.251	0.283	(0.065–0.475)	-	-	0.022	0.164	0.425	-	-
Pelagic fish	18 to 34	12	0.092	0.099	(0.051–0.173)	-	0.016	0.021	0.054	0.124	0.218	-
	35 to 49	15	0.077	0.118	(0.039–0.206)	-	0.013	0.015	0.021	0.087	0.189	-
	50 to 64	8	0.077	0.085	(0.037–0.160)	-	-	0.027	0.034	0.090	-	-
	≥65	3	0.008	0.009	(0.002–0.014)	-	-	0.003	0.004	0.011	-	-
Bottom fish	18 to 34	14	0.075	0.138	(0.033–0.205)	-	0.007	0.010	0.020	0.078	0.142	-
	35 to 49	16	0.066	0.069	(0.041–0.112)	-	0.007	0.023	0.053	0.077	0.152	-
	50 to 64	11	0.051	0.056	(0.026–0.098)	-	0.007	0.011	0.036	0.069	0.119	-
	≥65	3	0.015	0.005	(0.008–0.018)	-	-	0.013	0.017	0.018	-	-
Shellfish	18 to 34	23	0.440	0.487	(0.289–0.702)	0.049	0.053	0.131	0.196	0.582	1.076	1.410
	35 to 49	19	1.065	1.784	(0.536–2.461)	0.049	0.074	0.123	0.250	1.222	2.265	4.351
	50 to 64	14	0.245	0.216	(0.158–0.406)	-	0.048	0.117	0.224	0.282	0.417	-
	≥65	5	0.062	0.064	(0.027–0.135)	-	-	0.023	0.046	0.060	-	-
Other fish	18 to 34	15	0.097	0.146	(0.043–0.197)	-	0.010	0.017	0.033	0.102	0.319	-
	35 to 49	13	0.057	0.085	(0.022–0.123)	-	0.004	0.006	0.014	0.049	0.187	-
	50 to 64	6	0.075	0.138	(0.015–0.215)	-	-	0.012	0.018	0.038	-	-
	≥65	2	0.024	0.015	(0.014–0.024)	-	-	-	0.024	-	-	-
All finfish	18 to 34	27	0.378	0.548	(0.222–0.680)	0.018	0.022	0.080	0.156	0.438	0.840	1.677
	35 to 49	23	0.821	0.951	(0.532–1.315)	0.020	0.047	0.116	0.602	0.898	2.035	2.268
	50 to 64	16	0.467	0.535	(0.311–0.925)	-	0.186	0.227	0.301	0.503	0.615	-
	≥65	6	0.263	0.293	(0.091–0.518)	-	-	0.030	0.176	0.430	-	-
All fish	18 to 34	27	0.806	0.747	(0.575–1.182)	0.071	0.136	0.231	0.617	1.126	1.960	2.457
	35 to 49	24	1.661	2.466	(0.974–3.179)	0.017	0.069	0.177	0.968	2.005	3.147	5.707
	50 to 64	16	0.710	0.591	(0.513–1.144)	-	0.278	0.370	0.495	0.944	1.070	-
	≥65	6	0.322	0.344	(0.107–0.642)	-	-	0.062	0.195	0.475	-	-

- = No data.

Source: Polissar et al., 2006.

Table 10-113. Percentiles and Mean of Consumption Rates for Child Consumers Only (g/kg-day)

Species	*N*	Mean	SD	Percentiles						
				5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe										
Anadromous fish	33	0.392	1.295	0.005	0.006	0.030	0.049	0.130	0.686	0.786
Pelagic fish	21	0.157	0.245	0.010	0.014	0.019	0.044	0.107	0.547	0.712
Bottom fish	18	0.167	0.362	-	0.006	0.014	0.026	0.050	0.482	-
Shellfish	31	2.311	8.605	0.006	0.025	0.050	0.262	0.404	0.769	4.479
Other fish	30	0.577	0.584	0.012	0.051	0.111	0.400	0.566	1.620	1.628
All finfish	35	0.538	1.340	0.005	0.007	0.046	0.062	0.216	1.698	2.334
All fish	36	2.890	8.433	0.012	0.019	0.244	0.704	1.495	2.831	7.668
Tulalip Tribe										
Anadromous fish	14	0.148	0.229	-	0.012	0.026	0.045	0.136	0.334	-
Pelagic fish	7	0.152	0.178	-	-	0.027	0.053	0.165	-	-
Bottom fish	2	0.044	0.005	-	-	-	0.041	-	-	-
Shellfish	11	0.311	0.392	-	0.012	0.034	0.036	0.518	0.803	-
Other fish	1	0.115	0.115	-	-	-	-	-	-	-
All finfish	15	0.310	0.332	-	0.027	0.082	0.133	0.431	0.734	-
All fish	15	0.449	0.529	-	0.066	0.088	0.215	0.601	0.884	-

N = Sample size.
SD = Standard deviation.
\- = No data.

Source: Polissar et al., 2006.

Table 10-114. Percentiles and Mean of Consumption Rates by Sex for Child Consumers Only (g/kg-day)

					Percentiles						
Species	Sex	*N*	Mean	SD	5th	10th	25th	50th	75th	90th	95th
Squaxin Island Tribe											
Anadromous fish	Male	15	0.702	1.937	-	0.009	0.026	0.062	0.331	1.082	-
	Female	18	0.155	0.253	-	0.005	0.025	0.046	0.090	0.600	-
Pelagic fish	Male	8	0.102	0.138	-	-	0.015	0.058	0.099	-	-
	Female	13	0.179	0.280	-	0.015	0.020	0.040	0.109	0.681	-
Bottom fish	Male	6	0.038	0.057	-	-	0.016	0.020	0.026	-	-
	Female	12	0.244	0.442	-	0.005	0.010	0.028	0.105	0.736	-
Shellfish	Male	13	0.275	0.244	-	0.036	0.047	0.241	0.353	0.462	-
	Female	18	3.799	11.212	-	0.008	0.050	0.229	0.490	1.333	-
Other fish	Male	13	0.836	0.663	-	0.106	0.232	0.448	1.530	1.625	-
	Female	17	0.400	0.463	-	0.013	0.096	0.311	0.486	0.610	-
All finfish	Male	15	0.787	1.940	-	0.009	0.038	0.062	0.521	1.500	-
	Female	20	0.372	0.719	0.005	0.005	0.037	0.071	0.179	1.408	2.119
All fish	Male	15	1.700	1.965	-	0.061	0.476	1.184	1.937	2.444	-
	Female	21	3.655	10.738	0.008	0.014	0.160	0.599	0.916	2.764	16.374
Tulalip Tribe											
Anadromous fish	Male	7	0.061	0.052	-	-	0.023	0.034	0.067	-	-
	Female	7	0.237	0.306	-	-	0.032	0.080	0.198	-	-
Pelagic fish	Male	5	0.106	0.081	-	-	0.044	0.053	0.128	-	-
	Female	2	0.265	0.350	-	-	-	0.017	-	-	-
Bottom fish	Male	0	-	-	-	-	-	-	-	-	-
	Female	2	0.044	0.005	-	-	-	0.041	-	-	-
Shellfish	Male	5	0.141	0.221	-	-	0.012	0.027	0.110	-	-
	Female	6	0.431	0.459	-	-	0.034	0.219	0.651	-	-
Other fish	Male	0	-	-	-	-	-	-	-	-	-
	Female	1	0.115	0.115	-	-	-	-	-	-	-
All finfish	Male	8	0.208	0.176	-	-	0.087	0.133	0.322	-	-
	Female	7	0.433	0.440	-	-	0.045	0.165	0.652	-	-
All fish	Male	8	0.202	0.169	-	-	0.071	0.122	0.233	-	-
	Female	7	0.745	0.670	-	-	0.155	0.488	0.835	-	-

N = Sample size.
SD = Standard deviation.
\- = No data.

Source: Polissar et al., 2006.

Table 10-115. Consumption Rates of API Community Members

Category	*N*	Median (g/kg-day)	Mean (g/kg-day)	Percentage of Consumption[a]	SE	95% LCI (g/kg-day)	95% UCI (g/kg-day)	90th Percentile (g/kg-day)
Anadromous Fish	202	0.093	0.201	10.6%	0.008	0.187	0.216	0.509
Pelagic Fish	202	0.215	0.382	20.2%	0.013	0.357	0.407	0.829
Freshwater Fish	202	00.43	0.110	5.8%	0.005	0.101	0.119	0.271
Bottom Fish	202	0.047	0.125	6.6%	0.006	0.113	0.137	0.272
Shellfish Fish	202	0.498	0.867	45.9%	0.023	0.821	0.913	1.727
Seaweed/Kelp	202	0.014	0.084	4.4%	0.005	0.075	0.093	0.294
Miscellaneous Seafood	202	0.056	0.121	6.4%	0.004	0.112	0.130	0.296
All Finfish	202	0.515	0.818	43.3%	0.023	0.774	0.863	1.638
All Fish	202	1.363	1.807	95.6%	0.042	1.724	1.889	3.909
All Seafood	202	1.439	1.891	100.0%	0.043	1.805	1.976	3.928

[a] Percentage of consumption = the percent of each category that makes up the total (i.e., 10.6% of total fish eaten was anadromous fish).
N = Sample size.
SE = Standard error.
LCI = 95% lower confidence interval.
UCI = 95% upper confidence interval.
Note: Confidence intervals were computed based on the Student's t-distribution. Rates were weighted across ethnic groups.

Source: U.S. EPA, 1999.

Table 10-116. Demographic Characteristics of "Higher" and "Lower" Seafood Consumers

		All Finfish		Shellfish	
	N	Lower Consumers (%)	Higher Consumers[a] (%)	Lower Consumers (%)	Higher Consumers[b] (%)
Female	107	76	24	71	29
Male	95	81	19	79	21
18 to 29 years	78	85	15	73	27
30 to 54 years	85	79	21	78	22
55+	39	64	36	72	28
Cambodian	20	90	10	70	30
Chinese	30	83	17	70	30
Filipino	30	80	20	87	13
Japanese	29	48	52	79	21
Korean	22	91	9	68	32
Laotian	20	75	25	75	25
Mien	10	90	10	90	10
Hmong	5	100	0	100	0
Samoan	10	100	0	100	0
Vietnamese	26	69	31	50	50
Non-fishermen	136	82	18	76	24
Fishermen	66	71	29	73	27

[a] Higher Consumer: >75 percentile = 1.144 g/kg-day.
[b] Higher Consumer: >75 percentile = 1.072g/kg-day.
N = Sample size.

Source: U.S. EPA, 1999.

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a]

Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% with Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
Anadromous fish	Cambodian	20	0.118	0.050	0.000	0.030	0.453	18	90	0.014	0.223
($p < 0.001$)	Chinese	30	0.193	0.052	0.012	0.066	0.587	30	100	0.086	0.300
		30	0.152	0.027	0.025	0.100	0.384	29	96.7	0.098	0.206
	Japanese	29	0.374	0.056	0.086	0.251	0.921	29	100	0.261	0.488
	Korean	22	0.091	0.026	0.007	0.048	0.248	22	100	0.037	0.146
	Laotian	20	0.187	0.064	0.002	0.069	0.603	18	90	0.054	0.321
	Mien	10	0.018	0.008	0.000	0.011	0.080	7	70	0.000	0.036
	Hmong	5	0.059	0.013	n/a	0.071	n/a	5	100	0.026	0.091
	Samoan	10	0.067	0.017	0.012	0.054	0.185	10	100	0.030	0.104
Filipino	Vietnamese	26	0.124	0.026	0.017	0.072	0.349	26	100	0.071	0.176
	All Ethnicity (1)	202	0.201	0.008	0.016	0.093	0.509	194	96	0.187	0.216
Pelagic Fish	Cambodian	20	0.088	0.021	0.000	0.061	0.293	17	85	0.044	0.131
($p < 0.001$)	Chinese	30	0.325	0.068	0.022	0.171	0.824	30	100	0.187	0.463
		30	0.317	0.081	0.051	0.132	0.729	30	100	0.151	0.482
	Japanese	29	0.576	0.079	0.132	0.429	1.072	29	100	0.415	0.737
	Korean	22	0.313	0.056	0.073	0.186	0.843	22	100	0.196	0.429
	Laotian	20	0.412	0.138	0.005	0.115	1.061	20	100	0.124	0.700
		10	0.107	0.076	0.000	0.09	0.716	7	70	–0.064	0.277
	Hmong	5	0.093	0.028	n/a	0.090	n/a	5	100	0.021	0.164
	Samoan	10	0.499	0.060	0.128	0.535	0.792	10	100	0.365	0.633
Filipino	Vietnamese	26	0.377	0.086	0.059	0.208	0.956	26	100	0.201	0.553
	All Ethnicity (1)	202	0.382	0.013	0.046	0.215	0.829	196	97	0.357	0.407
Freshwater Fish	Cambodian	20	0.139	0.045	0.000	0.045	0.565	18	90	0.045	0.232
($p < 0.001$) Mien	Chinese	30	0.084	0.023	0.000	0.015	0.327	24	80	0.037	0.131
		30	0.132	0.034	0.018	0.086	0.273	30	100	0.062	0.202
	Japanese	29	0.021	0.006	0.000	0.007	0.071	20	69	0.010	0.032
	Korean	22	0.032	0.015	0.000	0.008	0.160	13	59.1	0.002	0.062
	Laotian	20	0.282	0.077	0.002	0.099	1.006	18	90	0.122	0.442
	Mien	10	0.097	0.039	0.007	0.070	0.407	10	100	0.010	0.184
	Hmong	5	0.133	0.051	n/a	0.081	n/a	5	100	0.002	0.263
	Samoan	10	0.026	0.007	0.000	0.025	0.061	9	90	0.011	0.041
Filipino	Vietnamese	26	0.341	0.064	0.068	0.191	1.036	26	100	0.209	0.472
	All Ethnicity (1)	202	0.110	0.005	0.000	0.043	0.271	173	85.6	0.101	0.119

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a] (continued)

Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% with Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
Bottom Fish	Cambodian	20	0.045	0.025	0.000	0.003	0.114	10	50	–0.006	0.097
($p < 0.001$)	Chinese	30	0.082	0.026	0.004	0.033	0.212	28	93.3	0.028	0.135
		30	0.165	0.043	0.001	0.103	0.560	27	90	0.078	0.253
	Japanese	29	0.173	0.044	0.023	0.098	0.554	28	96.6	0.083	0.263
	Korean	22	0.119	0.026	0.000	0.062	0.270	19	86.4	0.064	0.173
		20	0.066	0.031	0.000	0.006	0.173	13	65	0.000	0.131
		10	0.006	0.003	0.000	0.00	0.026	4	40	–0.001	0.013
	Hmong	5	0.036	0.021	n/a	0.024	n/a	3	60	–0.017	0.088
Filipino	Samoan	10	0.029	0.005	0.008	0.026	0.058	10	100	0.018	0.040
	Vietnamese	26	0.102	0.044	0.000	0.030	0.388	21	80.8	0.013	0.192
	All Ethnicity (1)	202	0.125	0.006	0.000	0.047	0.272	163	80.7	0.113	0.137
Laotian											
Shellfish Fish Mien	Cambodian	20	0.919	0.216	0.085	0.695	2.003	20	100	0.467	1.370
($p < 0.001$)	Chinese	30	0.985	0.168	0.176	0.569	2.804	30	100	0.643	1.327
		30	0.613	0.067	0.188	0.505	1.206	30	100	0.477	0.750
	Japanese	29	0.602	0.089	0.116	0.401	1.428	29	100	0.419	0.784
	Korean	22	1.045	0.251	0.251	0.466	2.808	22	100	0.524	1.566
		20	0.898	0.259	0.041	0.424	2.990	19	95	0.357	1.439
	Mien	10	0.338	0.113	0.015	0.201	1.058	10	100	0.086	0.590
	Hmong	5	0.248	0.014	n/a	0.252	n/a	5	100	0.212	0.283
Filipino	Samoan	10	0.154	0.024	0.086	0.138	0.336	10	100	0.100	0.208
	Vietnamese	26	1.577	0.260	0.247	1.196	4.029	26	100	1.044	2.110
	All Ethnicity (1)	202	0.867	0.023	0.168	0.498	1.727	201	99.5	0.821	0.913
Laotian											
Seaweed/Kelp	Cambodian	20	0.002	0.001	0.000	0.000	0.008	7	35	0.000	0.004
($p < 0.001$)	Chinese	30	0.062	0.022	0.001	0.017	0.314	29	96.7	0.016	0.107
		30	0.009	0.004	0.000	0.000	0.025	15	50	0.002	0.016
	Japanese	29	0.190	0.043	0.019	0.082	0.752	29	100	0.101	0.279
	Korean	22	0.200	0.050	0.011	0.087	0.686	21	95.5	0.096	0.304
	Laotian	20	0.004	0.003	0.000	0.000	0.013	6	30	–0.001	0.009
		10	0.000	0.000	0.000	0.000	0.000	0	0	0.000	0.000
	Hmong	5	0.002	0.001	n/a	0.001	n/a	3	60	0.000	0.004
Filipino	Samoan	10	0.000	0.000	0.000	0.000	0.000	0	0	0.000	0.000
	Vietnamese	26	0.017	0.012	0.000	0.000	0.050	6	23.1	–0.008	0.043
	All Ethnicity (1)	202	0.084	0.005	0.000	0.014	0.294	116	57.4	0.075	0.093

Mien

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a] (continued)

Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% with Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
Miscellaneous Fish	Cambodian	20	0.113	0.026	0.000	0.087	0.345	18	90	0.058	0.168
($p < 0.001$)	Chinese	30	0.081	0.021	0.003	0.030	0.201	30	100	0.038	0.123
		30	0.083	0.025	0.016	0.043	0.182	30	100	0.032	0.134
	Japanese	29	0.246	0.036	0.032	0.206	0.620	29	100	0.173	0.139
	Korean	22	0.092	0.031	0.004	0.047	0.307	21	95.5	0.028	0.156
		20	0.074	0.021	0.000	0.025	0.225	15	75	0.029	0.118
	Mien	10	0.015	0.008	0.000	0.002	0.063	7	70	0.003	0.033
	Hmong	5	0.019	0.014	n/a	0.008	n/a	4	80	0.018	0.055
Filipino	Samoan	10	0.076	0.028	0.003	0.045	0.276	10	100	0.014	0.138
	Vietnamese	26	0.089	0.013	0.013	0.087	0.184	25	96.2	0.062	0.115
	All Ethnicity (1)	202	0.121	0.004	0.005	0.056	0.296	189	93.6	0.112	0.130
Laotian All Finfish	Cambodian	20	0.390	0.098	0.061	0.223	1.379	20	100	0.185	0.594
($p < 0.001$)	Chinese	30	0.683	0.133	0.114	0.338	2.024	30	100	0.412	0.954
		30	0.766	0.148	0.268	0.452	1.348	30	100	0.464	1.067
	Japanese	29	1.144	0.124	0.194	1.151	2.170	29	100	0.890	1.398
	Korean	22	0.555	0.079	0.180	0.392	1.204	22	100	0.391	0.719
		20	0.947	0.204	0.117	0.722	2.646	20	100	0.523	1.372
		10	0.228	0.117	0.034	0.097	1.160	10	100	–0.032	0.488
	Hmong	5	0.319	0.073	n/a	0.268	n/a	5	100	0.131	0.507
Filipino	Samoan	10	0.621	0.059	0.225	0.682	0.842	10	100	0.490	0.751
	Vietnamese	26	0.944	0.171	0.188	0.543	2.568	26	100	0.593	1.296
	All Ethnicity (1)	202	0.818	0.023	0.166	0.515	1.638	202	100	0.774	0.863

Laotian
Mien

Table 10-117. Seafood Consumption Rates by Ethnicity for Asian and Pacific Islander Community (g/kg-day)[a] (continued)

Category	Ethnicity	*N*	Mean	SE	10 Percentile	Median	90 Percentile	% with Non-Zero Consumption	Consumers (%)	95% LCI	95% UCI
All Fish	Cambodian	20	1.421	0.274	0.245	1.043	3.757	20	100	0.850	1
($p < 0.001$)	Chinese	30	1.749	0.283	0.441	1.337	4.206	30	100	1.172	2.326
		30	1.462	0.206	0.660	1.137	2.423	30	100	1.041	1.883
	Japanese	29	1.992	0.214	0.524	1.723	3.704	29	100	1.555	2.429
	Korean	22	1.692	0.275	0.561	1.122	3.672	22	100	1.122	2.262
		20	1.919	0.356	0.358	1.467	4.147	20	100	1.176	2.663
	Mien	10	0.580	0.194	0.114	0.288	1.967	10	100	0.149	1.012
	Hmong	5	0.585	0.069	n/a	0.521	n/a	5	100	0.407	0.764
Filipino	Samoan	10	0.850	0.078	0.363	0.879	1.188	10	100	0.676	1.025
	Vietnamese	26	2.610	0.377	0.653	2.230	6.542	26	100	1.835	3.385
	All Ethnicity (1)	202	1.807	0.042	0.480	1.363	3.909	202	100	1.724	1.889
All Seafood Laotian	Cambodian	20	1.423	0.274	0.245	1.043	3.759	20	100	0.851	1.995
($p < 0.001$)	Chinese	30	1.811	0.294	0.452	1.354	4.249	30	100	1.210	2.411
		30	1.471	0.206	0.660	1.135	2.425	30	100	1.050	1.892
	Japanese	29	2.182	0.229	0.552	1.830	3.843	29	100	1.714	2.650
	Korean	22	1.892	0.294	0.608	1.380	4.038	22	100	1.281	2.503
		20	1.923	0.356	0.400	1.467	4.147	20	100	1.181	2.665
	Mien	10	0.580	0.194	0.114	0.288	1.967	10	100	0.149	1.012
	Hmong	5	0.587	0.069	n/a	0.521	n/a	5	100	0.410	0.765
Filipino	Samoan	10	0.850	0.078	0.363	0.879	1.188	10	100	0.676	1.025
	Vietnamese	26	2.627	0.378	0.670	2.384	6.613	26	100	1.851	3.404
	All Ethnicity (1)	202	1.891	0.043	0.521	1.439	3.928	202	100	1.805	1.976

a Laotian All consumption rates in g/kg body weight/day. Weighted by population percentage.
N = Sample size.
SE = Standard error.
LCI = Lower confidence interval.
UCI = Upper confidence interval.
Note: *p*-values are based on Kruskal-Wallis test.

Source: U.S. EPA, 1999.

Table 10-118. Consumption Rates by Sex for All Asian and Pacific Islander Community

	Female				Male			
Category	*N*	Mean (g/kg-day)	SE	Median (g/kg-day)	*N*	Mean (g/kg-day)	SE	Median (g/kg-day)
Anadromous Fish (*p* = 0.8)	107	0.165	0.022	0.076	95	0.169	0.024	0.080
Pelagic Fish (*p* = 0.4)	107	0.349	0.037	0.215	95	0.334	0.045	0.148
Freshwater Fish (*p* = 1.0)	107	0.131	0.021	0.054	95	0.137	0.023	0.054
Bottom Fish (*p* = 0. 6)	107	0.115	0.019	0.040	95	0.087	0.017	0.034
Shellfish (*p* = 0.8)	107	0.864	0.086	0.432	95	0.836	0.104	0.490
Seaweed/Kelp (*p* = 0.5)	107	0.079	0.018	0.005	95	0.044	0.010	0.002
Miscellaneous Seafood (*p* = 0.5)	107	0.105	0.013	0.061	95	0.104	0.015	0.055
All Finfish (*p* = 0.8)	107	0.759	0.071	0.512	95	0.726	0.072	0.458
All Fish (*p* = 0.5)	107	1.728	0.135	1.328	95	1.666	0.149	1.202
All Seafood (*p* = 0.4)	107	1.807	0.139	1.417	95	1.710	0.152	1.257

N = Sample size.
SE = Standard error.
Note: *p*-values are based on Mann-Whitney test.

Source: U.S. EPA, 1999.

Table 10-119. Types of Seafood Consumed/Respondents Who Consumed (%)

Type of Seafood	(%)
Anadromous Fish	
Salmon	93
Trout	61
Smelt	45
Salmon Eggs	27
Pelagic Fish	
Tuna	86
Cod	66
Mackerel	62
Snapper	50
Rockfish	34
Herring	21
Dogfish	7
Snowfish	6
Freshwater Fish	
Catfish	58
Tilapia	45
Perch	39
Bass	28
Carp	22
Crappie	17
Bottom Fish	
Halibut	65
Sole/Flounder	42
Sturgeon	13
Suckers	4
Shellfish	
Shrimp	98
Crab	96
Squid	82
Oysters	71
Manila/Littleneck Clams	72
Lobster	65
Mussel	62
Scallops	57

Table 10-119. Types of Seafood Consumed/Respondents Who Consumed (%) (continued)

Type of Seafood	(%)
Butter Clams	39
Geoduck	34
Cockles	21
Abalone	15
Razor Clams	16
Sea Cucumber	15
Sea Urchin	14
Horse Clams	13
Macoma Clams	9
Moonsnail	4
Seaweed/Kelp	
Seaweed	57
Kelp	29

Source: U.S. EPA, 1999.

Table 10-120. Mean, Median and 95th Percentile Fish Intake Rates for Different Groups (g/day)

Sample Group	Sample Size	Local Fish Intake[a]			Total Fish Intake[b]		
		Mean	Median	95th	Mean	Median	95th
Ethnicity							
African American	32	31.2	21.3	242.3	48.3	21.3	252.0
Southeast Asian	152	32.3	17.0	129.4	42.8	24.1	180.2
Hmong	67	17.8	14.9	89.6	22.3	19.1	89.6
Lao	30	57.6	21.3	310.4	65.2	24.1	317.5
Vietnamese	33	27.1	21.7	152.4	55.4	36.1	249.3
Asian/Pacific Islander	38	23.8	15.6	148.3	46.1	35.0	156.4
Hispanic	45	25.8	19.1	155.9	36.3	14.2	169.5
Native American	6	6.5	ND[c]	ND	69.9	108.4	ND
White	57	23.6	21.3	138.9	34.7	28.4	139.2
Russian	17	23.7	17.7	ND	36.1	35.5	ND
All Anglers	373	27.4	19.7	126.6	40.6	26.1	147.3
Southeast Asian[d]	286	40.8	17.0	128.5	50.3	25.5	144.5
Hmong[d]	130	21.3	14.9	102.1	26.5	17.0	119.7
Lao[d]	54	47.2	17.0	265.8	54.4	28.4	267.0
Age							
18 to 34	143	32.0	24.6	138.9	44.9	25.5	151.5
35 to 49	130	22.7	14.2	120.5	36.8	24.0	143.9
>49	87	30.6	17.0	207.0	44.3	24.1	217.2
Sex							
Female	35	38.2	22.5	226.8	53.9	24.6	263.1
Male	336	26.4	19.5	129.3	39.3	26.1	146.6
Household Contains							
Women 18 to 49 years	217	33.0	21.2	142.2	46.6	25.5	158.1
Children	174	35.1	22.2	142.8	49.2	27.1	171.9
Awareness[e]							
0	172	24.7	18.2	121.6	35.5	23.0	143.5
1	44	42.8	28.0	361.1	52.9	28.5	361.1
2	115	28.4	21.3	139.6	45.8	28.0	151.7
3	35	12.2	13.8	62.4	28.1	20.8	95.6
4	7	57.1	36.1	ND	65.0	39.0	ND

a Locally caught fish.
b Locally caught and commercially obtained fish.
c Not determined because of insufficient data.
d All data shown are for angler surveying, except for these groups which are rates from combined angler and community surveys.
e Respondent responses when asked about their awareness of warnings about fish contamination ranged from 0 = no awareness to 4 = high awareness.

Source: Shilling et al., 2010.

Table 10-121. Distribution of Quantity of Fish Consumed (in grams) per Eating Occasion, by Age and Sex

			Percentiles						
Age (years)-Sex Group	Mean	SD	5th	25th	50th	75th	90th	95th	99th
1 to 2 Male-Female	52	38	8	28	43	58	112	125	168
3 to 5 Male-Female	70	51	12	36	57	85	113	170	240
6 to 8 Male-Female	81	58	19	40	72	112	160	170	288
9 to 14 Male	101	78	28	56	84	113	170	255	425
9 to 14 Female	86	62	19	45	79	112	168	206	288
15 to 18 Male	117	115	20	57	85	142	200	252	454
15 to 18 Female	111	102	24	56	85	130	225	270	568
19 to 34 Male	149	125	28	64	113	196	284	362	643
19 to 34 Female	104	74	20	57	85	135	184	227	394
35 to 64 Male	147	116	28	80	113	180	258	360	577
35 to 64 Female	119	98	20	57	85	152	227	280	480
65 to 74 Male	145	109	35	75	113	180	270	392	480
65 to 74 Female	123	87	24	61	103	168	227	304	448
≥75 Male	124	68	36	80	106	170	227	227	336
≥75 Female	112	69	20	61	112	151	196	225	360
Overall	117	98	20	57	85	152	227	284	456

Source: Pao et al., 1982.

Table 10-122. Distribution of Quantity of Canned Tuna Consumed (grams) per Eating Occasion, by Age and Sex

Age (years)-Sex Group	Mean	SE	Percentiles						
			5th	10th	25th	50th	75th	90th	95th
2 to 5									
Male-Female	37	3	5*	8	14	29	56	73	85*
6 to 11									
Male-Female	58	8	14*	20*	28	49	60	99*	157*
12 to 19									
Male	98*	16*	-	18*	49*	84	162*	170*	186*
Female	64	6	14*	18*	28*	56	77*	105*	156*
20 to 39									
Male	84	7	15*	27*	49	57	113	160*	168*
Female	61	5	14*	14*	34	56	74	110*	142*
40 to 59									
Male	72	4	14*	27	37	57	96	127	168*
Female	60	4	13*	15	28	56	74	112	144
60 and older									
Male	64	5	12*	17*	37	56	81	114*	150*
Female	67	4	12*	23	42	57	85	112	153*

SE = Standard error.
* Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
- Indicates a percentage that could not be estimated.

Source: Smiciklas-Wright et al., 2002 (based on 1994–1996 CSFII data).

Table 10-123. Distribution of Quantity of Other Finfish Consumed (grams) per Eating Occasion, by Age and Sex

Age (years)-Sex Group	Mean	SE	Percentiles						
			5th	10th	25th	50th	75th	90th	95th
2 to 5									
Male-Female	64	4	8*	16	33	58	77	124	128*
6 to 11									
Male-Female	93	8	17*	31*	50	77	119	171*	232*
12 to 19									
Male	119*	11*	40*	50*	64*	89	170*	185*	249*
Female	89*	13*	20*	26*	47*	67	124*	164*	199*
20 to 39									
Male	117	8	37*	47	68	100	138	205	256*
Female	111	10	26*	36*	50	85	129	209*	289*
40 to 59									
Male	130	7	29*	47	75	110	153	243	287*
Female	107	9	29*	42	51	85	123	174	244*
60 and older									
Male	111	6	37*	45	57	90	133	220	261*
Female	108	6	33*	42	57	90	130	200	229*

SE = Standard error.
* Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

Source: Smiciklas-Wright et al., 2002 (based on 1994–1996 CSFII data).

Table 10-124. Percentage of Individuals Using Various Cooking Methods at Specified Frequencies

Study	Use Frequency	Bake	Pan Fry	Deep Fry	Broil or Grill	Poach	Boil	Smoke	Raw	Other
Connelly et al., 1992	Always	24[a]	51	13		24[a]				
	Ever	75[a]	88	59		75[a]				
Connelly et al., 1996	Always	13	4	4						
	Ever	84	72	42						
CRITFC, 1994	At Least Monthly	79	51	14	27	11	46	31	1	34[b] 29[c] 49[d]
	Ever	98	80	25	39	17	73	66	3	67[b] 71[c] 75[d]
Fitzgerald et al., 1995	Not Specified		94[e,f]	71[e,g]						
Puffer et al., 1981	As Primary Method	16.3	52.5	12					0.25	19[h]

[a] 24 and 75 listed as bake, BBQ, or poach.
[b] Dried.
[c] Roasted.
[d] Canned.
[e] Not specified whether deep or pan fried.
[f] Mohawk women.
[g] Control population.
[h] Boil, stew, soup, or steam.

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species

Species	Moisture Content (%)	Total Fat Content (%)	Comments
	FINFISH		
Anchovy, European	73.37	4.84	Raw
	50.30	9.71	Canned in oil, drained solids
Bass, Freshwater	75.66	3.69	Raw
	68.79	4,73	Cooked, dry heat
Bass, Striped	79.22	2.33	Raw
	73.36	2.99	Cooked, dry heat
Bluefish	70.86	4.24	Raw
	62.64	5.44	Cooked, dry heat
Burbot	79.26	0.81	Raw
	73.41	1.04	Cooked, dry heat
Butterfish	74.13	8.02	Raw
	66.83	10.28	Cooked, dry heat
Carp	76.31	5.60	Raw
	69.63	7.17	Cooked, dry heat
Catfish, Channel, Farmed	75.38	7.59	Raw
	71.58	8.02	Cooked, dry heat
Catfish, Channel, Wild	80.36	2.82	Raw
	77.67	2.85	Cooked, dry heat
Caviar, Black and Red	47.50	17.90	--
Cisco	78.93	69.80	Raw
	1.91	11.90	Smoked
Cod, Atlantic	81.22	0.67	Raw
	75.61	0.86	Canned, solids and liquids
	75.92	0.86	Cooked, dry heat
	16.14	2.37	Dried and salted
Cod, Pacific	81.28	0.63	Raw
	76.00	0.81	Cooked, dry heat
Croaker, Atlantic	78.03	3.17	Raw
	59.76	12.67	Cooked, breaded and fried
Cusk	76.35	0.69	Raw
	69,68	0.88	Cooked, dry heat
Dolphinfish	77.55	0.70	Raw
	71.22	0.90	Cooked, dry heat
Drum, Freshwater	77.33	4.93	Raw
	70.94	6.32	Cooked, dry heat
Eel	69.26	11.66	Raw
	59.31	14.95	Cooked, dry heat
Flatfish, Flounder, and Sole	79.06	1.19	Raw
	73.16	1.53	Cooked, dry heat
Grouper	79.22	1.02	Raw, mixed species
	73.36	1.30	Cooked, dry heat
Haddock	79.92	0.72	Raw
	74.25	0.93	Cooked, dry heat
	71.48	0.96	Smoked
Halibut, Atlantic and Pacific	77.92	2.29	Raw
	71.69	2.94	Cooked, dry heat

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
Halibut, Greenland	70.27	13.84	Raw
	61.88	17.74	Cooked, dry heat
Herring, Atlantic	72.05	9.04	Raw
	64.16	11.59	Cooked, dry heat
	59.70	12.37	Kippered
	55.22	18.00	Pickled
Herring, Pacific	71.52	13.88	Raw
	63.49	17.79	Cooked, dry heat
Ling	79.63	0.64	Raw
	73,88	0.82	Cooked, dry heat
Lingcod	81.03	1.06	Raw
	75.68	1.36	Cooked, dry heat
Mackerel, Atlantic	63.55	13.89	Raw
	53.27	17.81	Cooked, dry heat
Mackerel, Jack	69.17	6.30	Canned, drained solids
Mackerel, King	75.85	2.00	Raw
	69.04	2.56	Cooked, dry heat
Mackerel, Pacific and Jack	70.15	7.89	Raw
	61.73	10.12	Cooked, dry heat
Mackerel, Spanish	71.67	6.30	Raw
	68.46	6.32	Cooked, dry heat
Milkfish	70.85	6.73	Raw
	62.63	8.63	Cooked, dry heat
Monkfish	83.24	1.52	Raw
	78.51	1.95	Cooked, dry heat
Mullet, Striped	77.01	3.79	Raw
	70.52	4.86	Cooked, dry heat
Ocean Perch, Atlantic	78.70	1.63	Raw
	72.69	2.09	Cooked, dry heat
Perch	79.13	0.92	Raw
	73.25	1.18	Cooked, dry heat
Pike, Northern	78.92	0.69	Raw
	72.97	0.88	Cooked, dry heat
Pike, Walleye	79.31	1.22	Raw
	73.47	1.56	Cooked, dry heat
Pollock, Atlantic	78.18	0.98	Raw
	72.03	1.26	Cooked, dry heat
Pollock, Walleye	81.56	0.80	Raw
	74.06	1.12	Cooked, dry heat
Pompano, Florida	71.12	9.47	Raw
	62.97	12.14	Cooked, dry heat
Pout, Ocean	81.36	0.91	Raw
	76.10	1.17	Cooked, dry heat
Rockfish, Pacific	79.26	1.57	Raw
	73.41	2.01	Cooked, dry heat
Roe	67.73	6.42	Raw
	58.63	8.23	Cooked, dry heat
Roughy, Orange	75.67	0.70	Raw
	66.97	0.90	Cooked, dry heat

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
Sablefish	71.02	15.30	Raw
	62.85	19.62	Cooked, dry heat
	60.14	20.14	Smoked
Salmon, Atlantic, Farmed	68.90	10.85	Raw
	64.75	12.35	Cooked, dry heat
Salmon, Atlantic, Wild	68.50	6.34	Raw
	59.62	8.13	Cooked, dry heat
Salmon, Chinook	71.64	10.43	Raw
	65.60	13.38	Cooked, dry heat
	72.00	4.32	Smoked
Salmon, Chum	75.38	3.77	Raw
	68.44	4.83	Cooked, dry heat
	70.77	5.50	Drained solids with bone
Salmon, Coho, Farmed	70.47	7.67	Raw
	67.00	8.23	Cooked, dry heat
Salmon, Coho, Wild	72.66	5.93	Raw
	71.50	4.30	Cooked, dry heat
	65.39	7.50	Cooked, moist heat
Salmon, Pink	76.35	3.45	Raw
	69.68	4.42	Cooked, dry heat
	68.81	6.05	Canned, solids with bone and liquid
Salmon, Sockeye	70.24	8.56	Raw
	61.84	10.97	Cooked, dry heat
	67.51	7.31	Canned, drained solids with bone
Sardine, Atlantic	59.61	11.45	Canned in oil, drained solids with bone
Sardine, Pacific	66.65	10.46	Canned in tomato sauce, drained solids with bone
Scup	75.37	2.73	Raw
	68.42	3.50	Cooked, dry heat
Sea Bass	78.27	2.00	Raw
	72.14	2.56	Cooked, dry heat
Seatrout	78.09	3.61	Raw
	71.91	4.63	Cooked, dry heat
Shad, American	68.19	13.77	Raw
	59.22	17.65	Cooked, dry heat
Shark, mixed species	73.58	4.51	Raw
	60.09	13.82	Cooked, batter-dipped and fried
Sheepshead	77.97	2.41	Raw
	69.04	1.63	Cooked, dry heat
Smelt, Rainbow	78.77	2.42	Raw
	72.79	3.10	Cooked, dry heat
Snapper	76.87	1.34	Raw
	70.35	1.72	Cooked, dry heat
Spot	75.95	4.90	Raw
	69.17	6.28	Cooked, dry heat
Sturgeon	76.55	4.04	Raw
	69.94	5.18	Cooked, dry heat
	62.50	4.40	Smoked
Sucker, white	79.71	2.32	Raw
	73.99	2.97	Cooked, dry heat
Sunfish, Pumpkinseed	79.50	0.70	Raw

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
	73.72	0.90	Cooked, dry heat
Surimi	76.34	0.90	-
Swordfish	75.62	4.01	Raw
	68.75	5.14	Cooked, dry heat
Tilapia	78.08	1.70	Raw
	71.59	2.65	Cooked, dry heat
Tilefish	78.90	2.31	Raw
	70.24	4.69	Cooked, dry heat
Trout, Mixed Species	71.42	6.61	Raw
	63.36	8.47	Cooked, dry heat
Trout, Rainbow, Farmed	72.73	5.40	Raw
	67.53	7.20	Cooked, dry heat
Trout, Rainbow, Wild	71.87	3.46	Raw
	70.50	5.82	Cooked, dry heat
Tuna, Fresh, Bluefin	68.09	4.90	Raw
	59.09	6.28	Cooked, dry heat
Tuna, Fresh, Skipjack	70.58	1.01	Raw
	62.28	1.29	Cooked, dry heat
Tuna, Fresh, Yellowfin	70.99	0.95	Raw
	62.81	1.22	Cooked, dry heat
Tuna, Light	59.83	8.21	Canned in oil, drained solids
	74.51	0.82	Canned in water, drained solids
Tuna, White	64.02	8.08	Canned in oil, drained solids
	73.19	2.97	Canned in water, drained solids
Turbot, European	76.95	2.95	Raw
	70.45	3.78	Cooked, dry heat
Whitefish, mixed species	72.77	5.86	Raw
	65.09	7.51	Cooked, dry heat
	70.83	0.93	Smoked
Whiting, mixed species	80.27	1.31	Raw
	74.71	1.69	Cooked, dry heat
Wolffish, Atlantic	79.90	2.39	Raw
	74.23	3.06	Cooked, dry heat
Yellowtail, mixed species	74.52	5.24	Raw
	67.33	6.72	Cooked, dry heat
SHELLFISH			
Abalone	74.56	0.76	Raw
	60.10	6.78	Cooked, fried
Clam	81.82	0.97	Raw
	63.64	1.95	Canned, drained solids
	97.70	0.02	Canned, liquid
	61.55	11.15	Cooked, breaded and fried
	63.64	1.95	Cooked, moist heat
Crab, Alaska King	79.57	0.60	Raw
	77.55	1.54	Cooked, moist heat
	74.66	0.46	Imitation, made from surimi
Crab, Blue	79.02	1.08	Raw
	79.16	1.23	Canned
	77.43	1.77	Cooked, moist heat
	71.00	7.52	Crab cakes

Table 10-125. Mean Percent Moisture and Total Fat Content for Selected Species (continued)

Species	Moisture Content (%)	Total Fat Content (%)	Comments
Crab, Dungeness	79.18	0.97	Raw
	73.31	1.24	Cooked, moist heat
Crab, Queen	80.58	1.18	Raw
	75.10	1.51	Cooked, moist heat
Crayfish, Farmed	84.05	0.97	Raw
	80.80	1.30	Cooked, moist heat
Crayfish, Wild	82.24	0.95	Raw
	79.37	1.20	Cooked, moist heat
Cuttlefish	80.56	0.70	Raw
	61.12	1.40	Cooked, moist heat
Lobster, Northern	76.76	0.90	Raw
	76.03	0.59	Cooked, moist heat
Lobster, Spiny	74.07	1.51	Raw
	66.76	1.94	Cooked, moist heat
Mussel, Blue	80.58	2.24	Raw
	61.15	4.48	Cooked, moist heat
Octopus	80.25	1.04	Raw
	60.50	2.08	Cooked, moist heat
Oyster, Eastern	86.20	1.55	Raw, farmed
	85.16	2.46	Raw, wild
	85.14	2.47	Canned
	64.72	12.58	Cooked, breaded and fried
	81.95	2.12	Cooked, farmed, dry heat
	83.30	1.90	Cooked, wild, dry heat
	70.32	4.91	Cooked, wild, moist heat
Oyster, Pacific	82.06	2.30	Raw
	64.12	4.60	Cooked, moist heat
Scallop, mixed species	78.57	0.76	Raw
	58.44	10.94	Cooked, breaded and fried
	73.10	1.40	Steamed
Shrimp	75.86	1.73	Raw
	75.85	1.36	Canned
	52.86	12.28	Cooked, breaded and fried
	77.28	1.08	Cooked, moist heat
Squid	78.55	1.38	Raw
	64.54	7.48	Cooked, fried

Source: USDA, 2007.

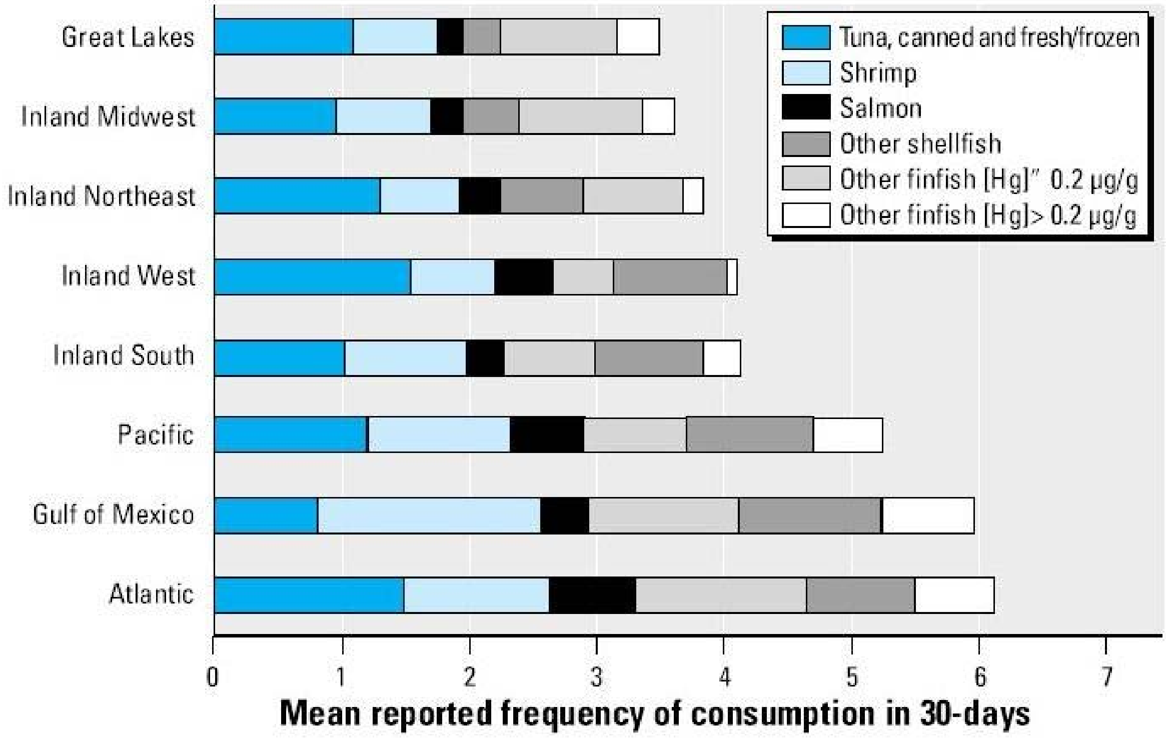

Figure 10-2. Species and Frequency of Meals Consumed by Geographic Residence.

Source: Mahaffey et al., 2009.

APPENDIX 10A:

RESOURCE UTILIZATION DISTRIBUTION

10A.1. RESOURCE UTILIZATION DISTRIBUTION

The percentiles of the resource utilization distribution of *Y* are to be distinguished from the percentiles of the (standard) distribution of *Y*. The latter percentiles show what percentage of individuals in the population are consuming below a given level. Thus, the 50^{th} percentile of the distribution of *Y* is that level such that 50% of individuals consume below it; on the other hand, the 50^{th} percentile of the resource utilization distribution is that level such that 50% of the overall consumption in the population is done by individuals consuming below it.

The percentiles of the resource utilization distribution of *Y* will always be greater than or equal to the corresponding percentiles of the (standard) distribution of *Y*, and, in the case of recreational fish consumption, usually considerably exceed the standard percentiles.

To generate the resource utilization distribution, one simply weights each observation in the data set by the *Y* level for that observation and performs a standard percentile analysis of weighted data. If the data already have weights, then one multiplies the original weights by the *Y* level for that observation, and then performs the percentile analysis.

Under certain assumptions, the resource utilization percentiles of fish consumption may be related (approximately) to the (standard) percentiles of fish consumption derived from the analysis of creel studies. In this instance, it is assumed that the creel survey data analysis did not employ sampling weights (i.e., weights were implicitly set to one); this is the case for many of the published analyses of creel survey data. In creel studies, the fish consumption rate for the i^{th} individual is usually derived by multiplying the amount of fish consumption per fishing trip (say C_i) by the frequency of fishing (say f_i). If it is assumed that the probability of sampling an angler is proportional to fishing frequency, then sampling weights of inverse fishing frequency ($1/f_i$) should be employed in the analysis of the survey data. Above it was stated that for data that are already weighted, the resource utilization distribution is generated by multiplying the original weights by the individual's fish consumption level to create new weights. Thus, to generate the resource utilization distribution from the data with weights of ($1/f_i$), one multiplies ($1/f_i$) by the fish consumption level of $f_i\ C_i$ to get new weights of C_i.

Now if C_i (amount of consumption per fishing trip) is constant over the population, then these new weights are constant and can be taken to be one. But weights of one is what (it is assumed) were used in the original creel survey data analysis. Hence, the resource utilization distribution is exactly the same as the original (standard) distribution derived from the creel survey using constant weights.

The accuracy of this approximation of the resource utilization distribution of fish by the (standard) distribution of fish consumption derived from an unweighted analysis of creel survey data depends then on two factors, how approximately constant the C_i's are in the population and how approximately proportional the relationship between sampling probability and fishing frequency is. Sampling probability will be roughly proportional to frequency if repeated sampling at the same site is limited or if re-interviewing is performed independent of past interviewing status.

Note: For any quantity *Y* that is consumed by individuals in a population, the percentiles of the "resource utilization distribution" of *Y* can be formally defined as follows: $Y_p\ (R)$ is the *p*th percentile of the resource utilization distribution if *p* percent of the overall consumption of *Y* in the population is done by individuals with consumption below $Y_p\ (R)$ and 100-*p* percent is done by individuals with consumption above $Y_p(R)$.

APPENDIX 10B:

FISH PREPARATION AND COOKING METHODS

Table 10B-1. Percent of Fish Meals Prepared Using Various Cooking Methods by Residence Size[a]

Residence Size	Large City/Suburb	Small City	Town	Small Town	Rural Non-Farm	Farm
Total Fish						
Cooking Method						
Pan Fried	32.7	31.0	36.0	32.4	38.6	51.6
Deep Fried	19.6	24.0	23.3	24.7	26.2	15.7
Boiled	6.0	3.0	3.4	3.7	3.4	3.5
Grilled/Broiled	23.6	20.8	13.8	21.4	13.7	13.1
Baked	12.4	12.4	10.0	10.3	12.7	6.4
Combination	2.5	6.0	8.3	5.0	2.3	7.0
Other (Smoked, etc.)	3.2	2.8	5.2	1.9	2.9	1.8
Don't Know	0.0000	0.0000	0.0000	0.5	0.2	--
Total (*N*)	393	317	388	256	483	94
Sport Fish						
Pan Fried	45.8	45.7	47.6	41.4	51.2	63.3
Deep Fried	12.2	14.5	17.5	15.2	21.9	7.3
Boiled	2.8	2.3	2.9	0.5	3.6	0
Grilled/Broiled	20.2	17.6	10.6	25.3	8.2	10.4
Baked	11.8	8.8	6.3	8.7	9.7	6.9
Combination	2.7	8.5	10.4	6.7	1.9	9.3
Other (smoked, etc.)	4.5	2.7	4.9	1.5	3.5	2.8
Don't Know	0	0	0	0.7	0	0
Total (*N*)	205	171	257	176	314	62

[a] Large City = over 100,000; Small City = 20,000–100,000; Town = 2,000–20,000; Small Town = 100-2,000.

N = Total number of respondents.

Source: West et al., 1993.

Table 10B-2. Percent of Fish Meals Prepared Using Various Cooking Methods by Age

Age (years)	17–30	31–40	41–50	51–64	>64	Overall
Total Fish						
Cooking Method						
Pan Fried	45.9	31.7	30.5	33.9	40.7	35.3
Deep Fried	23.0	24.7	26.9	23.7	14.0	23.5
Boiled	0.0000	6.0	3.6	3.9	4.3	3.9
Grilled or Boiled	15.6	15.2	24.3	16.1	18.8	17.8
Baked	10.8	13.0	8.7	12.8	11.5	11.4
Combination	3.1	5.2	2.2	6.5	6.8	4.7
Other (Smoked, etc.)	1.6	4.2	3.5	2.7	4.0	3.2
Don't Know	0.0000	0.0000	0.3	0.4	0.0000	0.2
Total (*N*)	246	448	417	502	287	1,946
Sport Fish						
Pan Fried	57.6	42.6	43.4	46.6	54.1	47.9
Deep Fried	18.2	21.0	17.3	14.8	7.7	16.5
Boiled	0.0000	4.4	0.8	3.2	3.1	2.4
Grilled/Broiled	15.0	10.1	25.9	12.2	12.2	14.8
Baked	3.6	10.4	6.4	11.7	9.9	8.9
Combination	3.8	7.2	3.0	7.5	8.2	5.9
Other (Smoked, etc.)	1.7	4.3	3.2	3.5	4.8	3.5
Don't Know	0.0000	0.0000	0.0000	0.4	0.0000	0.1
Total (*N*)	174	287	246	294	163	1,187

N = Total number of respondents.

Source: West et al., 1993.

Table 10B-3. Percent of Fish Meals Prepared Using Various Cooking Methods by Ethnicity					
Ethnicity	Black	Native American	Hispanic	White	Other
Total Fish					
Cooking Method					
Pan Fried	40.5	37.5	16.1	35.8	18.5
Deep Fried	27.0	22.0	83.9	22.7	18.4
Boiled	0	1.1	0	4.3	0
Grilled/Broiled	19.4	9.8	0	17.7	57.6
Baked	1.9	16.3	0	11.7	5.4
Combination	9.5	6.2	0	4.5	0
Other (Smoked, etc.)	1.6	4.2	3.5	2.7	4.0
Don't Know	0	0	0.3	0.4	0
Total (*N*)	52	84	12	1,744	33
Sport Fish					
Pan Fried	44.9	47.9	52.1	48.8	22.0
Deep Fried	36.2	20.2	47.9	15.7	9.6
Boiled	0	0	0	2.7	0
Grilled/Broiled	0	1.5	0	14.7	61.9
Baked	5.3	18.2	0	8.6	6.4
Combination	13.6	8.6	0	5.6	0
Other (Smoked, etc.)	0	3.6	0	3.7	0
Total (*N*)	19	60	4	39	0

N = Total number of respondents.

Source: West et al., 1993.

Table 10B-4. Percent of Fish Meals Prepared Using Various Cooking Methods by Education

Ethnicity	Through Some H.S.	H.S. Degree	College Degree	Post-Graduate Education
Total Fish				
Cooking Method				
Pan Fried	44.7	41.8	28.8	22.9
Deep Fried	23.6	23.6	23.8	19.4
Boiled	2.2	2.8	5.1	5.8
Grilled/Broiled	8.9	10.9	23.8	34.1
Baked	8.1	12.1	11.6	12.8
Combination	10.0	5.1	3.0	3.8
Other (Smoked, etc.)	2.1	3.4	4.0	1.3
Don't Know	0.5	0.3	0	0
Total (*N*)	236	775	704	211
Sport Fish				
Pan Fried	56.1	52.4	41.8	36.3
Deep Fried	13.6	15.8	18.6	12.9
Boiled	2.8	2.4	3.0	0
Grilled/Broiled	6.3	9.4	21.7	28.3
Baked	7.4	10.6	6.1	14.9
Combination	10.1	6.3	3.9	6.5
Other (Smoked, etc.)	2.8	3.3	4.6	1.0
Total (*N*)	0.8	0	0	0
	146	524	421	91

N = Total number of respondents.

Source: West et al., 1993.

Table 10B-5. Percent of Fish Meals Prepared Using Various Cooking Methods by Income			
Ethnicity	0–$24,999	$25,000–$39,999	$40,000–or more
Total Fish			
Cooking Method			
Pan Fried	44.8	39.1	26.5
Deep Fried	21.7	22.2	23.4
Boiled	2.1	3.5	5.6
Grilled/Broiled	11.3	15.8	25.0
Baked	9.1	12.3	13.3
Combination	8.7	2.9	2.5
Other (Smoked, etc.)	2.4	4.0	3.5
Don't Know	0	0.2	0.3
Total (*N*)	544	518	714
Sport Fish			
Pan Fried	51.5	51.4	42.0
Deep Fried	15.8	15.8	17.2
Boiled	1.8	2.1	3.7
Grilled/Broiled	12.0	12.2	19.4
Baked	7.2	10.0	10.0
Combination	9.1	3.8	3.5
Other (Smoked, etc.)	2.7	4.6	3.8
Total (*N*)	0	0	0.3
	387	344	369

N = Total number of respondents.

Source: West et al., 1993.

Table 10B-6. Percent of Fish Meals Where Fat was Trimmed or Skin was Removed, by Demographic Variables

	Total Fish		Sport Fish	
Population	Trimmed Fat (%)	Skin Off (%)	Trimmed Fat (%)	Skin Off (%)
Total Fish				
Residence Size				
Large City/Suburb	51.7	31.6	56.7	28.9
Small City	56.9	34.1	59.3	36.2
Town	50.3	33.4	51.7	33.7
Small Town	52.6	45.2	55.8	51.3
Rural Non-Farm	42.4	32.4	46.2	34.6
Farm	37.3	38.1	39.4	42.1
Age (years)				
17–30	50.6	36.5	53.9	39.3
31–40	49.7	29.7	51.6	29.9
41–50	53.0	32.2	58.8	37.0
51–65	48.1	35.6	48.8	37.2
Over 65	41.6	43.1	43.0	42.9
Ethnicity				
Black	25.8	37.1	16.0	40.1
Native American	50.0	41.4	56.3	36.7
Hispanic	59.5	7.1	50.0	23.0
White	49.3	34.0	51.8	35.6
Other	77.1	61.6	75.7	65.5
Education				
Some High School	50.8	43.9	49.7	47.1
High School Degree	47.2	37.1	49.5	37.6
College Degree	51.9	31.9	55.9	33.8
Post-Graduate	47.6	26.6	53.4	38.7
Income				
<$25,000	50.5	43.8	50.6	47.3
$25,000–$39,999	47.8	34.0	54.9	34.6
$40,000 or more	50.2	28.6	51.7	27.7
Overall	49.0	34.7	52.1	36.5

Source: Modified from West et al., 1993.

Table 10B-7. Method of Cooking of Most Common Species Kept by Sportfishermen						
Species	Percent of Anglers Catching Species	Use as Primary Cooking Method (%)				
		Deep Fried	Pan Fry	Bake and Charcoal Broil	Raw	Other[b]
White Croaker	34	19	64	12	0	5
Pacific Mackerel	25	10	41	28	0	21
Pacific Bonito	18	5	33	43	2	17
Queenfish	17	15	70	6	1	8
Jacksmelt	13	17	57	19	0	7
Walleye Perch	10	12	69	6	0	13
Shiner Perch	7	11	72	8	0	11
Opaleye	6	16	56	14	0	14
Black Perch	5	18	53	14	0	15
Kelp Bass	5	12	55	21	0	12
California Halibut	4	13	60	24	0	3
Shellfish[a]	3	0	0	0	0	100

[a] Crab, mussels, lobster, abalone.
[b] Boil, soup, steam, stew.
N = 1,059.

Source: Modified from Puffer et al., 1981.

Table 10B-8. Adult Consumption of Fish Parts							
Species	Number Consuming	Weighted Percent Consuming Specific Parts					
		Fillet	Skin	Head	Eggs	Bones	Organs
Salmon	473	95.1	55.8	42.7	42.8	12.1	3.7
Lamprey	249	86.4	89.3	18.1	4.6	5.2	3.2
Trout	365	89.4	68.5	13.7	8.7	7.1	2.3
Smelt	209	78.8	88.9	37.4	46.4	28.4	27.9
Whitefish	125	93.8	53.8	15.4	20.6	6.0	0.0
Sturgeon	121	94.6	18.2	6.2	11.9	2.6	0.3
Walleye	46	100	20.7	6.2	9.8	2.4	0.9
Squawfish	15	89.7	34.1	8.1	11.1	5.9	0.0
Sucker	42	89.3	50.0	19.4	30.4	9.8	2.1
Shad	16	93.5	15.7	0.0	0.0	3.3	0.0

Source: CRITFC, 1994.

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11. INTAKE OF MEATS, DAIRY PRODUCTS, AND FATS

11.1. INTRODUCTION

The American food supply is generally considered to be one of the safest in the world. Nevertheless, meats, dairy products, and fats may become contaminated with toxic chemicals by several pathways. These foods sources can become contaminated if animals are exposed to contaminated media (i.e., soil, water, or feed crops). To assess exposure through this pathway, information on meat, dairy, and fat ingestion rates are needed.

A variety of terms may be used to define intake of meats, dairy products, and fats (e.g., consumer-only intake, per capita intake, total meat, dairy product, or fat intake, as-consumed intake, uncooked edible portion intake, dry-weight intake). As described in Chapter 9, Intake of Fruits and Vegetables, consumer-only intake is defined as the quantity of meats, dairy products, or fats consumed by individuals during the survey period averaged across only the individuals who consumed these food items during the survey period. Per capita intake rates are generated by averaging consumer-only intakes over the entire population In general, per capita intake rates are appropriate for use in exposure assessment for which average dose estimates are of interest because they represent both individuals who ate the foods during the survey period and individuals who may eat the food items at some time, but did not consume them during the survey period. Per capita intake, therefore, represents an average across the entire population of interest, but does so at the expense of underestimating consumption for the subset of the population that consumes the food in question. Total intake refers to the sum of all meats, dairy products, or fats consumed in a day.

Intake rates may be expressed on the basis of the as-consumed weight (e.g., cooked or prepared) or on the uncooked or unprepared weight. As-consumed intake rates are based on the weight of the food in the form that it is consumed and should be used in assessments where the basis for the contaminant concentrations in foods is also indexed to the as-consumed weight. Some of the food ingestion values provided in this chapter are expressed as as-consumed intake rates because this is the fashion in which data were reported by survey respondents. Others are provided as uncooked weights based on analyses of survey data that account for weight changes that occur during cooking. This is of importance because concentration data to be used in the dose equation are often measured in uncooked food samples. It should be recognized that cooking can either increase or decrease food weight. Similarly, cooking can increase the mass of contaminant in food (due to formation reactions, or absorption from cooking oils or water) or decrease the mass of contaminant in food (due to vaporization, fat loss, or leaching). The combined effects of changes in weight and changes in contaminant mass can result in either an increase or decrease in contaminant concentration in cooked food. Therefore, if the as-consumed ingestion rate and the uncooked concentration are used in the dose equation, dose may be under-estimated or over-estimated. It is important for the assessor to be aware of these issues and choose intake rate data that best match the concentration data that are being used. For more information on cooking losses and conversions necessary to account for such losses, refer to Chapter 13 of this handbook.

Sometimes contaminant concentrations in food are reported on a dry-weight basis. When these data are used in an exposure assessment, it is recommended that dry-weight intake rates also be used. Dry-weight food concentrations and intake rates are based on the weight of the food consumed after the moisture content has been removed. Similarly, when contaminant concentrations in food are reported on a lipid-weight basis, lipid-weight intake rates should be used. For information on converting the intake rates presented in this chapter to dry-weight or lipid-weight intake rates, refer to Sections 11.5 and 11.6 of this chapter.

The purpose of this chapter is to provide intake data for meats, dairy products, and fats. The recommendations for ingestion rates of meats, dairy products, and fats are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on the key study identified by U.S. Environmental Protection Agency (EPA) for this factor. Following the recommendations, the key study on ingestion of meats, dairy products, and fats are summarized. Relevant data on ingestion of meats, dairy products, and fats are also provided. These studies are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of meats, dairy products, and fats.

11.2. RECOMMENDATIONS

Table 11-1 presents a summary of the recommended values for per capita and consumer-only intake of meats, dairy products, and fats. Table 11-2 provides confidence ratings for these recommendations.

U.S. EPA analyses of data from the 2003−2006 National Health and Nutrition Examination Survey (NHANES) were used in selecting recommended intake rates for intake of meats and dairy products by the general population. The U.S. EPA analysis of meat and dairy products was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations for children presented here, data were placed in the standardized age categories closest to those used in the analysis. The U.S. EPA analysis of fat intake data from the U.S. Department of Agriculture's (USDA's) Continuing Survey of Food Intake by Individuals (CSFII, U.S. EPA, 2007) were used in selecting recommended intake rates for fats. This study used the childhood age groups recommended by U.S. EPA (2005).

The NHANES data on which the recommendations for meats and dairy products are based, and the CSFII data on which the recommendations for fats are based are short-term survey data and may not necessarily reflect the long-term distribution of average daily intake rates. However, since these broad categories of food (i.e., total meats and dairy products), are eaten on a daily basis throughout the year with minimal seasonality, the short term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here will tend to overestimate the corresponding percentiles of the true long-term distribution. In general, the recommended values based on U.S. EPA's analyses of NHANES data and CSFII data represent the uncooked weight of the edible portion of meat, dairy, and fats. It should be noted that because the recommendations for fat intake are based on 1994−1996 and 1998 CSFII data, they may not reflect the most recent changes that may have occurred in consumption patterns.

Table 11-1. Recommended Values for Intake of Meats, Dairy Products, and Fats, Edible Portion, Uncooked

Age Group (years)	Per Capita		Consumers Only		Multiple Percentiles	Source
	Mean	95th Percentile	Mean	95th Percentile		
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Meat[a]						
Birth to 1	1.2	5.4[b]	2.7	8.1[b]	See Tables 11-3 and 11-4	U.S. EPA Analysis of NHANES 2003−2006.
1 to <2	4.0	10.0[b]	4.1	10.1[b]		
2 to <3	4.0	10.0[b]	4.1	10.1[b]		
3 to <6	3.9	8.5	3.9	8.6		
6 to <11	2.8	6.4	2.8	6.4		
11 to <16	2.0	4.7	2.0	4.7		
16 to <21	2.0	4.7	2.0	4.7		
21 to <50	1.8	4.1	1.8	4.1		
≥50	1.4	3.1	1.4	3.1		
Total Dairy Products[a]						
Birth to 1	10.1	43.2[b]	11.7	44.7[b]	See Tables 11-3 and 11-4	U.S. EPA Analysis of NHANES 2003−2006.
1 to <2	43.2	94.7[b]	43.2	94.7[b]		
2 to <3	43.2	94.7[b]	43.2	94.7[b]		
3 to <6	24.0	51.1	24.0	51.1		
6 to <11	12.9	31.8	12.9	31.8		
11 to <16	5.5	16.4	5.5	16.4		
16 to <21	5.5	16.4	5.5	16.4		
21 to <50	3.5	10.3	3.5	10.3		
≥50	3.3	9.6	3.3	9.6		
Individual Meat and Dairy Products—See Tables 11-5 and 11-6						

Table 11-1. Recommended Values for Intake of Meats, Dairy Products, and Fats, Edible Portion, Uncooked (continued)

Age Group	Per Capita Mean	Per Capita 95th Percentile	Consumers Only Mean	Consumers Only 95th Percentile	Multiple Percentiles	Source
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Fat						
Birth to <1 month	5.2	16	7.8	16	See Tables 11-31 and 11-33	U.S. EPA (2007)
1 to <3 months	4.5	12	6.0	12		
3 to <6 months	4.1	8.2	4.4	8.3		
6 to <12 months	3.7	7.0	3.7	7.0		
1 to <2 years	4.0	7.1	4.0	7.1		
2 to <3 years	3.6	6.4	3.6	6.4		
3 to <6 years	3.4	5.8	3.4	5.8		
6 to <11 years	2.6	4.2	2.6	4.2		
11 to <16 years	1.6	3.0	1.6	3.0		
16 to <21 years	1.3	2.7	1.3	2.7		
21 to <31 years years	1.2	2.3	1.2	2.3		
31 to <41 years	1.1	2.1	1.1	2.1		
41 to <51 years	1.0	1.9	1.0	1.9		
51 to <61 years	0.9	1.7	0.9	1.7		
61 to <71 years	0.9	1.7	0.9	1.7		
71 to <81 years	0.8	1.5	0.8	1.5		
≥81 years	0.9	1.5	0.9	1.5		

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA., 2005). Data were placed in the standardized age categories closest to those used in the analysis.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Table 11-2. Confidence in Recommendations for Intake of Meats, Dairy Products, and Fats

General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and data analysis were adequate. The surveys sampled approximately 16,000 for meats and dairy products and 20,000 individuals for fats. Analyses of primary data were conducted.	
Minimal (or Defined) Bias	No physical measurements were taken. The method relied on recent recall of meats and dairy products eaten.	
Applicability and Utility		High for meats and dairy products; medium for fats
Exposure Factor of Interest	The key studies were directly relevant to meat, dairy, and fat intake.	
Representativeness	The data were demographically representative of the U.S. population (based on stratified random sample).	
Currency	Data were collected between 2003 and 2006 for meat and dairy products and between 1994 and 1998 for fats.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The NHANES and CSFII data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	NHANES and CSFII follow strict QA/QC procedures. U.S. EPA analysis of NHANES data has only been reviewed internally.	
Variability and Uncertainty		Medium to high for averages, low for long-term upper percentiles; low for individual foods
Variability in Population	Full distributions were provided for total meats, total dairy products, and total fats. Means were provided for individual meats and dairy products.	
Uncertainty	Data collection was based on recall of consumption for a 2-day period; the accuracy of using these data to estimate long-term intake (especially at the upper percentiles) is uncertain. However, use of short-term data to estimate chronic ingestion can be assumed for broad categories of foods such as total meats, total dairy products, and total fats. Uncertainty is likely to be greater for individual meats and dairy products.	
Evaluation and Review		Medium
Peer Review	Both the NCHS NHANES and the USDA CSFII survey received high levels of peer review. The U.S. EPA analysis of the NHANES data has not been peer reviewed outside the Agency, but methodology has been used in analysis of previous data.	
Number and Agreement of Studies	There was one key study for intake of meat and dairy products (2003−2006 NHANES) and 1 key study for fat intake (U.S. EPA, 2007, based on 1994−1996, 1998 CSFII).	
Overall Rating		**Medium to high** confidence in the averages; **Low** confidence in the long-term upper percentiles

11.3. INTAKE OF MEAT AND DAIRY PRODUCTS

11.3.1. Key Meat and Dairy Intake Studies

11.3.1.1. *U.S. EPA Analysis of Consumption Data from 2003−2006 National Health and Nutrition Examination Survey (NHANES)*

The key source of recent information on consumption rates of meat and dairy products is the U.S. Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics' (NCHS) NHANES. Data from NHANES have been used by the U.S. EPA, Office of Pesticide Programs (OPP) to generate per capita and consumer-only intake rates for both individual meat and dairy products and total meat and dairy products.

NHANES is designed to assess the health and nutritional status of adults and children in the United States. In 1999, the survey became a continuous program that interviews a nationally representative sample of approximately 7,000 persons each year and examines a nationally representative sample of about 5,000 persons each year, located in counties across the country, 15 of which are visited each year. Data are released on a 2 year basis, thus, for example, the 2003 data are combined with the 2004 data to produce NHANES 2003−2004.

The dietary interview component of NHANES is called *What We Eat in America* and is conducted by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). DHHS' NCHS is responsible for the sample design and data collection and USDA's Food Surveys Research Group is responsible for the dietary data collection methodology, maintenance of the databases used to code and process the data, and data review and processing. Beginning in 2003, 2 non-consecutive days of 24-hour intake data were collected. The first day is collected in-person, and the second day is collected by telephone 3 to 10 days later. These data are collected using USDA's dietary data collection instrument, the Automated Multiple Pass Method. This method provides an efficient and accurate means of collecting intakes for large-scale national surveys. It is fully computerized and uses a 5-step interview. Details can be found at USDA's Agriculture Research Service (http://www.ars.usda.gov/ba/bhnrc/fsrg).

For NHANES 2003−2004, there were 12,761 persons selected; of these, 9,643 were considered respondents to the mobile examination center (MEC) examination and data collection. However, only 9,034 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,354 provided complete dietary intakes for Day 2. For NHANES 2005−2006, there were 12,862 persons selected; of these 9,950 were considered respondents to the MEC examination and data collection. However, only 9,349 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,429 provided complete dietary intakes for Day 2.

The 2003−2006 NHANES surveys are stratified, multistage probability samples of the civilian non-institutionalized U.S. population. The sampling frame was organized using 2000 U.S. population census estimates. NHANES oversamples low income persons, adolescents 12 to 19 years, persons 60 years and older, African Americans, and Mexican Americans. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all 4 years of the surveys can be combined. Additional information on NHANES can be obtained at http://www.cdc.gov/nchs/nhanes.htm.

In 2010, OPP used NHANES 2003−2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the U.S. Department of Agriculture's (USDA's) CSFII (USDA, 2000; U.S. EPA, 2000) (see Section 11.3.2.3), NHANES data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean plant (or animal) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, beef stew may contain the commodities beef, potatoes, carrots, and other vegetables. FCID contains approximately 558 unique commodity names and 8-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

Intake rates were generated for a variety of food items/groups based on the agricultural commodities included in the FCID. These intake rates represent intake of all forms of the product (e.g., both home produced and commercially produced) for individuals who provided data for 2 days of the survey. Note that if the person reported consuming food for only one day, their 2-day average would be half the amount reported for the one day of consumption. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the 4-year, 2-day sample weights provided in NHANES 2003−2006 to adjust the data for the sample population to reflect the national population. Summary statistics were generated on a consumer-only and on a per capita basis. Summary statistics, including number of observations, percentage of the population consuming the meats and dairy products being analyzed, mean intake rate, and standard error of the mean intake rate were calculated for total meats, total dairy products, and selected individual meats and dairy products. Percentiles of the intake rate distribution (i.e., 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and the maximum value) were also provided for total meats and dairy products. Data were provided for the following age groups: birth to 1 year, 1 to 2 years, 3 to 5 years, 6 to 12 years, 13 to 19 years, 20 to 49 years, and ≥50 years. Data on females 13 to 49 years were also provided. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 11-3 presents per capita intake data for total meats and dairy products in g/kg-day; Table 11-4 provides consumer-only intake data for total meats and total dairy products in g/kg-day. Table 11-5 provides per capita intake data for individual meats and dairy products, and Table 11-6 provides consumer-only intake data for individual meats and dairy products. In general, these data represent intake of the edible portions of uncooked foods.

The results are presented in units of g/kg-day. Thus, the use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the average daily dose (ADD) equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate because individual intake rates were indexed to the reported body weights of the survey respondents. Also, it should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) do not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. However, for broad categories of foods (e.g., total meats and total dairy) that are eaten on a daily basis throughout the year, the short-term distribution may be a reasonable approximation of the true long-term distribution, although it will show somewhat more variability. In this chapter, distributions are provided only for broad categories of meats and dairy (i.e., total meats and total dairy). Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution. For individual foods, only the mean, standard error, and percent consuming are provided.

An advantage of using the U.S. EPA's analysis of NHANES data is that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The data set was designed to be representative of the U.S. population and includes 4 years of intake data combined. Another advantage is the currency of the data; the NHANES data are from 2003−2006. However, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Because these are 2-day averages, consumption estimates at the upper end of the intake distribution may be underestimated if these consumption values are used to assess acute (i.e., short-term) exposures. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest.

11.3.2. Relevant Meat and Dairy Intake Studies

11.3.2.1. *USDA (1980, 1992, 1996a, b)—Food and Nutrient Intakes of Individuals in 1 Day in the U.S.*

USDA calculated mean per capita intake rates for meat and dairy products using Nationwide Food Consumption Survey (NFCS) data from 1977−1978 and 1987−1988 (USDA, 1980, 1992) and CSFII data from 1994 and 1995 (USDA, 1996a, b). The mean per capita intake rates for meat are presented in Tables 11-7 through 11-9 based on intake data for 1 day from the 1977−1978 (see Table 11-7) and

1987−1988 NFCSs (see Table 11-8), and 1994 and 1995 CSFII (see Table 11-9). Tables 11-10 through 11-12 present similar data for dairy products. Note that the age classifications used in the later surveys were slightly different than those used in the 1977−1978 NFCS.

The advantages of using these data are that they provide mean intake estimates for all meat, poultry, and dairy products. The consumption estimates are based on short-term (i.e., 1-day) dietary data, which may not reflect long-term consumption. These data are based on older surveys and may not be entirely representative of current eating patterns.

11.3.2.2. *USDA (1999a)—Food and Nutrient Intakes by Children 1994−1996, 1998, Table Set 17*

USDA (1999a) calculated national probability estimates of food and nutrient intake by children based on 4 years of the CSFII (1994−1996 and 1998) for children age 9 years and under and on CSFII 1994−1996 only for individuals age 10 years and over. The CSFII was a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. Intake data, based on 24-hour dietary recall, were collected through in-person interviews on 2 non-consecutive days. Section 11.3.2.3 provides additional information on these surveys.

USDA (1999a) used sample weights to adjust for non-response, to match the sample to the U.S. population in terms of demographic characteristics, and to equalize intakes over the 4 quarters of the year and the 7 days of the week. A total of 503 breast-fed children were excluded from the estimates, but both consumers and non-consumers were included in the analysis.

USDA (1999a) provided data on the mean per capita quantities (grams) of various food products/groups consumed per individual for 1 day, and the percent of individuals consuming those foods in 1 day of the survey. Tables 11-13 and 11-14 present data on the mean quantities (grams) of meat and eggs consumed per individual for 1 day, and the percentage of survey individuals consuming meats and eggs on that survey day. Tables 11-15 and 11-16 present similar data for dairy products. Data on mean intakes or mean percentages are based on respondents' Day-1 intakes.

The advantage of the USDA (1999a) study is that it uses the 1994−1996, 1998 CSFII data set, which includes 4 years of intake data, combined, and includes the supplemental data on children. These data are expected to be generally representative of the U.S. population, and they include data on a wide variety of meats and dairy products. The data set is one of a series of USDA data sets that are publicly available. One limitation of this data set is that it is based on 1 day, and short-term dietary data may not accurately reflect long-term eating patterns. Other limitations of this study are that it only provides mean values of food intake rates, consumption is not normalized by body weight, and presentation of results is not consistent with U.S. EPA's recommended age groups. These data are based on older surveys and may not be entirely representative of current eating patterns.

11.3.2.3. *U.S. EPA Analysis of CSFII 1994−1996, 1998 Based on USDA (2000) and U.S. EPA (2000)*

U.S. EPA/OPP, in cooperation with USDA's Agricultural Research Service, used data from the 1994−1996, 1998 CSFII to develop the FCID (U.S. EPA, 2000; USDA, 2000), as described in Section 11.3.1.1. The CSFII 1994−1996 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, DC. In each of the 3 survey years, data were collected for a nationally representative sample of individuals of all ages. The CSFII 1998 was conducted between December 1997 and December 1998 and surveyed children 9 years of age and younger. It used the same sample design as the CSFII 1994−1996 and was intended to be merged with CSFII 1994−1996 to increase the sample size for children. The merged surveys are designated as CSFII 1994−1996, 1998 (USDA, 2000). Additional information on the CSFII can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994−1996, 1998 collected dietary intake data through in-person interviews on 2 non-consecutive days. The data were based on 24-hour recall. A total of 21,662 individuals provided data for the first day; of those individuals, 20,607 provided data for a second day. The 2-day response rate for the 1994−1996 CSFII was approximately 76%. The 2-day response rate for CSFII 1998 was 82%. The CSFII 1994−1996, 1998 surveys were based on a complex multistage area probability sample design. The sampling frame was organized using 1990 U.S. population census estimates, and the stratification plan took into account geographic location, degree of urbanization, and socioeconomic characteristics. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all 4 years of the surveys can be combined. USDA recommends that all 4 years be combined in order to provide an adequate sample size for children.

The meats and dairy items/groups selected for the U.S. EPA analysis included total meats and total dairy products, and individual meats and dairy such as beef, pork, poultry, and eggs. CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. Intake rates for these food items/groups were calculated, and summary statistics were generated on both a per capita and a consumer-only basis using the same general methodology as in the U.S. EPA analysis of 2003−2006 NHANES data, as described in Section 11.3.1.1. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 11-17 presents per capita intake data for total meat and total dairy products in g/kg-day; Table 11-18 provides consumer-only intake data for total meat and total dairy products in g/kg-day. Table 11-19 provides per capita intake data for certain individual meats and dairy products, and Table 11-20 provides consumer-only intake data for these individual meats and dairy products. In general, these data represent intake of the edible portions of uncooked foods.

The results are presented in units of g/kg-day. Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the average daily dose equation. The cautions concerning converting these intake rates into units of g/day by multiplying by a single average body weight and the discussion of the use of short term data in the NHANES description in Section 11.3.1.1 apply to the CSFII estimates as well.

A strength of U.S. EPA's analysis is that it provides distributions of intake rates for various age groups, normalized by body weight. The analysis uses the 1994−1996, 1998 CSFII data set, which was designed to be representative of the U.S. population. The data set includes 4 years of intake data combined and is based on a 2-day survey period. As discussed above, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Although the analysis as conducted used slightly different age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005), given the similarities in the age groups used, the data should provide suitable intake estimates for the childhood age groups of interest**.** While the CSFII data are older than the NHANES data, they provide relevant information on consumption by season, region of the United States, and urbanization, cohorts that are not available in the publicly released NHANES data.

11.3.2.4. *Smiciklas-Wright et al. (2002)—Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994−1996*

Using data gathered in the 1994−1996 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of meat, poultry, and dairy products consumed per eating occasion by members of the U.S. population (i.e., serving sizes). The estimates of serving size are based on data obtained from 14,262 respondents, ages two years and above, who provided 2 days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumer-only data).

Table 11-21 presents serving size data for meats and dairy products. These data are presented on an as-consumed basis (grams) and represent the quantity of meats and dairy products consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. Only the mean and standard deviation serving size data and percent of the population consuming the food during the 2-day survey period are presented in this handbook. Percentiles of serving sizes of the foods consumed by these age groups of the U.S. population can be found in Smiciklas-Wright et al. (2002).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed were not provided by the respondents, standard recipes were used. As a result, the estimates of quantity consumed for some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods. This study used data from the 1994−1996 CSFII; data from the 1998 children's supplement were not included.

11.3.2.5. *Vitolins et al. (2002)—Quality of Diets Consumed by Older Rural Adults*

Vitolins et al. (2002) conducted a survey to evaluate the dietary intake, by food groups, of older (>70 years) rural adults. The sample consisted of 130 community dwelling residents from two rural counties in North Carolina. Data on dietary intake over the preceding year were obtained in face-to-face interviews conducted in participants' homes, or in a few cases, a senior center. The food frequency questionnaire used in the survey was a modified version of the National Cancer Institute Health Habits and History Questionnaire; this modified version included an expanded food list containing a greater number of ethnic foods than the original food frequency form. Demographic and personal data collected included sex, ethnicity, age, education, denture use, marital status, chronic disease, and weight.

Food items reported in the survey were grouped into food groups similar to the USDA Food Guide Pyramid and the National Cancer Institute's 5 A Day for Better Health program. These groups are: (1) fruits and vegetables; (2) bread, cereal, rice, and pasta; (3) milk, yogurt, and cheese; (4) meat, fish, poultry, beans, and eggs; and (5) fats, oils, sweets, and snacks. Medians, ranges, frequencies, and percentages were used to summarize intake of each food group, broken down by demographic and health characteristics. In addition, multiple regression models were used to determine which demographic and health factors were jointly predictive of intake of each of the five food groups.

Thirty-four percent of the survey participants were African American, 36% were European American, and 30% were Native American. Sixty-two percent were female, 62% were not married at the time of the interview, and 65% had some high school education or were high school graduates. Almost all of the participants (95%) had one or more chronic diseases. Sixty percent of the respondents were between 70 and 79 years of age; the median age was 78 years old. Table 11-22 presents the median servings of milk, yogurt, and cheese broken down by demographic and health characteristics. None of the demographic characteristics were significantly associated with milk intake, and only ethnicity was found to be borderline ($p = 0.13$). In addition, none of the demographic characteristics were jointly predictive of milk, yogurt, and cheese consumption.

One limitation of the study, as noted by the study authors, is that the study did not collect information on the length of time the participants had been practicing the dietary behaviors reported in the survey. The questionnaire asked participants to report the frequency of food consumption during the past year. The study authors noted that, currently, there are no dietary assessment tools that allow the collection of comprehensive dietary data over years of food consumption. Another limitation of the study is the small sample size used, which makes associations by sex and ethnicity difficult.

11.3.2.6. *Fox et al. (2004)—Feeding Infants and Toddlers Study: What Foods Are Infants and Toddlers Eating*

Fox et al. (2004) used data from the Feeding Infants and Toddlers study (FITS) to assess food consumption patterns in infants and toddlers. The FITS was sponsored by Gerber Products Company and was conducted to obtain current information on food and nutrient intakes of children, ages 4 to 24 months old, in the 50 states and the District of Columbia. The FITS is described in detail in Devaney et al. (2004). FITS was based on a random sample of 3,022 infants and toddlers for which dietary intake data were collected by telephone from their parents or caregivers between March and July 2002. An initial recruitment and household interview was conducted, followed by an interview to obtain information on intake based on 24-hour recall. The interview also addressed growth, development, and feeding patterns. A second dietary recall interview was conducted for a subset of 703 randomly selected respondents. The study over-sampled children in the 4 to 6 and 9 to 11-months age groups; sample weights were adjusted for non-response, over-sampling, and under-coverage of some subgroups. The response rate for the FITS was 73% for the recruitment interview. Of the recruited households, there was a response rate of 94% for the dietary recall interviews (Devaney et al., 2004). Table 11-23 shows the characteristics of the FITS study population.

Fox et al. (2004) analyzed the first set of 24-hour recall data collected from all study participants. For this analysis, children were grouped into six age categories: 4 to 6 months, 7 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Table 11-24 provides the percentage of infants and toddlers consuming milk, meats, or other protein sources at least once in a day. The percentage of children consuming any type of meat or protein source ranged from 14.2% for 4 to 6-month olds to 97.2% for 19 to 24 month olds (see Table 11-24).

The advantages of this study are that the study population represented the U.S. population and the sample size was large. One limitation of the analysis done by Fox et al. (2004) was that only frequency data were provided; no information on actual intake rates was included. In addition, Devaney et al. (2004) noted several limitations associated with the FITS data. For the FITS, a commercial list of infants and toddlers was used to obtain the sample used in the study. Since many of the households could not be located and did not have children in the target population, a lower response rate than would have occurred in a true national sample was obtained (Devaney et al., 2004). In addition, the sample was likely from a higher socioeconomic status when compared with all U.S. infants in this age group (4 to 24 months old), and the use of a telephone survey may have omitted lower-income households without telephones (Devaney et al., 2004).

11.3.2.7. *Ponza et al. (2004)—Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in WIC*

Ponza et al. (2004) conducted a study using selected data from FITS to assess feeding patterns, food choices, and nutrient intake of infants and toddlers participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Ponza et al. (2004) evaluated FITS data for the following age groups: 4 to 6 months (N = 862), 7 to 11 months (N = 1,159), and 12 to 24 months (N = 996). Table 11-25 shows the total sample size described by WIC participants and non-participants.

The foods consumed were analyzed by tabulating the percentage of infants who consumed specific foods/food groups per day (Ponza et al., 2004). Weighted data were used in all of the analyses used in the study (Ponza et al., 2004). Table 11-25 presents the demographic data for WIC participants and non-participants. Table 11-26 provides the food choices for infants and toddlers. In general, there was little difference in food choices among WIC participants and non-participants, except for consumption of yogurt by infants 7 to 11 months of age and toddlers 12 to 24 months of age (see Table 11-26). Non-participants, 7 to 24 months of age, were more likely to eat yogurt than WIC participants (Ponza et al., 2004).

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. A limitation of the study is that intake values for foods were not provided. Other limitations are associated with the FITS data and are described previously in Section 11.3.2.6.

11.3.2.8. *Mennella et al. (2006)—Feeding Infants and Toddlers Study: The Types of Foods Fed to Hispanic Infants and Toddlers*

Mennella et al. (2006) investigated the types of food and beverages consumed by Hispanic infants and toddlers in comparison to the non-Hispanic infants and toddlers in the United States. The FITS 2002 data for children between 4 and 24 months old were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Menella et al., 2006). Menella et al. (2006) grouped the infants as follows: 4 to 5 months (N = 84 Hispanic; 538 non-Hispanic), 6 to 11 months (N = 163 Hispanic; 1,228 non-Hispanic), and 12 to 24 months (N = 124 Hispanic; 871 non-Hispanic) of age.

Table 11-27 provides the percentages of Hispanic and non-Hispanic infants and toddlers consuming milk, meats, or other protein sources on a given day. In most instances, the percentages consuming the different types of meats and protein sources were similar (Mennella et al., 2006).

The advantage of the study is that it provides information on food preferences for Hispanic and non-Hispanic infants and toddlers. A limitation is that the study did not provide food intake data, but provided frequency of use data instead. Other limitations are those noted previously in Section 11.3.2.6 for the FITS data.

11.3.2.9. *Fox et al. (2006)—Average Portion of Foods Commonly Eaten by Infants and Toddlers in the United States*

Fox et al. (2006) estimated average portion sizes consumed per eating occasion by children 4 to 24 months of age who participated in the FITS. The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers and is described in Section 11.3.2.6 of this chapter. It included a stratified random sample of 3,022 children between 4 and 24 months of age.

Using the 24-hour recall data, Fox et al. (2006) derived average portion sizes for six major food groups, including meats and other protein sources.

Average portion sizes for select individual foods within these major groups were also estimated. For this analysis, children were grouped into six age categories: 4 to 5 months, 6 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Tables 11-28 and 11-29 present the average portion sizes of meats and dairy products for infants and toddlers, respectively.

11.4. INTAKE OF FAT

11.4.1. Key Fat Intake Study

11.4.1.1. *U.S. EPA (2007)—Analysis of Fat Intake Based on the U.S. Department of Agriculture's 1994–1996, 1998 Continuing Survey of Food Intakes by Individuals (CSFII)*

U.S. EPA conducted an analysis to evaluate the dietary intake of fats by individuals in the United States using data from the USDA's 1994–1996, 1998 CSFII (USDA, 2000). Intakes of CSFII foods were converted to U.S. EPA food commodity codes using data provided in U.S. EPA's FCID (U.S. EPA, 2000). The FCID contains a "translation file" that was used to break down the USDA CSFII food codes into 548 U.S. EPA commodity codes. The method used to translate USDA food codes into U.S. EPA commodity codes is discussed in detail in U.S. EPA (2000).

Each of the 548 U.S. EPA commodity codes was assigned a value between zero and one that indicated the mass fraction of fat in that food item. For many sources of fat, a commodity code existed solely for the nutrient fat portion of the food. For example, beef is represented in the FCID database by 10 different commodity codes; several of these codes specifically exclude fat, and one code is described as "nutrient fat only." In these cases, the fat fraction could be expressed as 0 or 1, as appropriate. Most animal food products and food oils were broken down in this way. The fat contents of other foods in the U.S. EPA commodity code list were determined using the USDA Nutrient Database for Standard Reference, Release 13 (USDA, 1999b). For each food item in the U.S. EPA code list, the best available match in the USDA Nutrient Database was used. If multiple values were available for different varieties of the same food item (e.g., green, white, and red grapes), a mean value was calculated. If multiple values were available for different cooking methods (i.e., fried vs. dry cooked), the method least likely to introduce other substances, such as oil or butter, was preferred. In some cases, not all of the items that fall under a given food commodity code could be assigned a fat content. For example, the food commodity code list identified "turkey, meat byproducts" as including gizzard, heart, neck, and tail. Fat contents could be determined only for the gizzard and heart. Because the relative amounts of the different items in the food commodity code were unknown, the mean fat content of these two items was assumed to be the best approximation of the fat content for the food code as a whole.

The analysis was based on respondents who had provided body weights and who had completed both days of the 2-day survey process. These individuals were grouped according to various age categories. The mean, standard error, and a range of percentiles of fat intake were calculated for 12 food categories (i.e., all fats, animal fats, meat and meat products, beef, pork, poultry, organ meats, milk and dairy products, fish, oils, nuts/seeds/beans/legumes/tubers, and others) and 98 demographic cohorts. Fat intake was calculated as a 2-day average consumption across both survey days in units of grams per day and grams per kilogram of body weight per day for the whole survey population and for consumers only.

A secondary objective of the study was to evaluate fat consumption patterns of individuals who consume high levels of animal fats. The entire data analysis was repeated for a subset of individuals who were identified as high consumers of animal fats. The selection of the high-consumption group was done for each age category individually, rather than on the whole population, because fat intake on a per-body-weight basis is heavily skewed towards young children, and an analysis across the entire American population was desired. For infants, the "less-than-1-year-old" group was used instead of the smaller infant groups (<1 month, 1 to <3 months, etc.). Within each of the age categories, individuals that ranked at or above the 90th percentile of consumption of all animal fats on a per-unit body-weight basis were identified. Because of the sample weighting factors, the high consumer group was not necessarily 10% of each age group. The selected individuals made up a survey population of 2,134 individuals. Fat intake of individuals in this group was calculated in g/day and g/kg-day for the whole population (i.e., per capita) and for consumers only.

The analysis presented in U.S. EPA (2007) was conducted before U.S. EPA published the guidance entitled *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Therefore, the age groups used for children in U.S. EPA (2007) were not entirely consistent with the age groups recommended in the 2005 guidance. A re-analysis of the some of the data was conducted to conform with U.S. EPA's recommended age groups for children. The results of this re-analysis are included in Tables 11-30 through 11-35 for all individuals. Only intake rates of all fats are provided in these tables; refer to U.S. EPA (2007) for fat intake rates from individual food sources. Tables 11-30 and 11-31 present intake rates of all fats for the whole population (i.e., per capita) in g/day and g/kg-day, respectively. Tables 11-32 and 11-33 present intake rates of all fats for consumers only in g/day and g/kg-day, respectively. Fat intake rates of all fats for the top decile of animal fat consumers from the consumers only group are presented in Table 11-34 in g/day and in Table 11-35 in g/kg-day (per capita total fat intake rates for the top decile of animal fat consumers are not provided because they are the same as those for consumers only).

11.4.2. Relevant Fat Intake Studies

11.4.2.1. *Cresanta et al. (1988)/Nicklas et al. (1993)/ Frank et al. (1986)—Bogalusa Heart Study*

Cresanta et al. (1988), Nicklas et al. (1993), and Frank et al. (1986) analyzed dietary fat intake data as part of the Bogalusa heart study. The Bogalusa study, an epidemiologic investigation of cardiovascular risk-factor variables and environmental determinants, collected dietary data on subjects residing in Bogalusa, LA, beginning in 1973. Among other research, the study collected fat intake data for children, adolescents, and young adults. Researchers examined various cohorts of subjects, including (1) six cohorts of 10-year olds, (2) two cohorts of 13-year olds, (3) one cohort of subjects from 6 months to 4 years of age, and (4) one cohort of subjects from 10 to 17 years of age (Nicklas, 1995). To collect the data, interviewers used the 24-hour dietary recall method. According to Nicklas (1995), "the diets of children in the Bogalusa study are similar to those reported in national studies of children." Thus, these data are useful in evaluating the variability of fat intake among the general population. Tables 11-36 and 11-37 present data for 6-month-old to 17-year-old individuals collected during 1973 to 1982 (Frank et al., 1986). Data are presented for total fats, animal fats, vegetable fats, and fish fats in units of g/day (see Table 11-36) and g/kg-day (see Table 11-37).

11.5. CONVERSION BETWEEN WET- AND DRY-WEIGHT INTAKE RATES

The intake rates presented in this chapter are reported in units of wet weight (i.e., as-consumed or uncooked weight of meats and dairy products consumed per day or per eating occasion). However, data on the concentration of contaminants in meats and dairy products may be reported in units of either wet or dry weight (e.g., mg contaminant per gram dry-weight of meats and dairy products). It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of meats and dairy products, then the dry-weight units should be used for their intake values).

If necessary, wet weight (e.g., as-consumed) intake rates may be converted to dry-weight intake rates using the moisture content percentages presented in Table 11-38 and the following equation:

$$IR_{dw} = IR_{ww}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 11-1)}$$

where:

IR_{dw} = dry-weight intake rate,
IR_{ww} = wet-weight intake rate, and
W = percent water content.

Alternatively, dry-weight residue levels in meat and dairy products may be converted to wet-weight residue levels for use with wet-weight (e.g., as-consumed) intake rates as follows:

$$C_{ww} = C_{dw}\left[\frac{100-W}{100}\right] \qquad \text{(Eqn. 11-2)}$$

where:

C_{ww} = wet-weight concentration,
C_{dw} = dry-weight concentration, and
W = percent water content.

The moisture content data presented in Table 11-38 are for selected meats and dairy products taken from USDA (2007).

11.6. CONVERSION BETWEEN WET-WEIGHT AND LIPID-WEIGHT INTAKE RATES

In some cases, the residue levels of contaminants in meat and dairy products may be reported as the concentration of contaminant per gram of fat. This may be particularly true for lipophilic compounds. When using these residue levels, the assessor should ensure consistency in the exposure assessment calculations by using consumption rates that are based on the amount of lipids consumed for the meat or dairy product of interest.

If necessary, wet-weight (e.g., as-consumed) intake rates may be converted to lipid-weight intake rates using the fat content percentages presented in Table 11-38 and the following equation:

$$IR_{lw} = IR_{ww}\left[\frac{L}{100}\right] \quad \text{(Eqn. 11-3)}$$

where:

IR_{lw} = lipid-weight intake rate,
IR_{ww} = wet-weight intake rate, and
L = percent lipid (fat) content.

Alternately, wet-weight residue levels in meat and dairy products may be estimated by multiplying the levels based on fat by the fraction of fat per product as follows:

$$C_{ww} = C_{lw}\left[\frac{L}{100}\right] \quad \text{(Eqn. 11-4)}$$

where:

C_{ww} = wet-weight concentration,
C_{lw} = lipid-weight concentration, and
L = percent lipid (fat) content.

The resulting residue levels may then be used in conjunction with wet-weight (e.g., as-consumed) consumption rates. Table 11-38 presents the total fat content data for selected meat and dairy products taken from USDA (2007).

11.7. REFERENCES FOR CHAPTER 11

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Table 11-3. Per Capita Intake of Total Meat and Total Dairy Products Based on 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	% Consuming	Mean	SE	Percentiles 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Meat														
Whole Population	16,783	98	2.0	0.02	0.0	0.2	0.5	0.9	1.6	2.5	3.8	4.8	7.8	23.4*
Age Group														
Birth to 1 year	865	44	1.2	0.12	0.0*	0.0*	0.0	0.0	0.0	1.7	3.6	5.4*	9.3*	18.7*
1 to 2 years	1,052	98	4.0	0.12	0.0*	0.4*	0.8	2.0	3.4	5.5	8.0	10.0*	14.0*	23.4*
3 to 5 years	978	99	3.9	0.13	0.0*	0.7	1.4	2.1	3.3	5.0	7.6	8.5	12.4*	19.5*
6 o 12 years	2,256	99	2.8	0.06	0.1*	0.5	0.9	1.5	2.5	3.8	5.2	6.4	8.9*	13.6*
13 to 19 years	3,450	99	2.0	0.04	0.0	0.3	0.6	1.0	1.7	2.7	3.8	4.7	6.8	13.5*
20 to 49 years	4,289	99	1.8	0.03	0.0	0.3	0.5	1.0	1.6	2.4	3.4	4.1	5.7	12.0*
Females 13 to 49 years	4,103	99	1.6	0.04	0.0	0.2	0.4	0.8	1.3	2.1	3.0	3.6	5.1	12.2*
50 years and older	3,893	99	1.4	0.02	0.0	0.2	0.4	0.8	1.3	1.9	2.6	3.1	4.4	8.6*
Race														
Mexican American	4,450	98	2.2	0.05	0.0	0.2	0.5	1.0	1.8	3.0	4.2	5.4	8.3	18.9*
Non-Hispanic Black	4,265	99	2.2	0.05	0.0	0.3	0.6	1.0	1.7	2.9	4.5	5.8	9.0	23.4*
Non-Hispanic White	6,757	98	1.8	0.02	0.0	0.2	0.5	0.9	1.5	2.4	3.5	4.4	6.9	18.7*
Other Hispanic	562	97	2.2	0.08	0.0*	0.2	0.5	1.1	1.9	2.8	4.0	6.0	10.1*	19.5*
Other Race—Including Multiple	749	98	2.3	0.12	0.0*	0.1	0.5	1.0	1.9	2.9	4.5	6.4	9.6*	15.1*
Total Dairy Product														
Whole Population	16,783	99.7	6.6	0.16	0.0	0.2	0.5	1.3	3.2	7.1	15.4	25.0	56.8	185.3*
Age Group														
Birth to 1 year	865	86	10.1	0.76	0.0*	*0.0	0.0	1.2	6.4	11.5	19.6	43.2*	83.1*	163.9*
1 to 2 years	1,052	100	43.2	1.80	1.0*	*5.7	10.7	20.3	39.1	59.4	84.1	94.7*	141.22*	185.3*
3 to 5 years	978	100	24.0	0.76	0.9*	4.5	8.3	13.6	20.7	32.0	41.9	51.1	68.2*	154.5*
6 to 12 years	2,256	100	12.9	0.42	0.5*	1.5	2.6	5.6	10.8	17.8	26.0	31.8	42.9*	57.7*
13 to 19 years	3,450	100	5.5	0.25	0.1	0.4	0.6	1.6	4.0	7.6	12.3	16.4	24.9	45.0*
20 to 49 years	4,289	99.8	3.5	0.14	0.0	0.2	0.4	1.0	2.4	4.7	8.1	10.3	17.1	52.7*
Females 13 to 49 years	4,103	99.6	3.8	0.16	0.0	0.2	0.5	1.1	2.5	5.2	8.5	11.3	18.9	52.7*
50 years and older	3,893	100	3.3	0.09	0.0	0.2	0.4	1.0	2.3	4.5	7.3	9.6	15.2	28.8*
Race														
Mexican American	4,450	99.6	8.5	0.36	0.0	0.2	0.7	1.4	3.7	9.4	21.8	34.4	67.2	156.4*
Non-Hispanic Black	4,265	99.5	5.0	0.19	0.0	0.1	0.2	0.7	1.8	4.6	12.6	20.1	50.6	175.2*
Non-Hispanic White	6,757	99.8	6.6	0.19	0.1	0.3	0.6	1.4	3.3	7.1	14.8	24.5	54.1	185.3*
Other Hispanic	562	99	8.1	0.88	0.0*	0.1	0.4	1.2	3.1	7.0	20.5	39.2	69.2*	141.2*
Other Race—Including Multiple	749	99.6	6.7	0.50	0.0*	0.0	0.3	0.9	3.3	7.9	15.3	23.1	54.4*	112.2*

N = Sample size.
SE = Standard error.
Max = Maximum value.

* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of 2003−2006 NHANES data.

Table 11-4. Consumer-Only Intake of Total Meat and Total Dairy Products Based on 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	Percentiles									Max
				1st	th	10th	25th	50th	75th	90th	95th	99th	
Total Meat													
Whole Population	16,147	2.0	0.02	0.05	0.3	0.5	1.0	1.6	2.6	3.8	4.8	7.8	23.4*
Age Group													
Birth to 1 year	385	2.7	0.20	0.0*	0.1*	0.2*	1.0	1.9	3.4	6.0*	8.1*	16.6*	18.7*
1 to 2 years	1,030	4.1	0.10	0.1*	0.5*	1.0	2.2	3.5	5.6	8.0	10.1*	14.0*	23.4*
3 to 5 years	968	3.9	0.13	0.0*	0.9	1.4	2.1	3.3	5.0	7.7	8.6	12.4*	19.5*
6 to 12 years	2,250	2.8	0.06	0.1*	0.5	0.9	1.5	2.5	3.8	5.2	6.4	8.9*	13.6*
13 to 19 years	3,422	2.0	0.04	0.0	0.4	0.6	1.1	1.7	2.7	3.8	4.7	6.9	13.5*
20 to 49 years	4,248	1.8	0.03	0.0	0.3	0.5	1.0	1.6	2.4	3.4	4.1	5.8	12.0*
Females 13 to 49 years	4,054	1.6	0.04	0.0	0.3	0.4	0.8	1.3	2.1	3.0	3.6	5.1	12.2*
50 years and older	3,844	1.4	0.02	0.0	0.3	05	0.8	1.3	1.9	2.6	3.1	4.4	8.6*
Race													
Mexican American	4,229	2.3	0.05	0.1	0.3	0.6	1.1	1.9	3.0	4.2	5.5	8.3	18.9*
Non-Hispanic Black	4,154	2.2	0.05	0.1	0.4	0.6	1.1	1.7	2.9	4.5	5.8	9.0	23.4*
Non-Hispanic White	6,520	1.9	0.02	0.0	0.3	0.5	0.9	1.6	2.4	3.5	4.5	7.0	18.7*
Other Hispanic	535	2.3	0.08	0.1*	0.4	0.7	1.2	1.9	2.8	4.1	6.0	10.1*	19.5*
Other Race—Including Multiple	709	2.3	0.12	0.0*	0.3	0.6	1.1	1.9	2.9	4.5	6.7	9.6*	15.1*
Total Dairy Product													
Whole Population	16,657	6.6	0.16	0.0	0.3	0.5	1.3	3.2	7.1	15.5	25.0	56.8	185.3*
Age Group													
Birth to 1 year	753	11.7	0.88	0.0*	0.1*	0.8*	3.1	7.8	12.3	22.1*	44.7*	86.4*	163.9*
1 to 2 years	1,052	43.2	1.79	1.0*	5.7*	10.6	20.3	39.1	59.4	84.0	94.7*	141.2*	185.3*
3 to 5 years	978	24.0	0.77	0.9*	4.7	8.3	13.7	20.7	32.0	41.9	51.1	68.2*	154.5*
6 to 12 years	2,256	12.9	0.42	0.5*	1.6	2.6	5.6	10.8	17.8	26.0	31.8	42.9*	57.7*
13 to 19 years	3,449	5.5	0.25	0.1	0.4	0.6	1.6	4.0	7.6	12.3	16.4	24.9	45.0*
20 to 49 years	4,280	3.5	0.14	0.0	0.2	0.4	1.0	2.4	4.7	8.1	10.3	17.1	52.7*
Females 13 to 49 years	4,095	3.8	0.16	0.0	0.2	0.5	1.1	2.5	5.3	8.5	11.3	18.9	52.7*
50 years and older	3,889	3.3	0.09	0.0	0.2	0.4	1.0	2.3	4.5	7.3	9.6	15.2	28.8*
Race													
Mexican American	4,406	8.6	0.36	0.0	0.3	0.5	1.4	3.8	9.5	21.8	34.4	67.1	156.4*
Non-Hispanic Black	4,246	5.0	0.19	0.0	0.1	0.2	0.7	1.8	4.7	12.7	20.3	50.6	175.2*
Non-Hispanic White	6,708	6.6	0.19	0.1	0.4	0.6	1.4	3.3	7.1	14.9	24.5	54.1	185.3*
Other Hispanic	553	8.1	0.87	0.0*	0.2	0.5	1.2	3.2	7.1	20.6	40.1	72.7*	141.2*
Other Race—Including Multiple	742	6.7	0.51	0.0*	0.0	0.3	0.9	3.3	7.9	15.3	23.1	54.4*	112.2*

N = Sample size;
SE = Standard error;
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of 2003−2006 NHANES data.

Table 11-5. Per Capita Intake of Individual Meats and Dairy Products Based on 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	% Consuming	Mean	SE	% Consuming	Mean	SE	% Consuming	Mean	SE
		Beef			Pork			Poultry		
Whole Population	16,783	88	0.77	0.01	80	0.39	0.01	75	0.77	0.02
Age Group										
Birth to 1 year	865	27	0.34	0.07	19	0.17	0.04	37	0.69	0.09
1 to 2 years	1,052	84	1.38	0.08	73	0.75	0.06	81	1.87	0.07
3 to 5 years	978	91	1.42	0.08	79	0.79	0.06	82	1.65	0.07
6 to 12 years	2,256	92	1.11	0.04	84	0.52	0.02	77	1.18	0.06
13 to 19 years	3,450	91	0.83	0.03	79	0.36	0.02	74	0.80	0.02
20 to 49 years	4,289	88	0.73	0.02	81	0.36	0.02	77	0.71	0.02
Females 13 to 49 years	4,103	86	0.60	0.02	79	0.28	0.01	77	0.66	0.02
50 years and older	3,893	87	0.58	0.01	82	0.33	0.01	71	0.50	0.02
Race										
Mexican American	4,450	86	0.94	0.04	86	0.43	0.02	78	0.82	0.02
Non-Hispanic Black	4,265	88	0.79	0.03	79	0.40	0.03	84	1.01	0.03
Non-Hispanic White	6,757	88	0.74	0.01	81	0.38	0.01	72	0.70	0.02
Other Hispanic	562	80	0.89	0.07	73	0.36	0.03	79	0.97	0.06
Other Race—Including Multiple	749	84	0.84	0.06	78	0.41	0.03	80	1.00	0.10

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 2003−2006 NHANES data.

Table 11-6. Consumer-Only Intake of Individual Meats and Dairy Products Based on 2003−2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Beef			Pork			Poultry		
Whole Population	14,328	0.88	0.01	13,180	0.49	0.01	12,660	1.03	0.02
Age Group									
Birth to 1 year	233	1.28	0.20	172	0.93	0.17	315	1.89	0.16
1 to 2 years	893	1.65	0.08	781	1.03	0.08	880	2.32	0.07
3 to 5 years	879	1.56	0.08	784	1.00	0.07	800	2.02	0.08
6 to 12 years	2,102	1.20	0.04	1,922	0.62	0.02	1,813	1.54	0.08
13 to 19 years	3,140	0.91	0.03	2,770	0.46	0.02	2,652	1.07	0.03
20 to 49 years	3,767	0.84	0.02	3,539	0.44	0.01	3,360	0.92	0.02
Females 13 to 49 years old	3,585	0.70	0.02	3,283	0.36	0.01	3,224	0.86	0.03
50 years and older	3,314	0.66	0.01	3,212	0.40	0.01	2,840	0.70	0.02
Race									
Mexican American	3,679	1.09	0.03	3,595	0.50	0.02	3,371	1.05	0.03
Non-Hispanic Black	3,751	0.90	0.03	3,312	0.51	0.03	3,522	1.21	0.03
Non-Hispanic White	5,843	0.84	0.02	5,304	0.48	0.01	4,769	0.97	0.02
Other Hispanic	450	1.11	0.06	397	0.50	0.05	434	1.23	0.07
Other Race—Including Multiple	605	1.00	0.06	572	0.53	0.04	564	1.26	0.10

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 2003−2006 NHANES data.

Table 11-7. Mean Meat Intakes per Individual in a Day, by Sex and Age (g/day, as-consumed)[a] for 1977−1978

Group Age (years)	Total Meat, Poultry and Fish	Beef	Pork	Lamb, Veal, Game	Frankfurters, Sausages, Luncheon Meats, Spreads	Total Poultry	Chicken Only	Meat Mixtures[b]
Male and Female								
1 and Under	72	9	4	3	2	4	1	51
1 to 2	91	18	6	-[c]	15	16	13	32
3 to 5	121	23	8	-[c]	15	19	19	49
6 to 8	149	33	15	1	17	20	19	55
Male								
9 to 11	188	41	22	3	19	24	21	71
12 to 14	218	53	18	-[c]	25	27	24	87
15 to 18	272	82	24	1	25	37	32	93
19 to 22	310	90	21	2	33	45	43	112
23 to 34	285	86	27	1	30	31	29	94
35 to 50	295	75	28	1	26	31	28	113
51 to 64	274	70	32	1	29	31	29	86
65 to 74	231	54	25	2	22	29	26	72
75 and Over	196	41	39	7	19	28	25	54
Female								
9 to 11	162	38	17	1	20	27	23	55
12 to 14	176	47	19	1	18	23	22	61
15 to 18	180	46	14	2	16	28	27	61
19 to 22	184	52	19	1	18	26	24	61
23 to 34	183	48	17	1	16	24	22	66
35 to 50	187	49	19	2	14	24	21	63
51 to 64	187	52	19	2	12	26	24	60
65 to 74	159	34	21	4	12	30	25	47
75 and Over	134	31	17	2	9	19	16	49
Male and Female								
All Ages	207	54	20	2	20	27	24	72

[a] Based on USDA Nationwide Food Consumption Survey 1977−1978 data for 1 day.
[b] Includes mixtures containing meat, poultry, or fish as a main ingredient.
[c] Less than 0.5 g/day, but more than 0.
\- Indicates data are not available.
Source: USDA, 1980.

Table 11-8. Mean Meat Intakes per Capita in a Day, by Sex and Age (g/day, as-consumed)[a] for 1987−1988

Group Age (years)	Total Meat, Poultry, and Fish	Beef	Pork	Lamb, Veal, Game	Frankfurters, Sausages, Luncheon Meats	Total Poultry	Chicken Only	Meat Mixtures[b]
Male and Female								
5 and Under	92	10	9	<0.5	11	14	12	39
Male								
6 to 11	156	22	14	<0.5	13	27	24	74
12 to 19	252	38	17	1	20	27	20	142
20 and over	250	44	19	23	2	31	25	108
Female								
6 to 11	151	26	9	1	11	20	17	74
12 to 19	169	31	10	<0.5	18	17	13	80
20 and over	170	29	12	1	13	24	18	73
All individuals	193	32	14	1	17	26	20	86

[a] Based on USDA Nationwide Food Consumption Survey 1987−1988 data for 1 day.
[b] Includes mixtures containing meat, poultry, or fish as a main ingredient.

Source: USDA, 1992.

Table 11-9. Mean Meat Intakes Per Capita in a Day, by Sex and Age (g/day, as-consumed)[a] for 1994 and 1995

Group Age (years)	Total Meat, Poultry, and Fish		Beef		Pork		Lamb, Veal, Game		Frankfurters, Sausages, Luncheon Meats		Total Poultry		Chicken Only		Meat Mixtures[b]	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Male and Female																
5 and Under	94	87	10	8	6	4	-[c]	-[c]	17	18	16	15	14	14	41	39
Male																
6 to 11	131	161	19	18	9	7	0	-[c]	22	27	19	25	16	22	51	68
12 to 19	238	256	31	29	11	11	1	1	21	27	40	26	29	23	119	150
20 and over	266	283	35	41	17	14	2	1	29	27	39	31	30	27	124	149
Female																
6 to 11	117	136	18	16	5	5	-[c]	-[c]	18	20	19	17	15	14	51	69
12 to 19	164	158	23	22	5	7	-[c]	0	16	10	20	19	15	18	94	82
20 and over	168	167	18	21	9	11	1	1	16	15	25	22	20	19	87	83
All individuals	195	202	24	27	11	10	1	1	21	21	29	24	23	21	98	104

[a] Based on USDA CSFII 1994 and 1995 data for 1 day.
[b] Includes mixtures containing meat, poultry, or fish as a main ingredient.
[c] Less than 0.5 grams/day, but more than 0.

Source: USDA, 1996a, b.

Table 11-10. Mean Dairy Product Intakes Per Capita in a Day, by Sex and Age (g/day, as-consumed)[a] for 1977−1978

Group Age (years)	Total Milk	Fluid Milk	Cheese	Eggs
Male and Female				
1 and Under	618	361	1	5
1 to 2	404	397	8	20
3 to 5	353	330	9	22
6 to 8	433	401	10	18
Male				
9 to 11	432	402	8	26
12 to 14	504	461	9	28
15 to 18	519	467	13	31
19 to 22	388	353	15	32
23 to 34	243	213	21	38
35 to 50	203	192	18	41
51 to 64	180	173	17	36
65 to 74	217	204	14	36
75 and Over	193	184	18	41
Female				
9 to 11	402	371	7	14
12 to 14	387	343	11	19
15 to 18	316	279	11	21
19 to 22	224	205	18	26
23 to 34	182	158	19	26
35 to 50	130	117	18	23
51 to 64	139	128	19	24
65 to 74	166	156	14	22
75 and Over	214	205	20	19

[a] Based on USDA Nationwide Food Consumption Survey 1977−1978 data for 1 day.

Source: USDA, 1980.

Table 11-11. Mean Dairy Product Intakes Per Capita in a Day, by Sex and Age (g/day, as-consumed)[a] for 1987−1988

Group Age (years)	Total Fluid Milk	Whole Milk	Lowfat/Skim Milk	Cheese	Eggs
Male and Female					
5 and under	347	177	129	7	11
Male					
6 to 11	439	224	159	10	17
12 to 19	392	183	168	12	17
20 and over	202	88	94	17	27
Female					
6 to 11	310	135	135	9	14
12 to 19	260	124	114	12	18
20 and over	148	55	81	15	17
All individuals	224	99	102	14	20

[a] Based on USDA Nationwide Food Consumption Survey 1987−1988 data for 1 day.

Source: USDA, 1992.

Table 11-12. Mean Dairy Product Intakes Per Capita in a Day, by Sex and Age (g/day, as-consumed)[a] for 1994 and 1995

Group Age (years)	Total Fluid Milk		Whole Milk		Lowfat Milk		Cheese		Eggs	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Male and Female										
5 and under	424	441	169	165	130	129	12	9	11	13
Male										
6 to 11	407	400	107	128	188	164	11	12	13	15
12 to 19	346	396	105	105	160	176	19	20	18	24
20 and over	195	206	50	57	83	88	19	16	23	23
Female										
6 to 11	340	330	101	93	136	146	17	13	12	15
12 to 19	239	235	75	71	88	107	14	13	13	17
20 and over	157	158	37	32	56	57	16	15	15	16
All individuals	229	236	65	66	89	92	17	15	17	19

[a] Based on USDA CSFII 1994 and 1995 data for 1 day.

Source: USDA, 1996a, b.

Table 11-13. Mean Quantities of Meat and Eggs Consumed Daily by Sex and Age, Per Capita (g/day, as-consumed)[a]

Age Group	Sample Size	Total	Beef	Pork	Lamb, veal, game	Organ meats	Frankfurters, sausages, luncheon meats	Poultry		Eggs	Mixtures, mainly meat/poultry/ fish
								Total	Chicken		
Male and Female											
Under 1	1,126	24	1[b]	-[b,c]	-[b,c]	-[b,c]	2	3	2	3	16
1	1,016	80	5	2	-[b,c]	-[b,c]	13	12	12	13	43
2	1,102	94	7	6	-[b,c]	-[b,c]	18	17	16	18	41
1 to 2	2,118	87	6	4	-[b,c]	-[b,c]	15	15	14	16	42
3	1,831	101	8	6	-[b,c]	-[b,c]	19	19	18	13	43
4	1,859	115	10	6	-[b,c]	-[b,c]	22	20	19	13	49
5	884	121	14	6	-[b,c]	-[b,c]	22	22	19	13	51
3 to 5	4,574	112	11	6	-[c]	-[b,c]	21	21	19	13	47
5 and under	7,818	93	8	5	-[c]	-[b,c]	17	16	15	13	42
Male											
6 to 9	787	151	18	7	-[b,c]	-[b,c]	24	23	21	11	71
6 to 11	1,031	154	19	7	-[b,c]	-[b,c]	24	22	20	12	72
12 to 19	737	250	30	12	1[b]	0	28	31	26	22	134
Female											
6 to 9	704	121	17	4	-[b,c]	-[b,c]	18	19	16	10	55
6 to 11	969	130	18	5	-[b,c]	-[b,c]	19	20	17	11	60
12 to 19	732	158	21	5	-[b,c]	-[b,c]	15	21	19	13	85
Male and Female											
9 and under	9,309	110	12	5	-[c]	-[b,c]	19	18	17	12	50
19 and under	11,287	152	18	7	-[b,c]	-[b,c]	20	22	19	14	76

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small sample size reporting intake.
[c] Value less than 0.5, but greater than 0.
Note: Consumption amounts shown are representative of the 1st day of each participant's survey response.

Source: USDA, 1999a.

Table 11-14. Percentage of Individuals Consuming Meats and Eggs, by Sex and Age (%)[a]

Age Group (years)	Sample Size	Total	Beef	Pork	Lamb, veal, game	Organ meats	Frankfurters, sausages, luncheon meats	Poultry		Eggs	Mixtures, mainly meat/poultry/ fish
								Total	Chicken		
Male and Female											
Under 1	1,126	26.0	2.1	1.1[b]	0.2[b]	0.2[b]	6.1	6.3	5.0	6.7	13.7
1	1,016	77.4	11.9	7.3	0.8[b]	0.2[b]	26.3	24.0	23.1	22.8	32.2
2	1,102	85.2	16.2	14.9	0.8[b]	0.2[b]	33.2	27.6	25.6	27.3	31.4
1 to 2	2,118	81.4	14.1	11.2	0.8[b]	0.2[b]	29.9	25.8	24.4	25.1	31.8
3	1,831	86.2	13.8	13.3	0.5[b]	-[b,c]	36.4	28.3	26.0	19.8	29.2
4	1,859	86.2	16.1	13.8	0.5[b]	0.2[b]	37.0	27.4	25.1	16.9	30.5
5	884	87.1	18.2	13.2	0.6[b]	0.2[b]	35.1	27.7	24.8	16.4	30.8
3 to 5	4,574	86.5	16.0	13.4	0.5	0.2[b]	36.1	27.8	25.3	17.7	30.2
5 and under	7,818	77.5	13.7	11.2	0.6	0.2[b]	30.4	24.5	22.6	18.9	28.8
Male											
6 to 9	787	87.4	20.1	11.9	0.4[b]	0.1[b]	37.4	24.8	22.3	15.1	36.2
6 to 11	1,031	87.8	22.0	12.2	0.4[b]	0.2[b]	36.2	22.9	20.5	15.6	35.7
12 to 19	737	86.8	24.2	15.8	0.6[b]	0.0	31.8	20.6	17.6	17.0	38.3
Female											
6 to 9	704	84.6	19.4	9.2	0.4[b]	0.2[b]	33.5	23.1	20.2	13.4	32.4
6 to 11	969	86.5	20.2	10.0	0.4[b]	0.1[b]	33.1	22.9	19.8	13.3	32.8
12 to 19	732	80.1	22.0	11.2	0.1[b]	0.1[b]	24.6	21.6	18.9	15.0	34.0
Male and Female											
9 and under	9,309	80.9	16.1	10.9	0.5	0.2[b]	24.3	24.3	22.0	17.1	31.0
19 and under	11,287	82.8	19.6	12.1	0.4	0.1[b]	22.7	22.7	20.1	16.4	33.3

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small sample size reporting intake.
[c] Value less than 0.5, but greater than 0.
Note: Percentages shown are representative of the 1st day of each participant's survey response.

Source: USDA, 1999a.

Table 11-15. Mean Quantities of Dairy Products Consumed Daily by Sex and Age, Per Capita (g/day, as-consumed)[a]

Age Group (year)	Sample Size	Total Milk and Milk Products	Milk, Milk Drinks, Yogurt							Milk Desserts	Cheese
			Total	Fluid Milk				Yogurt			
				Total	Whole	Lowfat	Skim				
Male and Female											
Under 1	1,126	762	757	61	49	11	-[b,c]	4		3	1
1	1,016	546	526	475	347	115	5[b]	14		11	9
2	1,102	405	377	344	181	141	17	10		16	11
1 to 2	2,118	474	450	408	262	128	11	12		14	10
3	1,831	419	384	347	166	150	26	10		22	12
4	1,859	407	369	328	147	149	27	10		23	14
5	884	417	376	330	137	159	25	9		25	14
3 to 5	4,574	414	376	335	150	153	26	10		23	13
5 and under	7,818	477	447	327	177	127	18	10		18	11
Male											
6 to 9	787	450	405	343	127	176	29	6		31	13
6 to 11	1,031	450	402	335	121	172	33	6		35	12
12 to 19	737	409	358	303	99	158	40	3[b]		29	19
Female											
6 to 9	704	380	337	288	105	146	26	4		29	13
6 to 11	969	382	336	283	108	136	29	4		30	14
12 to 19	732	269	220	190	66	92	30	4[b]		29	14
Male and Female											
9 and under	9,309	453	417	323	153	141	22	8		23	12
19 and under	11,287	405	362	291	121	135	29	6		27	14

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small sample size reporting intake.
[c] Value less than 0.5, but greater than 0.

Note: Consumption amounts shown are representative of the 1st day of each participant's survey response.

Source: USDA, 1999a.

Table 11-16. Percentage of Individuals Consuming Dairy Products, by Sex and Age (%)[a]

Age Group (year)	Sample Size	Total Milk and Milk Products	Milk, Milk Drinks, Yogurt						Milk Desserts	Cheese
			Total	Fluid Milk				Yogurt		
				Total	Whole	Lowfat	Skim			
Male and Female										
Under 1	1,126	85.4	84.6	11.1	8.3	2.4	0.2[b]	3.1	4.5	6.0
1	1,016	95.3	92.7	87.7	61.7	26.5	1.5[b]	10.0	13.9	29.7
2	1,102	91.6	87.3	84.3	44.8	36.3	5.2	6.8	17.5	32.6
1 to 2	2,118	93.4	90.0	86.0	53.0	31.5	3.4	8.4	15.8	31.2
3	1,831	94.3	88.3	84.6	42.5	39.5	6.8	7.3	21.4	37.0
4	1,859	93.2	87.8	85.0	41.3	40.4	7.7	5.8	21.7	36.9
5	884	93.1	86.4	81.2	38.1	41.7	6.5	5.5	21.4	34.9
3 to 5	4,574	93.5	87.5	83.6	40.6	40.6	7.0	6.2	21.5	36.3
5 and under	7,818	92.5	88.0	75.7	41.0	32.9	4.9	6.6	17.5	30.9
Male										
6 to 9	787	93.2	85.5	80.7	32.4	44.3	8.6	3.8	24.0	34.6
6 to 11	1,031	92.3	84.6	79.0	30.8	43.1	9.5	3.7	25.0	32.3
12 to 19	737	81.3	65.8	59.6	22.6	30.7	7.0	1.7[b]	13.6	37.1
Female										
6 to 9	704	90.2	82.5	77.5	31.5	40.8	8.1	2.9	24.1	30.9
6 to 11	969	90.2	81.5	76.0	33.2	37.8	8.4	3.0	22.4	31.9
12 to 19	732	75.4	54.0	49.7	17.5	23.9	9.5	2.2[b]	17.1	36.1
Male and Female										
9 and under	9,309	92.2	86.4	77.1	37.4	36.8	6.3	5.3	20.1	31.7
19 and under	11,287	86.7	75.6	68.1	30.1	33.1	7.5	3.8	18.6	33.5

[a] Based on data from 1994−1996, 1998 CSFII.
[b] Estimate is not statistically reliable due to small sample size reporting intake.
Note: Percentages shown are representative of the 1st day of each participant's survey response.

Source: USDA, 1999a.

Table 11-17 Per Capita Intake of Total Meat and Total Dairy Products (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles									
					1st	th	10th	25th	50th	75th	90th	95th	99th	Max
					Total Meat									
Whole Population	20,607	97.5	2.1	0.02	0.0 5	0.2	0.5	1.0	1.7	2.7	4.0	5.3	8.7	30.3
Age Group														
Birth to 1 year	1,486	40.0	1.2	0.1	0.0	0.0	0.0	0.0	0.0	1.6	4.2	6.7	10.7	29.6
1 to 2 years	2,096	97.3	4.1	0.1	0.0	0.2	0.8	1.9	3.6	5.7	8.0	9.8	14.1	20.6
3 to 5 years	4,391	98.8	4.1	0.05	0.0	0.6	1.2	2.2	3.6	5.4	7.7	9.4	12.7	23.4
6 to 12 years	2,089	98.7	2.9	0.05	0.0	0.4	0.8	1.5	2.5	3.8	5.4	6.5	9.6	18.0
13 to 19 years	1,222	98.8	2.1	0.05	0.0	0.2	0.5	1.0	1.9	2.7	3.8	4.8	7.1	30.3
20 to 49 years	4,677	98.2	1.9	0.04	0.0	0.2	0.5	1.0	1.6	2.5	3.5	4.2	6.9	13.4
50+ years	4,646	98.2	1.5	0.02	0.0	0.2	0.4	0.8	1.3	1.9	2.7	3.3	4.8	9.7
Season														
Fall	4,687	96.8	2.1	0.06	0.0	0.1	0.5	1.0	1.7	2.8	4.2	5.4	8.7	21.2
Spring	5,308	97.6	2.1	0.04	0.0	0.2	0.5	1.0	1.7	2.7	4.0	5.2	8.7	23.6
Summer	5,890	97.4	2.1	0.03	0.0	0.1	0.5	0.9	1.6	2.7	4.0	5.4	8.6	30.3
Winter	4,722	98.0	2.0	0.04	0.0	0.2	0.5	1.0	1.6	2.6	3.8	5.0	7.9	29.6
Race														
American Indian, Alaska Native	177	98.4	2.4	0.25	0.0	0.3	0.5	1.0	2.0	3.3	4.3	6.3	9.0	12.4
Asian, Pacific Islander	557	96.8	2.5	0.17	0.0	0.1	0.3	1.1	2.1	3.5	4.5	6.0	9.6	13.0
Black	2,740	97.9	2.6	0.10	0.0	0.3	0.6	1.2	2.0	3.3	5.4	7.1	10.4	23.6
Other	1,638	96.5	2.5	0.08	0.0	0.2	0.5	1.1	2.0	3.1	4.9	6.5	10.8	29.6
White	15,495	97.5	1.9	0.02	0.0	0.2	0.5	0.9	1.6	2.5	3.7	4.8	7.7	30.3
Region														
Midwest	4,822	97.9	2.2	0.04	0.0	0.3	0.6	1.1	1.8	2.8	4.1	5.3	9.1	30.3
Northeast	3,692	96.3	2.1	0.07	0.0	0.0	0.4	0.9	1.6	2.7	4.1	5.4	8.7	20.5
South	7,208	97.7	2.0	0.03	0.0	0.2	0.5	0.9	1.7	2.6	3.9	5.2	8.3	23.4
Midwest	4,822	97.9	2.2	0.04	0.0	0.3	0.6	1.1	1.8	2.8	4.1	5.3	9.1	30.3
West	4,885	97.6	2.0	0.06	0.0	0.2	0.4	0.9	1.6	2.7	4.0	5.2	8.1	29.6
Urbanization														
MSA, Central City	6,164	97.3	2.1	0.04	0.0	0.1	0.5	0.9	1.7	2.7	4.2	5.6	8.9	23.6
MSA, Outside Central City	9,598	97.3	2.0	0.04	0.0	0.2	0.5	1.0	1.6	2.6	3.9	5.1	8.0	29.6
Non-MSA	4,845	98.1	2.1	0.03	0.0	0.3	0.6	1.0	1.7	2.7	4.1	5.1	8.6	30.3

Table 11-17. Per Capita Intake of Total Meat and Total Dairy Products Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Dairy Product														
Whole population	20,607	99.5	6.7	0.1	0.01	0.2	0.4	1.2	3.2	7.3	16.1	25.4	52.1	223
Age Group														
Birth to 1 year	1,486	79.5	12.6	0.9	0.0	0.0	0.0	1.0	8.0	14.1	24.1	48.7	127	186
1 to 2 years	2,096	99.8	36.7	0.7	0.4	3.9	7.7	17.4	31.3	49.8	72.1	88.3	126	223
3 to 5 years	4,391	100.0	23.3	0.3	1.1	4.2	7.0	13.0	20.8	30.9	42.0	49.4	67.7	198
6 to 12 years	2,089	100.0	13.6	0.4	0.3	1.8	3.5	6.7	11.7	18.5	26.0	31.5	42.7	80.6
13 to 19 years	1,222	99.8	5.6	0.2	0.01	0.2	0.5	1.5	4.2	8.1	12.5	15.5	25.4	32.7
20 to 49 years	4,677	99.8	3.3	0.1	0.01	0.2	0.3	0.9	2.2	4.6	7.6	9.9	14.9	36.4
50+ years	4,646	99.8	3.2	0.1	0.02	0.2	0.4	1.0	2.4	4.5	6.9	8.9	14.1	42.5
Season														
Fall	4,687	99.7	7.0	0.2	0.0	0.2	0.4	1.3	3.4	8.0	16.9	26.9	55.3	156.8
Spring	5,308	99.5	6.6	0.2	0.0	0.2	0.4	1.3	3.1	7.3	16.2	25.0	52.0	185.6
Summer	5,890	99.6	6.4	0.2	0.0	0.2	0.4	1.2	3.1	6.8	15.2	24.7	52.8	164.8
Winter	4,722	99.4	6.7	0.1	0.0	0.2	0.5	1.3	3.4	7.3	16.4	25.0	49.1	223.2
Race														
American Indian, Alaska Native	177	99.8	8.0	1.1	0.0	0.0	0.1	0.8	3.1	11.0	21.2	30.2	68.9	146.2
Asian, Pacific Islander	557	97.0	6.4	0.4	0.0	0.0	0.0	0.6	3.0	7.4	14.9	28.1	51.7	164.8
Black	2,740	99.6	5.6	0.2	0.0	0.1	0.2	0.6	2.1	6.5	14.7	23.3	45.4	185.6
Other	1,638	99.1	9.5	0.6	0.0	0.1	0.4	1.3	4.2	11.5	25.4	36.3	69.3	185.2
White	15,495	99.6	6.6	0.1	0.0	0.3	0.5	1.4	3.4	7.2	15.6	24.7	51.2	223.2
Region														
Midwest	4,822	99.7	7.0	0.3	0.0	0.3	0.5	1.4	3.5	7.7	16.9	25.8	52.7	198.4
Northeast	3,692	99.6	6.7	0.2	0.0	0.3	0.6	1.5	3.4	7.3	15.9	25.7	54.2	185.6
South	7,208	99.6	6.0	0.1	0.0	0.2	0.3	1.0	2.8	6.3	14.5	23.7	48.6	223.2
West	4,885	99.2	7.4	0.4	0.0	0.2	0.4	1.4	3.7	8.5	17.5	27.6	54.5	185.2
Urbanization														
MSA, Central City	6,164	99.6	6.5	0.2	0.0	0.2	0.4	1.1	3.2	7.1	15.8	25.1	49.8	198.4
MSA, Outside Central City	9,598	99.4	7.0	0.1	0.0	0.2	0.5	1.4	3.4	7.7	16.9	26.3	54.3	223.2
Non-MSA	4,845	99.7	6.3	0.3	0.0	0.2	0.4	1.1	3.0	6.8	15.0	23.9	51.4	180.7

N = Sample size.
SE = Standard error.
MSA = Metropolitan statistical area.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 11-18. Consumer-Only Intake of Total Meat and Total Dairy Products Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	Percentiles									
				1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Total Meat													
Age Group				5									
Birth to 1 year	575	3.0	0.2	0.01	0.1	0.3	1.0	2.2	4.2	7.4	9.2	12.9	29.6
1 to 2 years	2,044	4.2	0.1	0.04	0.6	1.0	2.1	3.6	5.7	8.1	9.8	14.1	20.6
3 to 5 years	4,334	4.2	0.1	0.04	0.8	1.2	2.2	3.6	5.5	7.7	9.4	12.7	23.4
6 to 12 years	2,065	2.9	0.1	0.1	0.5	0.9	1.5	2.5	3.9	5.4	6.5	9.6	18.0
13 to 19 years	1,208	2.1	0.05	0.02	0.3	0.6	1.1	1.9	2.8	3.8	4.8	7.1	30.3
20 to 49 years	4,593	1.9	0.04	0.04	0.4	0.6	1.0	1.6	2.5	3.5	4.2	6.9	13.4
50+ years	4,565	1.5	0.02	0.03	0.3	0.5	0.8	1.3	2.0	2.7	3.3	4.8	9.7
Whole population	19,384	2.1	0.02	0.04	0.4	0.6	1.0	1.7	2.7	4.0	5.3	8.7	30.3
Season													
Fall	4,423	96.8	2.2	0.06	0.0	0.4	0.6	1.0	1.7	2.8	4.2	5.5	8.7
Spring	4,995	97.6	2.1	0.04	0.0	0.3	0.6	1.0	1.7	2.7	4.1	5.2	8.8
Summer	5,510	97.4	2.1	0.03	0.0	0.3	0.5	1.0	1.7	2.7	4.0	5.5	8.7
Winter	4,456	98.0	2.0	0.04	0.0	0.4	0.6	1.0	1.7	2.6	3.9	5.0	7.9
Race													
American Indian, Alaska Native	171	98.4	2.5	0.27	0.2	0.4	0.5	1.1	2.1	3.3	4.3	6.3	9.0
Asian, Pacific Islander	503	96.8	2.6	0.18	0.0	0.3	0.6	1.2	2.3	3.5	4.5	6.0	9.6
Black	2,588	97.9	2.6	0.10	0.0	0.5	0.7	1.2	2.0	3.3	5.4	7.2	10.5
Other	1,508	96.5	2.6	0.09	0.1	0.4	0.7	1.2	2.0	3.2	5.0	6.6	10.9
White	14,614	97.5	2.0	0.02	0.0	0.3	0.5	1.0	1.6	2.5	3.7	4.8	7.7
Region													
Midwest	4,573	97.9	2.2	0.04	0.1	0.4	0.7	1.1	1.8	2.8	4.1	5.3	9.2
Northeast	3,448	96.3	2.1	0.07	0.0	0.4	0.5	1.0	1.7	2.7	4.2	5.5	8.7
South	6,798	97.7	2.1	0.03	0.0	0.3	0.5	1.0	1.7	2.7	3.9	5.2	8.3
West	4,565	97.6	2.1	0.06	0.0	0.3	0.5	1.0	1.6	2.7	4.0	5.2	8.1
Urbanization													
MSA, Central City	5,783	97.3	2.2	0.04	0.0	0.3	0.5	1.0	1.7	2.8	4.2	5.6	9.1
MSA, Outside Central City	9,004	97.3	2.1	0.04	0.0	0.3	0.6	1.0	1.7	2.6	3.9	5.2	8.0
Non-MSA	4,597	98.1	2.2	0.02	0.0	0.4	0.6	1.1	1.7	2.8	4.1	5.1	8.6

Table 11-18. Consumer-Only Intake of Total Meat and Total Dairy Products Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight) (continued)

Population Group	*N*	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Total Dairy Product													
Whole population	20,287	6.7	0.1	0.02	0.2	0.4	1.3	3.3	7.4	16.2	25.5	52.2	223.2
Age Group													
Birth to 1 year	1,192	15.9	1.0	0.03	0.8	1.9	5.8	10.2	16.0	27.7	57.5	141.8	185.6
1 to 2 years	2,093	36.8	0.7	0.4	4.2	7.8	17.4	31.3	49.8	72.1	88.3	126.2	223.2
3 to 5 years	4,390	23.3	0.3	1.1	4.2	7.0	13.0	20.8	30.9	42.0	49.4	67.7	198.4
6 to 12 years	2,089	13.6	0.4	0.3	1.8	3.5	6.7	11.7	18.5	26.0	31.5	42.7	80.6
13 to 19 years	1,221	5.6	0.2	0.01	0.3	0.5	1.5	4.2	8.1	12.5	15.5	25.4	32.7
20 to 49 years	4,666	3.3	0.1	0.01	0.2	0.3	0.9	2.3	4.6	7.6	9.9	14.9	36.4
50+ years	4,636	3.2	0.1	0.02	0.2	0.4	1.1	2.4	4.5	6.9	8.9	14.1	42.5
Season													
Fall	4,630	99.7	7.1	0.2	0.0	0.2	0.5	1.3	3.4	8.0	16.9	26.9	55.4
Spring	5,210	99.5	6.6	0.2	0.0	0.2	0.4	1.3	3.2	7.3	16.3	25.1	52.1
Summer	5,801	99.6	6.4	0.2	0.0	0.2	0.4	1.2	3.1	6.8	15.2	24.7	53.0
Winter	4,646	99.4	6.7	0.1	0.0	0.2	0.5	1.3	3.4	7.3	16.5	25.1	49.2
Race													
American Indian, Alaskan Native	176	99.8	8.0	1.1	0.0	0.0	0.1	0.8	3.1	11.1	21.2	30.2	68.9
Asian, Pacific Islander	537	97.0	6.6	0.4	0.0	0.0	0.1	0.6	3.1	7.6	15.6	28.1	51.7
Black	2,708	99.6	5.7	0.2	0.0	0.1	0.2	0.6	2.1	6.6	14.8	23.4	45.4
Other	1,607	99.1	9.6	0.7	0.0	0.2	0.4	1.3	4.3	11.6	25.5	36.5	69.3
White	15,259	99.6	6.7	0.1	0.0	0.3	0.6	1.4	3.4	7.2	15.7	24.7	51.3
Region													
Midwest	4,765	99.7	7.1	0.3	0.1	0.3	0.6	1.4	3.5	7.8	16.9	25.8	52.7
Northeast	3,638	99.6	6.8	0.2	0.0	0.3	0.6	1.5	3.4	7.3	16.0	25.8	54.3
South	7,104	99.6	6.0	0.1	0.0	0.2	0.3	1.0	2.8	6.3	14.6	23.8	48.6
West	4,780	99.2	7.4	0.4	0.0	0.2	0.5	1.5	3.8	8.5	17.8	27.7	54.6
Urbanization													
MSA, Central City	6,072	99.6	6.5	0.2	0.0	0.2	0.4	1.2	3.2	7.2	15.9	25.2	49.8
MSA, Outside Central City	9,440	99.4	7.0	0.1	0.0	0.3	0.5	1.4	3.5	7.8	17.0	26.4	54.3
Non-MSA	4,775	99.7	6.3	0.3	0.0	0.2	0.4	1.1	3.0	6.8	15.0	23.9	51.5

N = Sample size.
SE = Standard error.
MSA = Metropolitan statistical area.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 11-19. Per Capita Intake of Individual Meats and Dairy Products Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Beef			Pork			Poultry			Eggs		
		Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
Whole population	20,607	85.9	0.9	0.02	78.5	0.42	0.01	67.6	0.71	0.01	93.4	0.40	0.01
Age Group													
Birth to 1 year	1,486	25.3	0.4	0.04	17.7	0.15	0.02	30.1	0.66	0.05	27.9	0.30	0.04
1 to 2 years	2,096	85.5	1.7	0.06	69.7	0.72	0.03	73.7	1.7	0.05	92.3	1.3	0.04
3 to 5 years	4,391	90.8	1.8	0.04	79.8	0.84	0.02	73.0	1.5	0.03	95.1	0.91	0.03
6 to 12 years	2,089	92.7	1.3	0.04	82.4	0.59	0.03	67.1	0.93	0.03	95.8	0.51	0.02
13 to 19 years	1,222	91.1	1.0	0.05	81.5	0.40	0.03	65.5	0.68	0.03	95.4	0.33	0.02
20 to 49 years	4,677	86.1	0.8	0.03	78.9	0.37	0.01	69.0	0.64	0.02	94.1	0.31	0.01
50+ years	4,646	83.5	0.6	0.02	79.3	0.34	0.01	66.5	0.52	0.02	94.0	0.33	0.01
Season													
Fall	4,687	85.0	0.9	0.05	78.5	0.41	0.02	69.7	0.76	0.03	93.1	0.39	0.02
Spring	5,308	86.4	0.9	0.03	78.1	0.44	0.02	66.8	0.70	0.02	93.5	0.41	0.02
Summer	5,890	85.7	0.9	0.03	78.1	0.42	0.02	65.4	0.69	0.02	93.3	0.39	0.01
Winter	4,722	86.7	0.9	0.02	79.1	0.40	0.02	68.6	0.70	0.02	93.8	0.39	0.02
Race													
American Indian, Alaskan Native	177	87.9	1.3	0.21	85.2	0.49	0.06	78.1	0.62	0.07	94.5	0.49	0.06
Asian, Pacific Islander	557	78.6	0.9	0.08	71.5	0.63	0.11	78.1	0.90	0.09	84.7	0.46	0.05
Black	2,740	85.3	1.1	0.10	82.1	0.53	0.04	73.3	0.93	0.05	93.9	0.48	0.01
Other	1,638	85.0	1.1	0.05	79.4	0.48	0.03	68.7	0.83	0.06	89.9	0.62	0.05
White	15,495	86.4	0.9	0.02	78.0	0.39	0.01	66.1	0.66	0.01	93.9	0.36	0.01
Region													
Midwest	4,822	89.8	1.0	0.02	83.1	0.47	0.02	66.9	0.69	0.03	95.1	0.38	0.01
Northeast	3,692	82.0	0.8	0.08	72.1	0.41	0.02	68.3	0.78	0.04	91.2	0.36	0.02
South	7,208	86.1	0.9	0.02	79.8	0.42	0.02	67.2	0.70	0.02	94.2	0.39	0.01
West	4,885	85.1	0.9	0.04	77.0	0.36	0.03	68.4	0.70	0.03	92.5	0.44	0.02
Urbanization													
MSA, Central City	6,164	84.0	0.9	0.04	77.1	0.41	0.02	70.6	0.78	0.02	92.8	0.41	0.01
MSA, Outside Central City	9,598	85.9	0.9	0.02	77.2	0.39	0.01	68.5	0.72	0.02	93.4	0.39	0.01
Non-MSA	4,845	88.9	1.0	0.04	83.3	0.49	0.02	61.1	0.60	0.03	94.5	0.39	0.01

N = Sample size.
SE = Standard error.
MSA = Metropolitan statistical area.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 11-20. Consumer-Only Intake of Individual Meats and Dairy Products Based on 1994−1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE
	Beef			Pork			Poultry			Eggs		
Whole population	17,116	1.1	0.02	15,431	0.53	0.01	13,702	1.1	0.01	18,450	0.42	0.01
Age Group												
Birth to 1 year	361	1.6	0.2	248	0.83	0.08	434	2.2	0.1	402	1.1	0.1
1 to 2 years	1,795	2.0	0.06	1,488	1.0	0.04	1,552	2.2	0.06	1,936	1.4	0.04
3 to 5 years	3,964	1.9	0.04	3,491	1.1	0.03	3,210	2.0	0.04	4,171	0.96	0.03
6 to 12 years	1,932	1.4	0.04	1,731	0.72	0.03	1,421	1.4	0.04	2,001	0.53	0.02
13 to 19 years	1,118	1.1	0.05	1,002	0.50	0.03	808	1.0	0.04	1,167	0.34	0.02
20 to 49 years	4,058	1.0	0.04	3,732	0.47	0.01	3,221	0.9	0.02	4,399	0.33	0.01
50+ years	3,888	0.7	0.02	3,739	0.43	0.01	3,056	0.8	0.02	4,374	0.35	0.01
Season												
Fall	3,894	1.1	0.06	3,547	0.5	0.02	3,217	1.1	0.03	4,211	0.4	0.02
Spring	4,429	1.0	0.03	3,979	0.6	0.02	3,491	1.1	0.02	4,751	0.4	0.02
Summer	4,855	1.1	0.03	4,354	0.5	0.02	3,810	1.1	0.03	5,245	0.4	0.01
Winter	3,938	1.0	0.02	3,551	0.5	0.02	3,184	1.0	0.03	4,243	0.4	0.02
Race												
American Indian, Alaskan Native	157	1.5	0.15	144	0.6	0.05	116	0.8	0.08	159	0.5	0.07
Asian, Pacific Islander	413	1.2	0.08	359	0.9	0.14	410	1.2	0.11	434	0.5	0.06
Black	2,280	1.3	0.11	2,122	0.6	0.04	2,025	1.3	0.05	2,462	0.5	0.02
Other	1,296	1.3	0.06	1,152	0.6	0.04	1,125	1.2	0.07	1,404	0.7	0.05
White	12,970	1.0	0.02	11,654	0.5	0.01	10,026	1.0	0.02	13,991	0.4	0.01
Region												
Midwest	4,179	1.1	0.02	3,856	0.6	0.01	3,115	1.0	0.03	4,398	0.4	0.01
Northeast	2,936	1.0	0.08	2,502	0.6	0.02	2,522	1.1	0.03	3,236	0.4	0.02
South	6,029	1.0	0.02	5,517	0.5	0.02	4,770	1.0	0.02	6,510	0.4	0.01
West	3,972	1.1	0.04	3,556	0.5	0.03	3,295	1.0	0.03	4,306	0.5	0.02
Urbanization												
MSA, Central City	4,992	1.1	0.05	4,516	0.5	0.02	4,275	1.1	0.02	5,475	0.4	0.01
MSA, Outside Central City	7,937	1.0	0.02	7,028	0.5	0.02	6,461	1.0	0.02	8,565	0.4	0.01
Non-MSA	4,187	1.1	0.03	3,887	0.6	0.02	2,966	1.0	0.03	4,410	0.4	0.01

N = Sample size.
SE = Standard error.
MSA = Metropolitan statistical area.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 11-21. Quantity (as-consumed) of Meat and Dairy Products Consumed per Eating Occasion and Percentage of Individuals Using These Foods in Two Days

	Quantity consumed per eating occasion (g)											
	2 to 5 years old			6 to 11 years old			12 to 19 years old					
	Male and Female (*N* = 2,109)			Male and Female (*N* = 1,432)			Male (*N* = 696)			Female (*N* = 702)		
Food category	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Meat												
Beef steaks	11.1	58	4	11.3	87	9	9.5	168	14	9.4	112	10
Beef roasts	5.2	49	5	4.8	67	7	5.1	233[a]	149[a]	5.5	97[a]	16[a]
Ground beef	59.5	31	1	63.7	41	1	73.4	66	3	61.5	52	3
Ham	6.9	35	4	8.5	40	4	11.6	68	7	9.9	40	5
Pork chops	11.0	48	3	10.1	62	4	11.6	100	8	8.5	72	7
Bacon	10.4	15	1	9.7	19	2	14.9	25	2	11.1	18	1
Pork breakfast sausage	5.3	33	2	6.0	32	3	6.3	40[a]	[a]	3.3	40[a]	[a]
Frankfurters and luncheon meats	51.7	49	1	50.9	57	2	46.7	76	3	38.5	57	3
Total chicken and turkey	63.8	46	1	53.8	62	2	58.4	100	4	54.1	71	2
Chicken	44.6	52	1	36.0	70	3	34.3	117	5	36.1	80	3
Turkey	5.1	63	7	5.7	66	5	8.2	117	14	5.8	60[a]	[a]
Dairy Product												
Fluid milk (all)	92.5	196	3	89.2	241	4	72.3	337	8	64.4	262	8
Fluid milk consumed with cereal	68.1	149	4	64.7	202	5	44.4	276	10	42.7	222	8
Whole milk	50.0	202	3	39.5	244	7	30.0	333	13	22.4	258	7
Whole milk consumed with cereal	33.8	161	5	26.2	212	11	14.8	265	18	14.1	235	13
Lowfat milk	47.5	189	3	52.8	238	4	39.6	326	8	32.4	262	13
Lowfat milk consumed with cereal	31.5	136	4	32.7	198	4	24.3	277	12	21.1	227	12
Skim milk	7.8	171	9	11.1	225	9	9.7	375	38	13.5	255	14
Skim milk consumed with cereal	4.9	131	11	7.5	188	14	6.5	285[a]	23[a]	8.3	181	13
Cheese, other than cream or cottage	53.2	24	1	50.4	29	1	61.1	38	2	53.9	27	1
Ice cream and ice milk	18.4	92	3	21.1	135	4	14.2	221	12	15.2	187	14
Boiled, poached, and baked eggs	8.0	36	3	8.2	34	3	5.0	44[a]	[a]	7.7	45	7
Fried eggs	17.3	48	1	14.0	58	2	14.9	83	5	13.5	59	3
Scrambled eggs	10.4	59	4	7.1	72	5	7.1	72	5	8.9	103	9

Table 11-21. Quantity (as-consumed) of Meat and Dairy Products Consumed per Eating Occasion and Percentage of Individuals Using These Foods in Two Days (continued)

	Quantity consumed per eating occasion (g)																	
	20 to 39 years old						40 to 59 years old						60 years and older					
	Male (*N* = 1,543)			Female (*N* = 1,449)			Male (*N* = 1,663)			Female (*N* = 1,694)			Male (*N* = 1,545)			Female (*N* = 1,429)		
Food category	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
Meat																		
Beef steaks	17.1	202	20	11.8	121	8	18.3	159	7	10.7	117	6	13.4	129	7	9.5	95	6
Beef roasts	6.9	132	14	5.8	85	8	9.9	119	8	9.6	74	5	11.7	102	6	8.8	80	4
Ground beef	65.3	80	4	51.5	52	2	50.0	82	3	44.6	57	2	40.7	73	3	36.2	62	3
Ham	10.8	78	7	9.7	47	4	13.5	68	5	12.2	50	4	15.2	56	3	14.4	45	3
Pork chops	12.8	117	8	12.5	71	4	14.3	108	6	13.0	67	4	16.4	89	3	13.1	62	3
Bacon	14.1	26	1	12.4	18	1	17.5	22	1	14.8	18	1	20.6	19	1	17.4	16	1
Pork breakfast sausage	6.6	57	4	5.1	37	3	6.6	48	4	5.8	38	4	10.7	48	4	5.5	34	3
Frankfurters and luncheon meats	46.2	88	6	35.6	61	2	44.9	79	2	34.3	59	2	41.6	62	2	33.9	51	2
Total chicken and turkey	57.3	112	4	57.8	78	2	56.8	111	4	58.7	80	2	53.8	87	3	57.8	71	2
Chicken	37.1	122	3	35.5	92	3	34.5	124	4	36.0	87	2	32.1	99	3	34.0	79	2
Turkey	6.8	131	21	5.6	76	6	8.5	115	12	8.8	81	8	7.7	80	7	7.2	77	7
Dairy Product																		
Fluid milk (all)	58.0	291	9	61.3	209	6	60.5	238	6	60.2	169	5	73.9	189	5	71.6	154	4
Fluid milk consumed with cereal	26.9	275	12	32.4	198	5	30.1	211	7	30.2	166	5	48.1	170	5	46.6	140	6
Whole milk	22.9	278	11	22.4	202	10	20.3	223	15	19.0	142	7	22.3	188	9	19.7	137	8
Whole milk consumed with cereal	7.9	272	16	8.7	216	14	6.2	216	16	6.1	183	10	10.1	177	10	9.9	156	13
Lowfat milk	29.4	298	15	29.4	198	7	31.2	242	7	27.7	159	5	40.2	189	5	37.8	161	6
Lowfat milk consumed with cereal	14.0	284	22	15.2	181	5	16.1	212	10	13.1	151	7	26.5	165	5	24.4	134	5
Skim milk	9.3	318	13	15.5	235	11	15.1	244	12	19.2	193	7	17.7	186	9	21.6	154	9
Skim milk consumed with cereal	5.6	260	12	9.3	207	10	8.7	197	11	11.8	173	7	12.4	174	9	14.2	135	9
Cheese, other than cream or cottage	63.8	39	2	52.6	30	1	48.3	36	1	46.3	29	1	40.9	33	2	35.4	26	1
Ice cream and ice milk	14.7	200	2	13.6	136	6	18.0	173	6	14.2	141	8	22.7	138	5	18.9	107	4
Boiled, poached, and baked eggs	9.4	50	4	10.4	39	3	12.0	45	3	14.2	38	2	15.7	45	3	16.1	39	2
Fried eggs	15.2	86	2	14.6	61	3	20.9	83	2	17.5	60	2	24.6	70	2	18.3	56	2
Scrambled eggs	10.7	89	4	7.8	74	3	11.1	83	3	8.0	66	3	12.0	73	4	9.3	64	5

[a] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
N = Sample size.
PC = Percent consuming at least once in 2 days.
SE = Standard error of the mean.

Source: Smiciklas-Wright et al. (2002, based on 1994−1996 CSFII data).

Table 11-22. Consumption of Milk, Yogurt, and Cheese: Median Daily Servings (and ranges) by Demographic and Health Characteristics

Subject Characteristic	*N*	Milk, Yogurt, and Cheese
Sex		
Female	80	1.6 (0.2−5.6)
Male	50	1.5 (0.3−7.4)
Ethnicity		
African American	44	1.9 (0.2−4.5)
European American	47	1.6 (0.2−5.6)
Native American	39	1.3 (0.5−7.4)
Age		
70 to 74 years	42	1.8 (0.3−7.4)
75 to 79 years	36	1.6 (0.2−5.6)
80 to 84 years	36	1.4 (0.2−4.5)
85+ years	16	1.6 (0.2−3.8)
Marital Status		
Married	49	1.5 (0.2−7.4)
Not Married	81	1.7 (0.2−5.4)
Education		
8th grade or less	37	1.8 (0.2−5.4)
9th to 12th grades	47	1.6 (0.2−5.6)
> High School	46	1.4 (0.3−7.4)
Denture		
Yes	83	1.5 (0.2−7.4)
No	47	1.6 (0.3−5.6)
Chronic Disease		
0	7	2.0 (0.8−4.5)
1	31	1.8 (0.3−5.6)
2	56	1.6 (0.2−7.4)
3	26	1.2 (0.2−4.8)
4+	10	1.5 (0.5−4.5)
Weight[a]		
≤130 pounds	18	1.3 (0.3−5.4)
131 to 150 pounds	32	1.6 (0.5−5.6)
151 to 170 pounds	27	1.8 (0.2−4.5)
171 to 190 pounds	22	1.6 (0.2−3.7)
≥191 pounds	29	1.5 (0.2−7.4)

[a] = Two missing values.
N = Number of subjects.

Source: Vitolins et al., 2002.

Table 11-23. Characteristics of the Feeding Infants and Toddlers Study (FITS) Sample Population		
	Sample Size	Percentage of Sample
Sex		
Male	1,549	51.3
Female	1,473	48.7
Age of Child		
4 to 6 months	862	28.5
7 to 8 months	483	16.0
9 to 11 months	679	22.5
12 to 14 months	374	12.4
15 to 18 months	308	10.2
19 to 24 months	316	10.4
Child's Ethnicity		
Hispanic or Latino	367	12.1
Non-Hispanic or Latino	2,641	87.4
Missing	14	0.5
Child's Race		
White	2,417	80.0
Black	225	7.4
Other	380	12.6
Urbanicity		
Urban	1,389	46.0
Suburban	1,014	33.6
Rural	577	19.1
Missing	42	1.3
Household Income		
Under $10,000	48	1.6
$10,000 to $14,999	48	1.6
$15,000 to $24,999	221	7.3
$25,000 to $34,999	359	11.9
$35,000 to $49,999	723	23.9
$50,000 to $74,999	588	19.5
$75,000 to $99,999	311	10.3
$100,000 and Over	272	9.0
Missing	452	14.9
Receives WIC		
Yes	821	27.2
No	2,196	72.6
Missing	5	0.2
Sample Size (Unweighted)	3,022	100.0

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Devaney et al., 2004.

Table 11-24. Percentage of Infants and Toddlers Consuming Milk, Meat, or Other Protein Sources

Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 months	7 to 8 months	9 to 11 months	12 to14 months	15 to18 months	19 to 24 months
Cow's Milk	0.8	2.9	20.3	84.8	88.3	87.7
Whole	0.5	2.4	15.1	68.8	71.1	58.8
Reduced-fat or Non-fat	0.3	0.5	5.3	17.7	20.7	38.1
Unflavored	0.8	2.9	19.5	84.0	87.0	86.5
Flavored	0.0	0.0	0.9	1.8	4.4	5.6
Soy Milk	0.0	0.5	1.7	1.5	3.9	3.8
Any Meat or Protein Source	14.2	54.9	79.2	91.3	92.7	97.2
Baby Food Meat	1.7	4.0	3.1	1.1	0.0	0.0
Non-baby Food Meat	1.5	8.4	33.7	60.3	76.3	83.7
Other Protein Sources	2.7	9.7	36.1	59.2	66.8	68.9
Dried Beans and Peas, Vegetarian Meat Substitutes	0.6	1.3	3.3	7.0	6.6	9.9
Eggs	0.7	2.9	7.3	17.0	25.0	25.2
Peanut Butter, Nuts, and Seeds	0.0	0.5	1.9	8.8	11.6	10.4
Cheese	0.4	2.1	18.5	34.0	39.1	41.1
Yogurt	1.2	4.1	15.7	14.9	20.2	15.3
Protein Sources in Mixed Dishes	11.0	43.3	46.2	30.1	25.5	20.5
Baby Food Dinners	9.5	39.8	33.5	10.2	2.4	1.3
Beans and Rice, Chili, Other Bean Mixtures	0.0	0.0	0.9	1.2	2.1	2.0
Mixtures with Vegetables and/or Rice/Pasta	0.9	1.2	4.7	8.2	9.0	7.8
Soup[a]	0.9	3.4	10.1	12.5	13.8	11.5
Types of Meat[b]						
Beef	0.9	2.6	7.7	16.1	16.3	19.3
Chicken or Turkey	2.0	7.3	22.4	33.0	46.9	47.3
Fish and Shellfish	0.0	0.5	1.9	5.5	8.7	7.1
Hotdogs, Sausages, and Cold cuts	0.0	2.1	7.1	16.4	20.1	27.0
Pork/Ham	0.3	1.7	4.0	9.7	11.2	13.9
Other	0.3	0.6	2.5	2.8	2.1	3.9

[a] The amount of protein actually provided by soups varies. Soups could not be sorted reliably into different food groups because all soups were assigned the same 2-digit food code and many food descriptions lacked detail about major soup ingredients.

[b] Includes baby food and non-baby food sources.

Source: Fox et al., 2004.

Table 11-25. Characteristics of WIC Participants and Non-Participants[a] (percentages)

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Sex						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		b		b		b
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		b		b		b
White	69	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child In Daycare				b		c
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother						
14 to 19 years	18	1	13	1	9	1
20 to 24 years	33	13	38	11	33	14
25 to 29 years	29	29	23	30	29	26
30 to 34 years	9	33	15	36	18	34
35 years or Older	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		b		b		b
11th Grade or Less	23	2	15	2	17	3
Completed High School	35	19	42	20	42	19
Some Postsecondary	33	26	32	27	31	28
Completed College	7	53	9	51	9	48
Missing	2	1	2	0	1	2
Parent's Marital Status		b		b		b
Married	49	93	57	93	58	88
Not Married	50	7	42	7	41	11
Missing	1	1	1	0	1	1
Mother or Female Guardian Work				c		c
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1
Urbanicity		b		b		b
Urban	34	55	37	50	35	48
Suburban	36	31	31	34	35	35
Rural	28	13	30	15	28	16
Missing	2	1	2	1	2	2
Sample Size (Unweighted)	265	597	351	808	205	791

a X^2 test were conducted to test for statistical significance in the differences between WIC participants and non-participants within each age group for each variable. The results of χ^2 test are listed next to the variable under the column labeled non-participants for each of the three age groups.
b = $p > 0.01$; non-participants significantly different from WIC participants on the variable.
c = $p < 0.05$; non-participants significantly different from WIC participants on the variable.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 11-26. Food Choices for Infants and Toddlers by WIC Participation Status

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Cow's Milk	1.0	0.6	11.4	13.2	92.3	85.8[a]
Meat or Other Protein Source						
Baby Food Meat	0.9	2.0	3.3	3.6	0.0	0.3
Non-baby Meat	3.7	0.5[b]	25.0	22.0	77.7	75.1
Eggs	0.9	0.6	8.5	4.2[b]	24.1	23.0
Peanut Butter, Nuts, Seeds	0.0	0.0	1.4	1.3	12.9	9.8
Cheese	0.0	0.6	9.0	12.5	38.5	38.8
Yogurt	0.8	1.4	5.5	13.3[b]	9.3	18.9[b]
Sample Size (unweighted)	265	597	351	808	205	791

a = p <0.05; non-participants significantly different from WIC participants.
b = p <0.01; non-participants significantly different from WIC participants.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 11-27. Percentage of Hispanic and Non-Hispanic Infants and Toddlers Consuming Different Types of Milk, Meats, or Other Protein Sources on a Given Day

	Age 4 to 5 months		Age 6 to 11months		Age 12 to 24 months	
	Hispanic (N = 84)	Non-Hispanic (N = 538)	Hispanic (N = 163)	Non-Hispanic (N = 1,228)	Hispanic (N = 124)	Non-Hispanic (N = 871)
Milk						
Fed Any Cow's or Goat Milk	-	-	7.5†	11.3	85.6	87.7
Fed Cow's Milk						
Whole	-	-	5.6†	8.3	61.7	66.3
Reduced Fat or Non-fat	-	-	2.2†	3.0	29.0	27.0
Meat or Other Protein Source						
Any Meat or Protein Source[a]	9.7†	5.3	71.6	62.0	90.3	94.7
Non-baby Food Meat	-	-	22.5	19.2	72.3	76.0
Other Protein Sources	1.4†	-	26.5	21.2	70.1	65.3
Beans and Peas	1.4†	-	5.8†	1.8	19.1[c]	6.5
Eggs	-	-	9.5	4.2	26.4	22.5
Cheese	-	-	11.2	9.4	29.3	40.2
Yogurt	-	-	7.7	9.8	15.7	17.0
Protein Sources in Mixed Dishes	7.5†	4.4	44.8	41.6	33.3	22.7
Baby Food dinners	6.9†	3.9	24.7[c]	35.3	3.5†	3.9
Soup[b]	-	-	16.3[d]	5.1	23.4[c]	10.7
Types of Meat[a]						
Beef	-	-	5.0†	4.6	25.2	16.0
Chicken and Turkey	-	-	11.2	11.9	46.5	43.6
Hotdogs, Sausages, and Cold Cuts	-	-	7.2†	3.4	14.8	23.3
Pork/Ham	-	-	3.8†	1.7	11.7	12.1

a Includes baby food and non-baby food sources.
b The amount of protein actually provided by soups varies. Soups could not be sorted reliably into different food groups because many food descriptions lacked detail about major soup ingredients.
c = Significantly different from non-Hispanic at p <0.05.
d = Significantly different from non-Hispanic at p >0.01.
\- = Less than 1% of the group consumed this food on a given day.
† = Statistic is potentially unreliable because of a high coefficient of variation.
N = Sample size.

Source: Mennella et al., 2006.

Table 11-28. Average Portion Sizes per Eating Occasion of Meats and Dairy Products Commonly Consumed by Infants from the 2002 Feeding Infants and Toddlers Study

Food Group	Reference Unit	4 to 5 months (*N* = 624)	6 to 8 months (*N* = 708)	9 to 11 months (*N* = 687)
			Mean ± SE	
Non-baby food meats	ounce	-	0.9 ± 0.16	0.8 ± 0.05
Cheese	ounce	-	-	0.7 ± 0.05
Scrambled eggs	cup	-	-	0.2 ± 0.02
Yogurt	ounce	-	-	3.1 ± 0.20
Baby food dinners	ounce	2.9 ± 0.24	3.3 ± 0.09	3.8 ± 0.11

- = Cell size was too small to generate a reliable estimate.
N = Number of respondents.
SE = Standard error of the mean.

Source: Fox et al., 2006.

Table 11-29. Average Portion Sizes per Eating Occasion of Meats and Dairy Products Commonly Consumed by Toddlers from the 2002 Feeding Infants and Toddlers Study

Food Group	Reference Unit	12 to 14 months (*N* = 371)	15 to 18 months (*N* = 312)	19 to 24 months (*N* = 320)
			Mean ± SE	
Milk				
Milk	fluid ounce	5.6 ± 0.14	5.9 ± 0.14	6.2 ± 0.17
Milk, as a beverage	fluid ounce	5.7 ± 0.14	6.1 ± 0.14	6.4 ± 0.17
Milk, on cereal	fluid ounce	3.4 ± 0.37	2.7 ± 0.26	3.6 ± 0.29
Meats and other protein source				
All meats	ounce	1.2 ± 0.06	1.3 ± 0.08	1.3 ± 0.07
Beef	ounce	0.8 ± 0.08	1.2 ± 0.15	1.2 ± 0.14
Chicken or turkey, plain	ounce	1.3 ± 0.10	1.3 ± 0.16	1.3 ± 0.10
Hot dogs, luncheon meats, sausages	ounce	1.3 ± 0.13	1.5 ± 0.13	1.5 ± 0.12
Chicken, breaded[a]	ounce	1.5 ± 0.14	1.5 ± 0.13	1.8 ± 0.12
	nugget	2.4 ± 0.22	2.4 ± 0.21	2.8 ± 0.19
Scrambled eggs	cup	0.2 ± 0.02	0.3 ± 0.03	0.3 ± 0.02
Peanut butter	tablespoon	0.7 ± 0.08	0.7 ± 0.09	0.9 ± 0.13
Yogurt	ounce	3.4 ± 0.19	3.8 ± 0.26	3.8 ± 0.28
Cheese	ounce	0.8 ± 0.05	0.8 ± 0.05	0.7 ± 0.04

[a] Not included in total for all meats because weight includes breading.
N = Number of respondents.
SE = Standard error of the mean.

Source: Fox et al., 2006.

Table 11-30. Per Capita Total Fat Intake (g/day)

Age Group[a]	*N*	Mean	SE	Percentiles 10th	25th	50th	75th	95th	Max
Birth to <1 year									
All	1,422	29	18	0	19	31	40	59	107
Female	728	28	17	0	18	30	39	57	92
Male	694	30	18	0	20	32	40	61	107
Birth to <1 month									
All	88	17	16	0	0	19	32	52	64
Female	50	19	15	0	0	18	29	39	52
Male	38	15	18	0	0	19	31	43	64
1 to <3 months									
All	245	22	18	0	0	27	34	47	75
Female	110	20	16	0	0	24	33	45	50
Male	135	23	19	0	0	28	34	55	75
3 to <6 months									
All	411	28	17	0.1	20	31	39	52	107
Female	223	27	17	0	16	29	38	51	74
Male	188	30	18	0.2	22	31	39	50	107
6 to <12 months									
All	678	33	17	8.5	25	34	43	62	100
Female	345	32	17	5.1	24	33	43	62	92
Male	333	34	16	11	25	34	44	62	100
1 to <2 years									
All	1,002	46	19	24	33	43	55	79	159
Female	499	45	18	25	33	43	54	77	116
Male	503	46	20	23	32	44	56	80	159
2 to <3 years									
All	994	51	21	27	37	48	60	87	197
Female	494	49	20	24	35	46	59	83	127
Male	500	52	21	29	39	50	61	89	197
3 to <6 years									
All	4,112	59	22	34	44	56	70	99	218
Female	2,018	56	21	33	43	54	68	96	194
Male	2,094	61	23	35	45	59	72	103	218
6 to <11 years									
All	1,553	68	24	41	50	66	81	111	179
Female	742	64	22	38	48	61	77	101	156
Male	811	72	25	43	55	70	86	115	179
11 to <16 years									
All	975	80	38	42	56	74	97	145	342
Female	493	69	29	37	49	65	82	123	259
Male	482	91	42	50	64	84	111	163	342

Table 11-30. Per Capita Total Fat Intake (g/day) (continued)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
All	743	85	47	37	54	76	108	168	463
Female	372	79	39	35	49	75	96	154	317
Male	371	92	53	41	57	77	114	186	463
21 to <31 years									
All	1,412	84	45	36	53	76	104	164	445
Female	682	65	31	30	43	59	81	126	201
Male	730	103	48	50	68	93	125	181	445
31 to <41 years									
All	1,628	83	43	36	52	74	106	162	376
Female	781	64	31	29	42	58	79	121	228
Male	847	101	45	49	69	96	127	190	376
41 to <51 years									
All	1644	78	39	36	50	70	99	153	267
Female	816	63	29	31	43	59	78	114	208
Male	828	93	42	46	63	87	119	166	267
51 to <61 years									
All	1,578	73	37	31	46	66	90	137	306
Female	768	58	26	27	39	56	73	104	165
Male	810	88	40	39	57	82	110	156	306
61 to <71 years									
All	1,507	66	33	29	42	60	80	123	235
Female	719	53	24	26	36	49	68	96	184
Male	788	78	35	37	53	73	98	138	235
71 to <81 years									
All	888	60	27	28	41	55	72	104	201
Female	421	51	22	27	37	49	62	86	158
Male	467	68	29	34	48	67	86	114	201
81+ years									
All	392	57	29	24	36	54	69	102	227
Female	190	49	23	22	32	48	64	84	132
Male	202	64	32	31	43	61	82	106	227

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
N = Sample size.
SE = Standard error.

Source: U.S. EPA, 2007.

Table 11-31. Per Capita Total Fat Intake (g/kg-day)									
Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
All	1,422	4.0	2.8	0	2.3	4.1	5.6	8.9	20
Female	728	4.1	2.8	0	2.4	4.3	5.8	8.7	18
Male	694	4.0	2.8	0	2.3	4.0	5.5	9.2	20
Birth to <1 month									
All	88	5.2	4.9	0	0	5.7	9.1	16	20
Female	50	5.9	4.6	0	0	6.2	8.4	13	16
Male	38	4.3	5.3	0	0	4.7	9.7	18	20
1 to <3 months									
All	245	4.5	3.8	0	0	4.9	6.8	12	18
Female	110	4.3	3.6	0	0	4.8	6.5	11	14
Male	135	4.7	3.9	0	0	4.9	7.0	10	18
3 to <6 months									
All	411	4.1	2.7	0	2.4	4.3	5.7	8.2	18
Female	223	4.2	2.8	0	2.3	4.5	6.0	8.2	18
Male	188	4.1	2.5	0	2.6	4.1	5.5	8.2	16
6 to <12 months									
All	678	3.7	1.8	1.0	2.7	3.8	4.8	7.0	11
Female	345	3.7	1.9	0.7	2.8	3.8	5.0	7.0	9.8
Male	333	3.6	1.7	1.3	2.6	3.7	4.6	6.8	11
1 to <2 years									
All	1,002	4.0	1.7	2.1	2.8	3.7	4.7	7.1	12
Female	499	4.1	1.6	2.2	3.0	3.7	5.0	6.9	9.7
Male	503	3.9	1.7	1.9	2.6	3.6	4.5	7.2	12
2 to <3 years									
All	994	3.6	1.5	1.9	2.6	3.4	4.4	6.4	12
Female	494	3.7	1.6	1.8	2.4	3.4	4.4	6.6	10
Male	500	3.6	1.5	2.0	2.6	3.4	4.3	6.1	12
3 to <6 years									
All	4,112	3.4	1.3	1.9	2.4	3.2	4.0	5.8	11
Female	2,018	3.4	1.3	1.8	2.4	3.1	4.0	5.8	11
Male	2,094	3.5	1.4	1.9	2.4	3.2	4.1	5.8	11
6 to <11 years									
All	1,553	2.6	1.1	1.3	1.7	2.3	3.0	4.2	9.9
Female	742	2.4	1.0	1.3	1.6	2.2	2.8	4.0	7.7
Male	811	2.7	1.1	1.4	1.8	2.4	3.1	4.4	9.9
11 to <16 years									
All	975	1.6	0.8	0.8	1.1	1.4	2.0	3.0	5.7
Female	493	1.4	0.7	0.7	0.9	1.3	1.7	2.6	5.0
Male	482	1.8	0.9	0.9	1.2	1.6	2.1	3.3	5.7

Table 11-31. Per Capita Total Fat Intake (g/kg-day) (continued)

Age Group[a]	*N*	Mean	SE	Percentiles 10th	25th	50th	75th	95th	Max
16 to <21 years									
All	743	1.3	0.66	0.54	0.81	1.2	1.6	2.7	6.0
Female	372	1.1	0.56	0.48	0.75	1.1	1.4	2.1	4.4
Male	371	1.4	0.73	0.63	0.85	1.2	1.7	2.9	6.0
21 to <31 years									
All	1,412	1.2	0.61	0.53	0.72	1.1	1.5	2.3	7.3
Female	682	1.0	0.52	0.44	0.65	0.9	1.3	2.0	3.7
Male	730	1.3	0.66	0.63	0.85	1.2	1.6	2.4	7.3
31 to <41 years									
All	1,628	1.1	0.55	0.49	0.69	1.0	1.4	2.1	4.7
Female	781	1.0	0.52	0.45	0.61	0.9	1.3	1.9	4.7
Male	847	1.2	0.54	0.59	0.85	1.2	1.5	2.3	4.3
41 to <51 years									
All	1,644	1.0	0.49	0.48	0.66	0.9	1.3	1.9	4.4
Female	816	0.9	0.43	0.43	0.61	0.9	1.2	1.7	2.9
Male	828	1.1	0.53	0.53	0.72	1.0	1.4	2.0	4.4
51 to <61 years									
All	1,578	0.9	0.46	0.42	0.61	0.86	1.2	1.7	3.8
Female	768	0.8	0.38	0.39	0.56	0.79	1.1	1.5	2.4
Male	810	1.0	0.50	0.47	0.65	0.95	1.3	1.9	3.8
61 to <71 years									
All	1,507	0.9	0.43	0.40	0.55	0.79	1.1	1.7	3.2
Female	719	0.8	0.39	0.36	0.50	0.74	1.0	1.5	3.2
Male	788	1.0	0.45	0.46	0.61	0.87	1.2	1.8	3.1
71 to <81 years									
All	888	0.8	0.37	0.40	0.56	0.78	1.0	1.5	3.2
Female	421	0.8	0.37	0.39	0.53	0.72	1.0	1.4	3.2
Male	467	0.9	0.37	0.42	0.61	0.82	1.1	1.5	2.6
81+ years									
All	392	0.9	0.43	0.37	0.56	0.82	1.1	1.5	3.7
Female	190	0.8	0.39	0.35	0.54	0.82	1.1	1.5	2.1
Male	202	0.9	0.47	0.39	0.56	0.82	1.1	1.6	3.7

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.

N = Sample size.

SE = Standard error.

Source: U.S. EPA, 2007.

Table 11-32. Consumers-Only Total Fat Intake (g/day)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
All	1,301	31	16	7.0	24	32	41	61	107
Female	664	30	16	5.1	24	32	40	58	92
Male	637	32	16	9.0	25	33	41	62	107
Birth to <1 month									
All	59	26	13	6.7	17	27	32	52	64
Female	37	26	11	7.8	17	25	32	39	52
Male	22	25	17	-	-	-	-	-	64
1 to <3 months									
All	182	29	14	5.8	24	31	35	53	75
Female	79	28	12	4.3	21	30	35	46	50
Male	103	31	16	8.5	27	31	38	59	75
3 to <6 months									
All	384	30	16	2.5	24	32	40	54	107
Female	205	29	16	1.2	24	31	39	52	72
Male	179	31	17	4.6	25	33	39	53	107
6 to <12 months									
All	676	33	16	8.9	25	34	43	62	100
Female	343	32	17	6.2	24	34	43	62	92
Male	333	34	16	11	25	34	44	62	100
1 to <2 year									
All	1,002	46	19	24	33	43	55	79	159
Female	499	45	18	25	33	43	54	77	116
Male	503	46	20	23	32	44	56	80	159
2 to <3 years									
All	994	51	21	27	37	48	60	87	197
Female	494	49	20	24	35	46	59	83	127
Male	500	52	21	29	39	50	61	89	197
3 to <6 years									
All	4,112	59	22	34	44	56	70	99	218
Female	2,018	56	21	33	43	54	68	96	194
Male	2,094	61	23	35	45	59	72	103	218
6 to <11 years									
All	1,553	68	24	41	50	66	81	111	179
Female	742	64	22	38	48	61	77	101	156
Male	811	72	25	43	55	70	86	115	179
11 to <16 years									
All	975	80	38	42	56	74	97	145	342
Female	493	69	29	37	49	65	82	123	259
Male	482	91	42	50	64	84	111	163	342

Table 11-32. Consumers-Only Total Fat Intake (g/day) (continued)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
All	743	85	47	37	54	76	108	168	463
Female	372	79	39	35	49	75	96	154	317
Male	371	92	53	41	57	77	114	186	463
21 to <31 years									
All	1,412	84	45	36	53	76	104	164	445
Female	682	65	31	30	43	59	81	126	201
Male	730	103	48	50	68	93	125	181	445
31 to <41 years									
All	1,628	83	43	36	52	74	106	162	376
Female	781	64	31	29	42	58	79	121	228
Male	847	101	45	49	69	96	127	190	376
41 to <51 years									
All	1,644	78	39	36	50	70	99	153	267
Female	816	63	29	31	43	59	78	114	208
Male	828	93	42	46	63	87	119	166	267
51 to <61 years									
All	1,578	73	37	31	46	66	90	137	306
Female	768	58	26	27	39	56	73	104	165
Male	810	88	40	39	57	82	110	156	306
61 to <71 years									
All	1,507	66	33	29	42	60	80	123	235
Female	719	53	24	26	36	49	68	96	184
Male	788	78	35	37	53	73	98	138	235
71 to <81 years									
All	888	60	27	28	41	55	72	104	201
Female	421	51	22	27	37	49	62	86	158
Male	467	68	29	34	48	67	86	114	201
81+ years									
All	392	57	29	24	36	54	69	102	227
Female	190	49	23	22	32	48	64	84	132
Male	202	64	32	31	43	61	82	106	227

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.
\- = Percentiles were not calculated for sample sizes less than 30.
N = Sample size.
SE = Standard error.

Source: U.S. EPA, 2007.

Table 11-33. Consumers-Only Total Fat Intake (g/kg-day)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
All	1,301	4.4	2.6	0.94	2.9	4.3	5.8	9.2	20
Female	664	4.5	2.6	0.67	3.1	4.5	6.0	8.9	18
Male	637	4.3	2.6	1.2	2.8	4.1	5.6	9.3	20
Birth to <1 month									
All	59	7.8	4.1	1.4	5.4	8.0	9.7	16	20
Female	37	8.0	3.5	2.0	5.3	7.7	9.1	13	16
Male	22	7.4	4.9	-	-	-	-	-	20
1 to <3 months									
All	182	6.0	3.1	1.0	4.1	6.0	7.8	12	18
Female	79	5.9	2.9	0.80	4.3	6.0	7.7	12	14
Male	103	6.1	3.3	1.8	4.1	6.0	7.8	12	18
3 to <6 months									
All	384	4.4	2.5	0.35	3.1	4.5	5.8	8.3	18
Female	205	4.5	2.6	0.14	3.1	4.7	6.1	8.2	18
Male	179	4.3	2.4	0.57	3.1	4.2	5.6	8.8	16
6 to <12 months									
All	676	3.7	1.8	1.0	2.7	3.8	4.8	7.0	11
Female	343	3.7	1.9	0.75	2.8	3.8	5.0	7.0	9.8
Male	333	3.6	1.7	1.3	2.6	3.7	4.6	6.8	11
1 to <2 years									
All	1,002	4.0	1.7	2.1	2.8	3.7	4.7	7.1	12
Female	499	4.1	1.6	2.2	3.0	3.7	5.0	6.9	9.7
Male	503	3.9	1.7	1.9	2.6	3.6	4.5	7.2	12
2 to <3 years									
All	994	3.6	1.5	1.9	2.6	3.4	4.4	6.4	12
Female	494	3.7	1.6	1.8	2.4	3.4	4.4	6.6	10
Male	500	3.6	1.5	2.0	2.6	3.4	4.3	6.1	12
3 to <6 years									
All	4,112	3.4	1.3	1.9	2.4	3.2	4.0	5.8	11
Female	2,018	3.4	1.3	1.8	2.4	3.1	4.0	5.8	11
Male	2,094	3.5	1.4	1.9	2.4	3.2	4.1	5.8	11
6 to <11 years									
All	1,553	2.6	1.1	1.3	1.7	2.3	3.0	4.2	9.9
Female	742	2.4	1.0	1.3	1.6	2.2	2.8	4.0	7.7
Male	811	2.7	1.1	1.4	1.8	2.4	3.1	4.4	9.9
11 to <16 years									
All	975	1.6	0.80	0.77	1.1	1.4	2.0	3.0	5.7
Female	493	1.4	0.69	0.67	0.91	1.3	1.7	2.6	5.0
Male	482	1.8	0.86	0.88	1.2	1.6	2.1	3.3	5.7

Table 11-33 Consumers-Only Total Fat Intake (g/kg-day) (continued)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
16 to <21 years									
All	743	1.3	0.66	0.54	0.81	1.2	1.6	2.7	6.0
Female	372	1.1	0.56	0.48	0.75	1.1	1.4	2.1	4.4
Male	371	1.4	0.73	0.63	0.85	1.2	1.7	2.9	6.0
21 to <31 years									
All	1,412	1.2	0.61	0.53	0.72	1.1	1.5	2.3	7.3
Female	682	1.0	0.52	0.44	0.65	0.93	1.3	2.0	3.7
Male	730	1.3	0.66	0.63	0.85	1.2	1.6	2.4	7.3
31 to <41 years									
All	1,628	1.1	0.55	0.49	0.69	1.0	1.4	2.1	4.7
Female	781	0.98	0.52	0.45	0.61	0.91	1.3	1.9	4.7
Male	847	1.2	0.54	0.59	0.85	1.2	1.5	2.3	4.3
41 to <51 years									
All	1,644	1.0	0.49	0.48	0.66	0.94	1.3	1.9	4.4
Female	816	0.92	0.43	0.43	0.61	0.86	1.2	1.7	2.9
Male	828	1.1	0.53	0.53	0.72	1.0	1.4	2.0	4.4
51 to <61 years									
All	1,578	0.94	0.46	0.42	0.61	0.86	1.2	1.7	3.8
Female	768	0.83	0.38	0.39	0.56	0.79	1.1	1.5	2.4
Male	810	1.0	0.50	0.47	0.65	0.95	1.3	1.9	3.8
61 to <71 years									
All	1,507	0.88	0.43	0.40	0.55	0.79	1.1	1.7	3.2
Female	719	0.79	0.39	0.36	0.50	0.74	0.99	1.5	3.2
Male	788	0.95	0.45	0.46	0.61	0.87	1.2	1.8	3.1
71 to <81 years									
All	888	0.82	0.37	0.40	0.56	0.78	1.0	1.5	3.2
Female	421	0.77	0.37	0.39	0.53	0.72	0.95	1.4	3.2
Male	467	0.87	0.37	0.42	0.61	0.82	1.1	1.5	2.6
81+ years									
All	392	0.86	0.43	0.37	0.56	0.82	1.1	1.5	3.7
Female	190	0.83	0.39	0.35	0.54	0.82	1.1	1.5	2.1
Male	202	0.89	0.47	0.39	0.56	0.82	1.1	1.6	3.7

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.

\- = Percentiles were not calculated for sample sizes less than 30.

N = Sample size.

SE = Standard error.

Source: U.S. EPA, 2007.

Table 11-34. Consumers-Only Total Fat Intake—Top 10% of Animal Fat Consumers (g/day)									
Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
All	140	45	16	28	35	45	54	77	100
Female	70	45	15	26	35	45	54	69	92
Male	70	45	17	28	34	44	53	79	100
1 to <2 years									
All	109	75	20	52	61	74	85	108	159
Female	54	68	16	52	57	70	78	89	114
Male	55	81	22	54	67	78	90	125	159
2 to <3 years									
All	103	79	20	55	64	74	85	116	133
Female	58	77	16	55	65	74	79	109	116
Male	45	81	24	52	61	73	90	121	133
3 to <6 years									
All	461	88	25	62	72	84	102	135	218
Female	217	84	24	59	68	80	95	130	194
Male	244	92	25	66	76	90	103	136	218
6 to <11 years									
All	198	94	25	66	77	88	105	140	178
Female	71	88	21	58	70	86	100	123	156
Male	127	97	27	69	78	91	112	168	178
11 to <16 years									
All	96	133	53	85	95	121	154	223	342
16 to <21 years									
All	68	167	64	98	122	154	189	278	463
11 to <21 years									
All	165	146	60	90	105	139	168	254	463
Female	53	117	30	81	92	111	140	162	195
Male	112	160	65	94	117	151	191	276	463
21 to <31 years									
All	150	151	55	97	113	139	173	236	445
Female	44	115	31	80	97	108	131	160	201
Male	106	166	56	107	128	161	177	254	445
31 to <41 years									
All	148	147	51	93	110	135	172	352	376
Female	48	120	33	79	93	106	132	160	228
Male	100	160	53	110	125	149	201	352	376
41 to <51 years									
All	166	137	42	88	110	136	156	208	267
Female	49	110	30	72	86	103	130	150	208
Male	117	148	41	106	119	142	166	218	267

Table 11-34. Consumers-Only Total Fat Intake—Top 10% of Animal Fat Consumers (g/day) (continued)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
51 to <61 years									
All	183	127	41	80	98	118	144	206	306
Female	39	96	27	63	74	86	106	126	165
Male	144	135	41	96	112	122	151	214	306
61 to <71 years									
All	168	114	35	74	88	108	133	183	235
Female	47	91	24	68	74	87	103	120	184
Male	121	123	35	87	102	117	140	197	235
71 to <81 years									
All	104	98	28	65	76	92	109	144	201
81+ years									
All	40	97	37	60	67	86	104	137	227
71+ years									
All	144	98	30	62	72	91	107	144	227
Female	50	83	25	54	63	72	95	123	147
Male	94	105	30	76	88	97	115	165	227

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.

N = Sample size.

SE = Standard error.

Source: U.S. EPA, 2007.

Table 11-35. Consumers-Only Total Fat Intake—Top 10% of Animal Fat Consumers (g/kg-day)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
Birth to <1 year									
All	140	4.7	1.7	2.8	3.7	4.6	6.0	7.7	11
Female	70	4.8	1.6	2.7	3.7	4.7	6.0	7.7	9.5
Male	70	4.6	1.7	2.8	3.6	4.4	5.8	7.5	11
1 to <2 years									
All	109	6.9	1.5	5.1	5.7	6.8	7.7	9.5	12
Female	54	6.6	1.2	5.1	5.7	6.7	7.4	9.3	9.7
Male	55	7.1	1.6	5.1	5.8	6.9	8.0	9.4	12
2 to <3 years									
All	103	6.1	1.3	4.6	5.2	5.8	6.7	8.3	9.5
Female	58	6.2	1.2	4.6	5.2	5.9	6.8	7.9	9.5
Male	45	6.1	1.3	4.5	5.2	5.6	6.6	8.4	9.5
3 to <6 years									
All	461	5.6	1.3	4.2	4.7	5.3	6.2	8.3	11
Female	217	5.5	1.3	4.2	4.5	5.3	6.0	7.8	11
Male	244	5.7	1.3	4.2	4.8	5.3	6.2	8.4	11
6 to <11 years									
All	198	4.2	1.1	3.0	3.4	3.8	4.6	6.0	9.9
Female	71	4.2	1.1	2.9	3.3	3.8	4.8	5.8	7.7
Male	127	4.2	1.1	3.0	3.4	3.8	4.5	6.3	9.9
11 to <16 years									
All	96	3.0	0.85	2.0	2.4	2.8	3.3	4.6	5.7
16 to <21 years									
All	68	2.5	0.74	1.7	2.0	2.4	2.9	3.7	6.0
11to <21 years									
All	165	2.8	0.84	1.9	2.1	2.7	3.1	4.4	6.0
Female	53	2.6	0.65	1.7	2.0	2.3	2.7	3.4	4.6
Male	112	2.9	0.90	1.9	2.3	2.8	3.1	4.5	6.0
21 to <31 years									
All	150	2.2	0.73	1.5	1.7	2.1	2.4	3.2	7.3
Female	44	2.0	0.54	1.5	1.8	1.9	2.3	3.1	3.7
Male	106	2.2	0.79	1.6	1.7	2.1	2.4	3.2	7.3
31 to <41 years									
All	148	2.1	0.59	1.5	1.7	1.9	2.4	3.9	4.7
Female	48	2.1	0.62	1.5	1.7	1.9	2.2	2.8	4.7
Male	100	2.1	0.58	1.5	1.6	2.0	2.6	3.9	4.3
41 to <51 years									
All	166	1.8	0.49	1.3	1.5	1.8	2.1	2.8	4.0
Female	49	1.8	0.45	1.3	1.4	1.8	2.1	2.6	2.9
Male	117	1.9	0.50	1.4	1.6	1.8	2.0	2.8	4.0

Table 11-35. Consumers-Only Total Fat Intake—Top 10% of Animal Fat Consumers (g/kg-day) (continued)

Age Group[a]	*N*	Mean	SE	Percentiles					
				10th	25th	50th	75th	95th	Max
51 to <61 years									
All	183	1.7	0.46	1.2	1.3	1.6	1.9	2.5	3.8
Female	39	1.5	0.34	1.1	1.3	1.4	1.7	2.0	2.4
Male	144	1.7	0.48	1.2	1.4	1.6	1.9	2.6	3.8
61 to <71 years									
All	168	1.6	0.42	1.2	1.3	1.5	1.8	2.5	3.2
Female	47	1.6	0.42	1.1	1.3	1.5	1.7	2.3	3.2
Male	121	1.6	0.43	1.2	1.3	1.5	1.8	2.5	3.1
71 to <81 years									
All	104	1.4	0.37	1.0	1.1	1.3	1.5	2.0	3.2
81+ years									
All	40	1.6	0.48	1.1	1.2	1.4	1.7	2.0	3.7
71+ years									
All	144	1.4	0.41	1.0	1.1	1.3	1.6	2.0	3.7
Female	50	1.4	0.41	0.96	1.1	1.4	1.6	1.8	3.2
Male	94	1.5	0.41	1.1	1.2	1.3	1.5	2.1	3.7

[a] Age groups are based on U.S. EPA (2005) *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*.

N = Sample size

SE = Standard error.

Source: U.S. EPA, 2007.

Table 11-36. Fat Intake Among Children Based on Data from the Bogalusa Heart Study, 1973−1982 (g/day)

Age	*N*	Mean	SD	Percentiles					Minimum	Maximum
				10th	25th	50th	75th	90th		
Total Fat Intake										
6 months	125	37.1	17.5	18.7	25.6	33.9	46.3	60.8	3.4	107.6
1 year	99	59.1	26.0	29.1	40.4	56.1	71.4	94.4	21.6	152.7
2 years	135	86.7	41.3	39.9	55.5	79.2	110.5	141.1	26.5	236.4
3 years	106	91.6	38.8	50.2	63.6	82.6	114.6	153.0	32.6	232.5
4 years	219	98.6	56.1	46.0	66.8	87.0	114.6	163.3	29.3	584.6
10 years	871	93.2	50.8	45.7	60.5	81.4	111.3	154.5	14.6	529.5
13 years	148	107.0	53.9	53.0	69.8	90.8	130.7	184.1	9.8	282.2
15 years	108	97.7	48.7	46.1	65.2	85.8	124.0	165.2	10.0	251.3
17 years	159	107.8	64.3	41.4	59.7	97.3	140.2	195.1	8.5	327.4
Total Animal Fat										
6 months	125	18.4	16.0	0.7	4.2	13.9	28.4	42.5	0.0	61.1
1year	99	36.5	20.0	15.2	23.1	33.0	45.9	65.3	0.0	127.1
2 years	135	49.5	28.3	20.1	28.9	42.1	66.0	81.4	10.0	153.4
3 years	106	50.1	29.4	21.3	29.1	42.9	64.4	88.9	14.1	182.6
4 years	219	50.8	31.7	21.4	28.1	42.6	66.4	92.6	5.9	242.2
10 years	871	54.1	39.6	20.3	30.6	45.0	64.6	97.5	0.0	412.3
13 years	148	56.2	39.8	19.8	28.5	44.8	72.8	109.4	4.7	209.6
15 years	108	53.8	35.1	15.9	28.3	44.7	67.9	105.8	0.6	182.1
17 years	159	64.4	48.5	15.2	30.7	51.6	86.6	128.8	2.6	230.3
Total Vegetable Fat Intake										
6 months	125	9.2	12.8	0.6	1.2	2.8	11.6	29.4	0.0	53.2
1 year	99	15.4	14.3	3.7	6.1	11.3	18.1	38.0	0.2	70.2
2 years	135	19.3	16.3	3.8	7.9	14.8	26.6	42.9	0.7	96.6
3 years	106	21.1	15.5	3.9	8.6	18.7	26.6	45.2	1.0	70.4
4 years	219	24.5	18.6	5.7	10.4	21.8	33.3	48.5	0.9	109.0
10 years	871	23.7	21.6	4.3	9.5	18.3	30.6	49.0	0.6	203.7
13 years	148	34.3	27.4	8.4	17.9	31.2	44.6	57.5	0.0	238.3
15 years	108	27.3	22.8	5.1	11.9	22.6	38.1	54.4	0.7	132.2
17 years	159	25.7	21.3	4.2	11.7	20.8	32.9	47.6	0.0	141.5
Total Fish Fat Intake										
6 months	125	0.05	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.9
1 year	99	0.05	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9
2 years	135	0.04	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9
3 years	106	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	4.5
4 years	219	2.3	31.1	0.0	0.0	0.0	0.0	0.0	0.0	459.2
10 years	871	0.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0	19.2
13 years	148	0.3	2.2	0.0	0.0	0.0	0.0	0.0	0.0	25.4
15 years	108	0.4	1.5	0.0	0.0	0.0	0.0	1.5	0.0	9.5
17 years	159	0.5	2.0	0.0	0.0	0.0	0.0	0.4	0.0	15.3

N = Sample size.
SD = Standard deviation.
Source: Frank et al., 1986.

Table 11-37. Fat Intake Among Children Based on Data from the Bogalusa Heart Study, 1973−1982 (g/kg-day)										
Age	*N*	Mean	SD	Percentiles					Minimum	Maximum
				10th	25th	50th	75th	90th		
Total Fat Intake										
6 months	125	4.9	2.3	2.4	3.3	4.7	6.2	8.0	0.4	13.2
1 year	99	6.1	2.8	3.0	4.1	5.7	7.5	9.5	2.3	16.4
2 years	132	7.0	3.3	3.4	4.5	6.2	8.6	11.9	2.1	18.7
3 years	106	6.4	2.7	3.6	4.6	5.5	8.2	9.9	2.2	16.7
4 years	218	6.1	3.7	2.9	4.0	5.2	7.0	10.0	2.0	38.2
10 years	861	2.7	1.5	1.2	1.7	2.4	3.3	4.5	0.3	13.9
13 years	147	2.3	1.3	1.0	1.5	2.0	2.8	3.8	0.2	10.2
15 years	105	1.7	0.8	0.8	1.2	1.5	2.1	3.1	0.2	4.7
17 years	149	1.8	1.0	0.7	0.9	1.6	2.2	3.1	0.2	6.2
Total Animal Fat										
6 months	125	2.4	2.1	0.08	0.6	2.0	3.7	5.5	0.0	9.0
1 year	99	3.8	2.1	1.7	2.4	3.4	4.9	6.5	0.0	13.6
2 years	132	4.0	2.3	1.7	2.3	3.4	5.2	6.7	0.7	13.4
3 years	106	3.5	2.0	1.6	2.1	3.1	4.2	6.1	0.9	13.1
4 years	218	3.1	2.1	1.3	1.7	2.6	4.0	5.4	0.4	15.4
10 years	861	16	1.2	0.6	0.8	1.3	1.9	2.8	0.00	10.8
13 years	147	1.2	0.9	0.4	0.6	0.9	1.6	2.3	0.08	5.2
15 years	105	1.0	0.6	0.3	0.5	0.8	1.3	1.9	0.01	3.1
17 years	149	1.0	0.8	0.3	0.5	0.8	1.4	2.0	0.05	4.2
Total Vegetable Fat Intake										
6 months	125	1.2	1.8	0.08	0.2	0.4	1.6	4.1	0.0	8.2
1year	99	1.6	1.6	0.4	0.6	1.2	1.9	3.8	0.02	7.6
2 years	132	1.6	1.4	0.3	0.7	1.1	2.0	3.5	0.06	8.5
3 years	106	1.5	1.1	0.3	0.6	1.4	2.0	3.0	0.08	5.1
4 years	218	1.5	1.2	0.4	0.6	1.2	2.1	2.8	0.06	7.3
10 years	861	0.7	0.6	0.1	0.3	0.5	0.9	1.4	0.02	4.2
13 years	147	0.8	0.8	0.2	0.4	0.6	0.9	1.3	0.0	8.6
15 years	105	0.5	0.4	0.09	0.2	0.4	0.7	0.9	0.01	2.2
17 years	149	0.4	0.4	0.07	0.2	0.4	0.6	0.9	0.0	2.1
Total Fish Fat Intake										
6 months	125	0.01	0.02	0.0	0.0	0.0	0.0	0.02	0.0	0.1
1 year	99	0.01	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2 years	132	0.003	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3 years	106	0.01	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.3
4 years	218	0.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
10 years	861	0.01	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.6
13 years	147	0.01	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.4
15 years	105	0.01	0.03	0.0	0.0	0.0	0.0	0.04	0.0	0.2
17 years	149	0.01	0.03	0.0	0.0	0.0	0.0	0.008	0.0	0.2

N = Sample size.
SD = Standard deviation.
Source: Frank et al., 1986.

Table 11-38. Mean Percent Moisture and Total Fat Content of Selected Meat and Dairy Products[a]

Product	Moisture Content (%)	Total Fat Content (%)	Comment
	Meat		
Beef (composite of trimmed retail cuts; all grades)	70.62	6.16	Raw; lean only
	59.25	9.91	Cooked; lean only
	60.44	19.24	Raw; lean and fat, 1/4 in fat trim
	51.43	21.54	Cooked; lean and fat, 1/4 in fat trim
Pork (composite of trimmed retail cuts)	72.34	5.88	Raw; lean only
	60.31	9.66	Cooked; lean only
	65.11	14.95	Raw; lean and fat
	54.55	17.18	Cooked; lean and fat
Cured ham	63.46	12.90	Center slice, unheated; lean and fat
	55.93	8.32	Raw, center slice, country style; lean only
Cured bacon	40.20	45.04	Raw
	12.52	43.27	Cooked, baked
	12.32	41.78	Cooked, broiled
	12.12	40.30	Cooked, pan-fried
	16.49	37.27	Cooked, microwaved
Lamb (composite of trimmed retail cuts)	73.42	5.25	Raw; lean only
	61.96	9.52	Cooked; lean only
	60.70	21.59	Raw; lean and fat, 1/4 in fat trim
	53.72	20.94	Cooked; lean and fat, 1/4 in fat trim
Veal (composite of trimmed retail cuts)	75.91	2.87	Raw; lean only
	60.16	6.58	Cooked; lean only
	72.84	6.77	Raw; lean and fat, 1/4 in fat trim
	57.08	11.39	Cooked; lean and fat, 1/4 in fat trim
Rabbit (domesticated)	72.82	5.55	Raw
	60.61	8.05	Cooked, roasted
	58.82	8.41	Cooked, stewed
Chicken (broilers or fryers)	75.46	3.08	Raw; meat only
	66.81	6.71	Cooked, stewed; meat only
	63.79	7.41	Cooked, roasted; meat only
	57.53	9.12	Cooked, fried; meat only
	65.99	15.06	Raw; meat and skin
	63.93	12.56	Cooked, stewed; meat and skin
	59.45	13.60	Cooked, roasted; meat and skin
	52.41	14.92	Cooked, fried, flour; meat and skin
Duck (domesticated)	73.77	5.95	Raw; meat only
	64.22	11.20	Cooked, roasted; meat only
	48.50	39.34	Raw; meat and skin
	51.84	28.35	Cooked, roasted; meat and skin
Turkey (all classes)	74.16	2.86	Raw; meat only
	64.88	4.97	Cooked, roasted; meat only
	70.40	8.02	Raw; meat and skin
	61.70	9.73	Cooked, roasted; meat and skin
	71.97	8.26	Raw; ground
	59.42	13.15	Cooked; ground

Table 11-38. Mean Percent Moisture and Total Fat Content of Selected Meat and Dairy Products[a] (continued)

Product		Moisture Content (%)	Total Fat Content (%)	Comment
		Dairy		
Milk				
	Whole	88.32	3.25	3.25% milkfat
	Human	87.50	4.38	Whole, mature, fluid
	Lowfat (1%)	89.81	0.97	Fluid, with added non-fat milk solids and vitamin A
	Reduced fat (2%)	88.86	1.92	Fluid, with added non-fat milk solids and vitamin A
	Skim or fat free	90.38	0.25	Fluid, with added non-fat milk solids and vitamin A
Cream				
	Half and half	80.57	11.50	Fluid
	Light (coffee cream or table cream)	73.75	19.31	Fluid
	Heavy-whipping	57.71	37.00	Fluid
	Sour	70.95	20.96	Cultured
	Sour, reduced fat	80.14	12.00	Cultured
Butter		15.87	81.11	Salted
Cheese				
	American	39.16	31.25	Pasteurized
	Cheddar	36.75	33.14	
	Swiss	37.12	27.80	
	Cream	53.75	34.87	
	Parmesan	29.16; 20.84	25.83; 28.61	Hard; grated
	Cottage, lowfat	82.48; 79.31	1.02; 1.93	1% fat; 2% fat
	Colby	38.20	32.11	
	Blue	42.41	28.74	
	Provolone	40.95	26.62	
	Mozzarella	50.01; 53.78	22.35; 15.92	Whole milk; Skim milk
Yogurt		85.07; 87.90	1.55; 3.25	Plain, lowfat; Plain, with fat
Egg		75.84	9.94	Chicken, whole raw, fresh

[a] Based on the water and lipid content in 100 grams, edible portion. Total Fat Content = saturated, monosaturated, and polyunsaturated. For additional information, consult the USDA nutrient database.

Source: USDA, 2007.

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12. INTAKE OF GRAIN PRODUCTS

12.1. INTRODUCTION

The American food supply is generally considered to be one of the safest in the world. Nevertheless, grain products may become contaminated with toxic chemicals by several different pathways. Ambient air pollutants may be deposited on or absorbed by the plants, or dissolved in rainfall or irrigation waters that contact the plants. Pollutants may also be absorbed through plant roots from contaminated soil and ground water. The addition of pesticides, soil additives, and fertilizers may also result in contamination of grain products. To assess exposure through this pathway, information on ingestion rates of grain products is needed.

A variety of terms may be used to define intake of grain products (e.g., consumer-only intake, per capita intake, total grain intake, as-consumed intake, uncooked edible intake, dry-weight intake). As described in Chapter 9 (Intake of Fruits and Vegetables), consumer-only intake is defined as the quantity of grain products consumed by individuals during the survey period. These data are generated by averaging intake across only the individuals in the survey who consumed these food items. Per capita intake rates are generated by averaging consumer-only intakes over the entire population (including those that reported no intake). In general, per capita intake rates are appropriate for use in exposure assessments for which average dose estimates for individuals are of interest because they represent both individuals who ate the foods during the survey period and those who may eat the food items at some time but did not consume them during the survey period. Per capita intake, therefore, represents an average across the entire population of interest, but does so at the expense of underestimating consumption for the subset of the population that consumed the food in question. Total grain intake refers to the sum of all grain products consumed in a day.

Intake rates may be expressed on the basis of the as-consumed weight (e.g., cooked or prepared) or on the uncooked or unprepared weight. As-consumed intake rates are based on the weight of the food in the form that it is consumed and should be used in assessments where the basis for the contaminant concentrations in foods is also indexed to the as-consumed weight. Some of the food ingestion values provided in this chapter are expressed as as-consumed intake rates because this is the fashion in which data were reported by survey respondents. Others are provided as uncooked weights based on analyses of survey data that account for weight changes that occur during cooking. This is of importance because concentration data to be used in the dose equation are often measured in uncooked food samples. It should be recognized that cooking can either increase or decrease food weight. Similarly, cooking can increase the mass of contaminant in food (due to formation reactions, or absorption from cooking oils or water) or decrease the mass of contaminant in food (due to vaporization, fat loss, or leaching). The combined effects of changes in weight and changes in contaminant mass can result in either an increase or decrease in contaminant concentration in cooked food. Therefore, if the as-consumed ingestion rate and the uncooked concentration are used in the dose equation, dose may be under-estimated or over-estimated. It is important for the assessor to be aware of these issues and choose intake rate data that best match the concentration data that are being used. For more information on cooking losses and conversions necessary to account for such losses, refer to Chapter 13 of this handbook.

Sometimes contaminant concentrations in food are reported on a dry-weight basis. When these data are used in an exposure assessment, it is recommended that dry-weight intake rates also be used. Dry-weight food concentrations and intake rates are based on the weight of the food consumed after the moisture content has been removed. For information on converting the intake rates presented in this chapter to dry-weight intake rates, refer to Section 12.4.

The purpose of this chapter is to provide intake data for grain products for the general population. The recommendations for ingestion rates of grain products are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on the key study identified by U.S. Environmental Protection Agency (EPA) for this factor. Following the recommendations, the key study on ingestion of grain products is summarized. Relevant data on ingestion of grain products are also provided. These data are presented to provide the reader with added perspective on the current state-of-knowledge pertaining to ingestion of grain products among children.

12.2. RECOMMENDATIONS

Table 12-1 presents a summary of the recommended values for per capita and consumer-only intake of grain products. Table 12-2 provides confidence ratings for the grain intake recommendations for the general population.

The U.S. EPA analysis of data from the 2003−2006 National Health and Nutrition Examination Survey (NHANES) was used in selecting recommended intake rates. The U.S. EPA analysis was conducted using childhood age groups that differed slightly from U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, for the purposes of the recommendations presented here, data were placed in the standardized age categories closest to those used in the analysis.

The NHANES data on which the recommendations are based are short-term survey data and may not necessarily reflect the long-term distribution of average daily intake rates. However, because broad categories of food (i.e., total grains), are eaten on a daily basis throughout the year with minimal seasonality, the short-term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here will tend to overestimate the corresponding percentiles of the true long-term distribution. In general, the recommended values based on U.S. EPA's analysis of NHANES data represent the uncooked weight of the edible portion of grain products.

Table 12-1. Recommended Values for Intake of Grains, Edible Portion, Uncooked[a]

Age Group (years)	Per Capita		Consumers Only		Multiple Percentiles	Source
	Mean	95th Percentile	Mean	95th Percentile		
	g/kg-day	g/kg-day	g/kg-day	g/kg-day		
Total Grains						
Birth to 1	3.1	9.5[b]	4.1	10.3[b]	See Tables 12-3 and 12-4	U.S. EPA Analysis of NHANES 2003–2006
1 to <2	6.4	12.4[b]	6.4	12.4[b]		
2 to <3	6.4	12.4[b]	6.4	12.4[b]		
3 to <6	6.2	11.1	6.2	11.1		
6 to <11	4.4	8.2	4.4	8.2		
11 to <16	2.4	5.0	2.4	5.0		
16 to <21	2.4	5.0	2.4	5.0		
20 to <50	2.2	4.6	2.2	4.6		
≥50	1.7	3.5	1.7	3.5		
Individual Grain Products—See Tables 12-5 and 12-6						

[a] Analysis was conducted using slightly different childhood age groups than those recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Data were placed in the standardized age categories closest to those used in the analysis.

[b] Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Table 12-2. Confidence in Recommendations for Intake of Grain Products		
General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodology and data analysis were adequate. The survey sampled more than 16,000 individuals. An analysis of primary data was conducted.	
Minimal (or defined) Bias	No physical measurements were taken. The method relied on recent recall of grain products eaten.	
Applicability and Utility		High
Exposure Factor of Interest	The key study was directly relevant to grain intake.	
Representativeness	The data were demographically representative of the U.S. population (based on stratified random sample).	
Currency	Data were collected between 2003 and 2006.	
Data Collection Period	Data were collected for two non-consecutive days.	
Clarity and Completeness		High
Accessibility	The NHANES data are publicly available.	
Reproducibility	The methodology used was clearly described; enough information was included to reproduce the results.	
Quality Assurance	NHANES follows strict QA/QC procedures. The U.S. EPA analysis has only been reviewed internally, but the methodology has been used in an analysis of previous data.	
Variability and Uncertainty		
Variability in Population	Full distributions were provided for total grains. Means were provided for individual grain products.	Medium to high for averages, low for long-term upper percentiles; low for individual foods
Minimal Uncertainty	Data collection was based on recall for a two-day period; the accuracy of using these data to estimate long-term intake (especially at the upper percentiles) is uncertain. However, use of short-term data to estimate chronic ingestion can be assumed for broad categories of foods such as total grains. Uncertainty is greater for individual grain products.	
Evaluation and Review		Medium
Peer Review	The NCHS NHANES survey received a high level of peer review. The U.S. EPA analysis of these data has not been peer reviewed outside the Agency, but the methodology has been used in an analysis of previous data.	
Number and Agreement of Studies	There was one key study.	
Overall Rating		**Medium to High** confidence in the averages; **Low** confidence in the long-term upper percentiles

12.3. INTAKE STUDIES

12.3.1. Key Grain Intake Study

12.3.1.1. *U.S. EPA Analysis of Consumption Data from 2003−2006 National Health and Nutrition Examination Survey (NHANES)*

The key source of recent information on consumption rates of grain products is the U.S. Centers for Disease Control and Prevention's National Center for Health Statistics' (NCHS) NHANES. Data from NHANES 2003−2006 have been used by the U.S. EPA, Office of Pesticide Programs (OPP) to generate per capita and consumer-only intake rates for both individual grain products and total grain products.

NHANES is designed to assess the health and nutritional status of adults and children in the United States. In 1999, the survey became a continuous program that interviews a nationally representative sample of approximately 7,000 persons each year and examines a nationally representative sample of about 5,000 persons each year, located in counties across the country, 15 of which are visited each year. Data are released on a 2-year basis; thus, for example, the 2003 data are combined with the 2004 data to produce NHANES 2003−2004.

The dietary interview component of NHANES is called *What We Eat in America* and is conducted by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS). DHHS' NCHS is responsible for the sample design and data collection, and USDA's Food Surveys Research Group is responsible for the dietary data collection methodology, maintenance of the databases used to code and process the data, and data review and processing. Beginning in 2003, 2 non-consecutive days of 24-hour intake data were collected. The first day was collected in-person, and the second day was collected by telephone, 3 to 10 days later. These data were collected using USDA's dietary data collection instrument, the Automated Multiple Pass Method. This method provides an efficient and accurate means of collecting intakes for large-scale national surveys. It is fully computerized and uses a five-step interview. Details can be found at USDA's Agriculture Research Service (http://www.ars.usda.gov/ba/bhnrc/fsrg).

For NHANES 2003−2004, there were 12,761 persons selected; of these, 9,643 were considered respondents to the mobile examination center (MEC) examination and data collection. However, only 9,034 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,354 provided complete dietary intakes for Day 2. For NHANES 2005−2006, there were 12,862 persons selected; of these, 9,950 were considered respondents to the MEC examination and data collection. However, only 9,349 of the MEC respondents provided complete dietary intakes for Day 1. Furthermore, of those providing the Day 1 data, only 8,429 provided complete dietary intakes for Day 2.

The 2003−2006 NHANES surveys are stratified, multistage probability samples of the civilian non-institutionalized U.S. population. The sampling frame was organized using 2000 U.S. population census estimates. NHANES oversamples low income persons, adolescents 12 to 19 years, persons 60 years and older, African Americans, and Mexican Americans. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all 4 years of the surveys can be combined. Additional information on NHANES can be obtained at http://www.cdc.gov/nchs/nhanes.htm.

In 2010, U.S. EPA, OPP used NHANES 2003−2006 data to update the Food Commodity Intake Database (FCID) that was developed in earlier analyses of data from the USDA's Continuing Survey of Food Intake by Individuals (CSFII) (USDA, 2000; U.S. EPA, 2000) (see Section 12.3.2.4), NHANES data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. "Agricultural commodity" is a term used by U.S. EPA to mean plant (or animal) parts consumed by humans as food; when such items are raw or unprocessed, they are referred to as "raw agricultural commodities." For example, an apple pie may contain the commodities apples, flour, fat, sugar, and spices. FCID contains approximately 558 unique commodity names and 8-digit codes. The FCID commodity names and codes were selected and defined by U.S. EPA and were based on the U.S. EPA Food Commodity Vocabulary (http://www.epa.gov/pesticides/foodfeed/).

Intake rates were generated for a variety of food items/groups based on the agricultural commodities included in the FCID. These intake rates represent intake of all forms of the product (e.g., both home produced and commercially produced) for individuals who provided data for two days of the survey. Note that if the person reported consuming food for only one day, their two-day average would be half the amount reported for the one day of consumption. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the 4-year, 2-day sample weights provided in NHANES 2003−2006 to adjust the data for the sample population to reflect the national population.

Summary statistics were generated on a consumer-only and on a per capita basis. Summary statistics, including number of observations, percentage of the population consuming the grains being analyzed, mean intake rate, and standard error of the mean intake rate were calculated for total grains and selected individual grains. Percentiles of the intake rate distribution (i.e., 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and the maximum value) were also provided for total grains. Data were provided for the following age groups: birth to 1 year, 1 to 2 years, 3 to 5 years, 6 to 12 years, 13 to 19 years, 20 to 49 years, and ≥50 years. Data on females 13 to 49 years were also provided. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 12-3 presents per capita intake data for total grains in g/kg-day; Table 12-4 provides consumer-only intake data for total grains in g/kg-day. Table 12-5 provides per capita intake data for individual grains in g/kg-day, and Table 12-6 provides consumer-only intake data for individual grains in g/kg-day. In general, these data represent intake of the edible portions of i.e., uncooked foods.

The results are presented in units of g/kg-day. Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the average daily dose (ADD) equation. It should be noted that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate, because individual intake rates were indexed to the reported body weights of the survey respondents. Also, it should be noted that the distribution of average daily intake rates generated using short-term data (e.g., 2-day) does not necessarily reflect the long-term distribution of average daily intake rates. The distributions generated from short-term and long-term data will differ to the extent that each individual's intake varies from day to day; the distributions will be similar to the extent that individuals' intakes are constant from day to day. Day-to-day variation in intake among individuals will be high for grains that are not typically eaten every day. For these grains, the intake distribution generated from short-term data will not be a good reflection of the long-term distribution. On the other hand, for broad categories of foods (e.g., total grains) that are eaten on a daily basis throughout the year, the short-term distribution may be a reasonable approximation of the true long-term distribution, although it will show somewhat more variability. In this chapter, distributions are provided for broad categories of grains (e.g., total grains). Because of the increased variability of the short-term distribution, the short-term upper percentiles shown here may overestimate the corresponding percentiles of the long-term distribution. For individual foods, only the mean, standard error, and percent consuming are provided. An advantage of using the U.S. EPA's analysis of NHANES data is that it provides distributions of intake rates for various age groups of children and adults, normalized by body weight. The data set was designed to be representative of the U.S. population and includes 4 years of intake data combined. Another advantage is the currency of the data; the NHANES data are from 2003−2006. However, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Because these are 2-day averages, consumption estimates at the upper end of the intake distribution may be underestimated if these consumption values are used to assess acute (i.e., short-term) exposures. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest.

12.3.2. Relevant Grain Intake Studies

12.3.2.1. *USDA (1980, 1992, 1996a, b)—Food and Nutrient Intakes of Individuals in 1 Day in the United States*

USDA calculated mean per capita intake rates for total and individual grain products using Nationwide Food Consumption Survey (NFCS) data from 1977−1978 and 1987−1988 (USDA, 1980, 1992) and CSFII data from 1994 and 1995 (USDA, 1996a, b). The mean per capita intake rates for grain products are presented in Tables 12-7 and 12-8 for the two NFCS survey years, respectively. Table 12-9 presents similar data from the 1994 and 1995 CSFII for grain products.

The advantages of using these data are that they provide mean intake estimates for various grain products. The consumption estimates are based on short-term (i.e., 1-day) dietary data, which may not reflect long-term consumption. These data are based on older surveys and may not be entirely representative of current eating patterns.

12.3.2.2. *USDA (1999a)—Food Consumption, Prices, and Expenditures, 1970−1997*

The USDA's Economic Research Service calculates the amount of food available for human consumption in the United States annually. Supply and utilization balance sheets are generated. These are based on the flow of food items from production to end uses. Total available supply is estimated as the sum of production (i.e., some products are measured at the farm level or during processing), starting inventories, and imports (USDA, 1999a). The availability of food for human use commonly termed as "food disappearance" is determined by subtracting exported foods, products used in industries, farm inputs (seed and feed), and end-of-the-year inventories from the total available supply (USDA, 1999a). USDA (1999a) calculates the per capita food consumption by dividing the total food disappearance by the total U.S. population.

USDA (1999a) estimated per capita consumption data for grain products from 1970−1997. In this section, the 1997 values, which are the most recent final data, are presented. Table 12-10 presents per capita consumption in 1997 for grains.

An advantage of this study is that it provides per capita consumption rates for grains that are representative of long-term intake because disappearance data are generated annually. Daily per capita intake rates are generated by dividing annual consumption by 365 days/year. One of the limitations of this study is that disappearance data do not account for losses from the food supply from waste, spoilage, or foods fed to pets. Thus, intake rates based on these data may overestimate daily consumption because they are based on the total quantity of marketable commodity utilized. Therefore, these data may be useful for estimating bounding exposure estimates. It should also be noted that per capita estimates based on food disappearance are not a direct measure of actual consumption or quantity ingested, instead the data are used as indicators of changes in usage over time (USDA, 1999a). These data are based on older surveys and may not be entirely representative of current consumption patterns.

12.3.2.3. *USDA (1999b)—Food and Nutrient Intakes by Children 1994−1996, 1998, Table Set 17*

USDA (1999b) calculated national probability estimates of food and nutrient intake by children based on 4 years of the CSFII (1994−1996 and 1998) for children age 9 years and under, and on CSFII 1994−1996 only for individuals age 10 years and over. The CSFII was a series of surveys designed to measure the kinds and amounts of foods eaten by Americans. Intake data, based on 24-hour dietary recall, were collected through in-person interviews on 2 non-consecutive days. Section 12.3.2.4 provides additional information on these surveys.

USDA used sample weights to adjust for non-response, to match the sample to the U.S. population in terms of demographic characteristics, and to equalize intakes over the four quarters of the year and the 7 days of the week. A total of 503 breast-fed children were excluded from the estimates, but both consumers and non-consumers were included in the analysis.

USDA (1999b) provided data on the mean per capita quantities (grams) of various food products/groups consumed per individual for 1 day, and the percent of individuals consuming those foods in 1 day of the survey. Tables 12-11 and 12-12 present data on the mean quantities (grams) of grain products consumed per individual for 1 day, and the percentage of survey individuals consuming grain products that survey day. Data on mean intakes or mean percentages are based on respondents' Day-1 intakes.

The advantage of the USDA (1999b) study is that it uses the 1994−1996, 1998 CSFII data set, which includes 4 years of intake data, combined, and includes the supplemental data on children. These data are expected to be generally representative of the U.S. population, and they include data on a wide variety of grain products. The data set is one of a series of USDA data sets that are publicly available. One limitation of this data set is that it is based on 1-day, and short-term dietary data may not accurately reflect long-term eating patterns. Other limitations of this study are that it only provides mean values of food intake rates, consumption is not normalized by body weight, and presentation of results is not consistent with U.S. EPA's recommended age groups. These data are based on older surveys and may not be entirely representative of current eating patterns.

12.3.2.4. *U.S. EPA Analysis of Continuing Survey of Food Intake by Individuals (CSFII) 1994−1996, 1998*

U.S. EPA/OPP, in cooperation with USDA's Agricultural Research Service, used data from the 1994−1996, 1998 CSFII to develop the FCID (U.S. EPA, 2000; USDA, 2000), as described in Section 12.3.1.1. The CSFII 1994−1996 was conducted between January 1994 and January 1997 with a target population of non-institutionalized individuals in all 50 states and Washington, DC. In each of the three survey years, data were collected for a nationally representative sample of individuals of all ages. The CSFII 1998 was conducted between December 1997 and December 1998 and surveyed children 9 years of age and younger. It used the same sample design as the CSFII 1994−1996 and was intended to be merged with CSFII 1994−1996 to increase the sample size for children. The merged surveys are designated as CSFII 1994−1996, 1998 (USDA, 2000). Additional information on the CSFII can be obtained at http://www.ars.usda.gov/Services/docs.htm?docid=14531.

The CSFII 1994−1996, 1998 collected dietary intake data through in-person interviews on two non-consecutive days. The data were based on 24-hour recall. A total of 21,662 individuals provided data for the first day; of those individuals, 20,607 provided data for a second day. The 2-day response rate for the 1994−1996 CSFII was approximately 76%. The 2-day response rate for CSFII 1998 was 82%. The CSFII 1994−1996, 1998 surveys were based on a complex multistage area probability sample design. The sampling frame was organized using 1990 U.S. population census estimates, and the stratification plan took into account geographic location, degree of urbanization, and socioeconomic characteristics. Several sets of sampling weights are available for use with the intake data. By using appropriate weights, data for all 4 years of the surveys can be combined. USDA recommends that all four years be combined in order to provide an adequate sample size for children.

The grain items/groups selected for the U.S. EPA analysis included total grains, and individual grain products such as cereal and rice. U.S. EPA (2003) presents the food codes and definitions used to determine the various grain products used in the analysis. CSFII data on the foods people reported eating were converted to the quantities of agricultural commodities eaten. Intake rates for these food items/groups and summary statistics were generated on both a per capita and a consumer-only basis using the same general methodology as in the U.S. EPA analysis of 2003−2006 NHANES data, as described in Section 12.3.1.1. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).

Table 12-13 presents per capita intake data for total grains in g/kg-day; Table 12-14 provides consumer-only intake data for total grains in g/kg-day. Table 12-15 provides per capita intake data for individual grain products, and Table 12-16 provides consumer-only intake data for individual grain products. In general, these data represent intake of the edible portions of unprepared (i.e., uncooked) foods. Tables 12-17 through 12-24 present per capita intake data for individual grain products. The data come from CSFII 1994−1996 only. The results are presented in units of g/kg-day. These data represent as-consumed intake rates.

The results are presented in units of g/kg-day. Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the ADD equation. The cautions concerning converting these intake rates into units of g/day by multiplying by a single average body weight and the discussion of the use of short term data in the NHANES description in Section 12.3.1.1, apply to the CSFII estimates as well.

A strength of U.S. EPA's analysis is that it provides distributions of intake rates for various age groups of individuals, normalized by body weight. The analysis uses the 1994−1996, 1998 CSFII data set, which was designed to be representative of the U.S. population. Also, the data set includes 4 years of intake data combined and is based on a 2-day survey period. However, as discussed above, short-term dietary data may not accurately reflect long-term eating patterns and may under-represent infrequent consumers of a given food. This is particularly true for the tails (extremes) of the distribution of food intake. Also, the analysis was conducted using slightly different childhood age groups than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the childhood age groups used, the data should provide suitable intake estimates for the age groups of interest. While the CSFII data are older than the NHANES data, they provide relevant information on consumption by season, region of the United States, and urbanization, breakdowns that are not available in the publically released NHANES data.

12.3.2.5. *Smiciklas-Wright et al. (2002)—Foods Commonly Eaten in the United States: Quantities Consumed per Eating Occasion and in a Day, 1994−1996*

Using data gathered in the 1994−1996 USDA CSFII, Smiciklas-Wright et al. (2002) calculated distributions for the quantities of grain products consumed per eating occasion by members of the U.S. population (i.e., serving sizes). The estimates of serving size are based on data obtained from 14,262 respondents, ages two and above, who provided two days of dietary intake information. Only dietary intake data from users of the specified food were used in the analysis (i.e., consumer-only data). Table 12-25 presents, as-consumed, the quantity of grain products consumed per eating occasion and the percentage of individuals using these foods in a 2-day period for a selected variety of grain products. Table 12-26 presents the same data by sex and age.

These data are presented on an as-consumed basis (grams) and represent the quantity of grain products consumed per eating occasion. These estimates may be useful for assessing acute exposures to contaminants in specific foods, or other assessments where the amount consumed per eating occasion is necessary. Only the mean and standard deviation serving size data and percent of the population consuming the food during the 2-day survey period are presented in this handbook. Percentiles of serving sizes of the foods consumed by these age groups of the U.S. population can be found in Smiciklas-Wright et al. (2002).

The advantages of using these data are that they were derived from the USDA CSFII and are representative of the U.S. population. The analysis conducted by Smiciklas-Wright et al. (2002) accounted for individual foods consumed as ingredients of mixed foods. Mixed foods were disaggregated via recipe files so that the individual ingredients could be grouped together with similar foods that were reported separately. Thus, weights of foods consumed as ingredients were combined with weights of foods reported separately to provide a more thorough representation of consumption. However, it should be noted that since the recipes for the mixed foods consumed were not provided by the respondents, standard recipes were used. As a result, the estimates of quantity consumed for some food types are based on assumptions about the types and quantities of ingredients consumed as part of mixed foods. This study used data from the 1994 to 1996 CSFII; data from the 1998 children's supplement were not included.

12.3.2.6. *Vitolins et al. (2002)—Quality of Diets Consumed by Older Rural Adults*

Vitolins et al. (2002) conducted a survey to evaluate the dietary intake, by food groups, of older (>70 years) rural adults. The sample consisted of 130 community dwelling residents from two rural counties in North Carolina. Data on dietary intake over the preceding year were obtained in face-to-face interviews conducted in participants' homes, or in a few cases, a senior center. The food frequency questionnaire used in the survey was a modified version of the National Cancer Institute Health Habits and History Questionnaire; this modified version included an expanded food list containing a greater number of ethnic foods than the original food frequency form. Demographic and personal data collected included sex, ethnicity, age, education, denture use, marital status, chronic disease, and weight.

Food items reported in the survey were grouped into food groups similar to the USDA Food Guide Pyramid and the National Cancer Institute's 5 A Day for Better Health program. These groups are (1) fruits, and vegetables; (2) bread, cereal, rice, and pasta; (3) milk, yogurt, and cheese; (4) meat, fish, poultry, beans, and eggs; and (5) fats, oils, sweets, and snacks. Medians, ranges, frequencies, and percentages were used to summarize intake of each food group, broken down by demographic and health characteristics. In addition, multiple regression models were used to determine which demographic and health factors were jointly predictive of intake of each of the five food groups.

Thirty-four percent of the survey participants were African American, 36% were European American, and 30% were Native American. Sixty-two percent were female, 62% were not married at the time of the interview, and 65% had some high school education or were high school graduates. Almost all of the participants (95%) had one or more chronic diseases. Sixty percent of the respondents were between 70 and 79 years of age; the median age was 78 years old. Table 12-27 presents the median servings of bread, cereal, rice, and pasta broken down by demographic and health characteristic. Only sex was statistically predictive of bread, cereal, rice, and pasta intake ($p < 0.01$), with males consuming approximately an extra serving per day compared to women. Also, the multiple regression model indicated that sex was predictive of breads, cereal, rice, and pasta intake after controlling for other demographic variables.

One limitation of the study, as noted by the study authors, is that the study did not collect information on the length of time the participants had been practicing the dietary behaviors reported in the survey. The questionnaire asked participants to report the frequency of food consumption during the past year. The study authors noted that, currently, there are no dietary assessment tools that allow the collection of comprehensive dietary data over years of food consumption. Another limitation of the study is that the small sample size used makes associations by sex and ethnicity difficult.

12.3.2.7. *Fox et al. (2004)—Feeding Infants and Toddlers Study: What Foods Are Infants and Toddlers Eating*

Fox et al. (2004) used data from the Feeding Infants and Toddlers study (FITS) to assess food consumption patterns in infants and toddlers. The FITS was sponsored by Gerber Products Company and was conducted to obtain current information on food and nutrient intakes of children, ages 4 to 24 months old, in the 50 states and the District of Columbia. The FITS is described in detail in Devaney et al. (2004). FITS was based on a random sample of 3,022 infants and toddlers for which dietary intake data were collected by telephone from their parents or caregivers between March and July 2002. An initial recruitment and household interview was conducted, followed by an interview to obtain information on intake based on 24-hour recall. The interview also addressed growth, development, and feeding patterns. A second dietary recall interview was conducted for a subset of 703 randomly selected respondents. The study over-sampled children in the 4 to 6 and 9 to 11 months age groups; sample weights were adjusted for non-response, over sampling, and under coverage of some subgroups. The response rate for the FITS was 73% for the recruitment interview. Of the recruited households, there was a response rate of 94% for the dietary recall interviews (Devaney et al., 2004). Table 12-28 shows the characteristics of the FITS population.

Fox et al. (2004) analyzed the first set of 24-hour recall data collected from all study participants. For this analysis, children were grouped into six age categories: 4 to 6 months, 7 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Table 12-29 provides the percentage of infants and toddlers consuming different types of grains or grain products at least once a day. The percentages of children eating any type of grain or grain product ranged from 65.8% for 4 to 6 month-olds to 99.2% for 19- to 24-month-olds.

The advantages of this study is that it represents the U.S. population, and the sample size was large. One limitation of the analysis done by Fox et al. (2004) is that only frequency data were provided; no information on actual intake rates was included. In addition, Devaney et al. (2004) noted several limitations associated with the FITS data. For the FITS, a commercial list of infants and toddlers was used to obtain the sample used in the study. Since many of the households could not be located and did not have children in the target population, a lower response rate than would have occurred in a true national sample was obtained (Devaney et al., 2004). In addition, the sample was likely from a higher socioeconomic status when compared with all U.S. infants in this age group (4 to 24 months old), and the use of a telephone survey may have omitted lower-income households without telephones (Devaney et al., 2004).

12.3.2.8. *Ponza et al. (2004)—Nutrient Food Intakes and Food Choices of Infants and Toddlers Participating in WIC*

Ponza et al. (2004) conducted a study using selected data from the FITS to assess feeding patterns, food choices, and nutrient intake of infants and toddlers participating in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Ponza et al. (2004) evaluated FITS data for the following age groups: 4 to 6 months ($N = 862$), 7 to 11 months ($N = 1,159$), and 12 to 24 months ($N = 996$). Table 12-30 shows the total sample size described by WIC participants and non-participants.

The foods consumed were analyzed by tabulating the percentage of infants who consumed specific foods/food groups per day (Ponza et al., 2004). Weighted data were used in all of the analyses used in the study (Ponza et al., 2004). Table 12-30 presents the demographic data for WIC participants and non-participants. Table 12-31 provides information on the food choices for the infants and toddlers studied. In general, there was little difference in grain product choices among WIC participants and non-participants, except for the 7 to 11 months age category (see Table 12-31). Non-participants, ages 7 to 11 months, were more likely to eat non-infant cereals than WIC participants.

An advantage of this study is that it had a relatively large sample size and was representative of the U.S. general population of infants and children. A limitation of the study is that intake values for foods were not provided. Other limitations are those associated with the FITS data, as described previously in Section 12.3.2.7.

12.3.2.9. *Fox et al. (2006)—Average Portion of Foods Commonly Eaten by Infants and Toddlers in the United States*

Fox et al. (2006) estimated average portion sizes consumed per eating occasion by children 4 to 24 months of age who participated in the FITS. The FITS is a cross-sectional study designed to collect and analyze data on feeding practices, food consumption, and usual nutrient intake of U.S. infants and toddlers and is described in Section 12.3.2.7 of this chapter. It included a stratified random sample of 3,022 children between 4 and 24 months of age.

Using the 24-hour recall data, Fox et al. (2006) derived average portion sizes for six major food groups, including breads and grains. Average portion sizes for select individual foods within these major groups were also estimated. For this analysis, children were grouped into six age categories: 4 to 5 months, 6 to 8 months, 9 to 11 months, 12 to 14 months, 15 to 18 months, and 19 to 24 months. Tables 12-32 and 12-33 present the average portion sizes for grain products for infants and toddlers, respectively.

12.3.2.10. *Mennella et al. (2006)—Feeding Infants and Toddlers Study: The Types of Foods Fed to Hispanic Infants and Toddlers*

Menella et al. (2006) investigated the types of food and beverages consumed by Hispanic infants and toddlers in comparison to the non-Hispanic infants and toddlers in the United States. The FITS 2002 data for children between 4 and 24 months of age were used for the study. The data represent a random sample of 371 Hispanic and 2,367 non-Hispanic infants and toddlers (Menella et al., 2006). Menella et al. (2006) grouped the infants as follows: 4 to 5 months ($N = 84$ Hispanic; 538 non-Hispanic), 6 to 11 months ($N = 163$ Hispanic; 1,228 non-Hispanic), and 12 to 24 months ($N = 124$ Hispanic; 871 non-Hispanic) of age.

Table 12-34 provides the percentage of Hispanic and non-Hispanic infants and toddlers consuming grain products. In most instances, the percentages consuming the different types are similar. However, 6 to 11 month old Hispanic children were more likely to eat rice and pasta than non-Hispanic children in this age groups.

The advantage of the study is that it provides information on food preferences for Hispanic and non-Hispanic infants and toddlers. A limitation is that the study did not provide food intake data but provided frequency of use data instead. Other limitations are those noted previously in Section 12.3.2.7 for the FITS data.

12.4. CONVERSION BETWEEN WET- AND DRY-WEIGHT INTAKE RATES

The intake data presented in this chapter are reported in units of wet weight (i.e., as-consumed or uncooked weight of grain products consumed per day or per eating occasion). However, data on the concentration of contaminants in grain products may be reported in units of either wet or dry weight (e.g., mg contaminant per gram dry weight of grain products). It is essential that exposure assessors be aware of this difference, so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the contaminant concentration is measured in dry weight of grain products, then the dry-weight units should be used for their intake values).

If necessary, wet-weight (e.g., as-consumed) intake rates may be converted to dry-weight intake rates using the moisture content percentages presented in Table 12-35 and the following equation:

$$IR_{dw} = IR_{ww} \left[\frac{100 - W}{100} \right] \qquad \text{(Eqn. 12-1)}$$

where:

IR_{dw} = dry-weight intake rate,
IR_{ww} = wet-weight intake rate, and
W = percent water content.

Alternatively, dry-weight residue levels in grain products may be converted to wet-weight residue levels for use with wet-weight (e.g., as-consumed) intake rates as follows:

$$C_{ww} = C_{dw} \left[\frac{100 - W}{100} \right] \qquad \text{(Eqn. 12-2)}$$

where:

C_{ww} = wet concentration rate,
C_{dw} = dry-weight concentration, and
W = percent water content.

The moisture data presented in Table 12-35 are for selected grain products taken from USDA (2007).

12.5. REFERENCES FOR CHAPTER 12

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Table 12-3. Per Capita Intake of Total Grains Based 2003–2006 NHANES (g/kg-day, edible portion, uncooked weight)														
		%			Percentiles									
Population Group	*N*	Consuming	Mean	SE	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,783	100	2.6	0.04	0.2	0.6	0.8	1.3	2.0	3.2	5.1	6.7	9.9	34.8*
Age Group														
Birth to 1 year	865	76	3.1	0.20	0.0*	0.0*	0.0	0.1	2.3	5.0	7.5	9.5*	12.5*	34.9*
1 to 2 years	1,052	100	6.4	0.17	1.5*	2.3*	3.0	4.2	5.8	8.4	10.5	12.4*	15.9*	21.1*
3 to 5 years	978	100	6.2	0.13	2.0*	2.4	3.3	4.4	5.9	7.6	9.6	11.1	13.2*	15.6*
6 to 12 years	2,256	100	4.4	0.09	0.6*	1.4	1.8	2.8	4.1	5.5	7.4	8.2	11.1*	14.5*
13 to 19 years	3,450	100	2.4	0.05	0.4	0.7	1.0	1.5	2.1	3.2	4.2	5.0	7.5	14.3*
20 to 49 years	4,289	100	2.2	0.04	0.3	0.6	0.8	1.2	1.9	2.8	3.9	4.6	7.1	15.0*
Females 13 to 49 years	4,103	100	1.9	0.04	0.2	0.5	0.8	1.1	1.7	2.5	3.4	3.9	5.5	9.8*
50 years and older	3,893	100	1.7	0.03	0.3	0.5	0.7	1.0	1.5	2.1	2.9	3.5	5.2	9.4*
Race														
Mexican American	4,450	99	3.0	0.05	0.1	0.8	1.0	1.6	2.4	3.9	5.8	7.2	10.6	17.8*
Non-Hispanic Black	4,265	100	2.4	0.04	0.2	0.5	0.7	1.1	1.8	2.9	5.0	6.8	10.2	21.1*
Non-Hispanic White	6,757	100	2.5	0.05	0.3	0.6	0.8	1.3	1.9	3.1	4.9	6.5	9.6	34.8*
Other Hispanic	562	99	2.7	0.13	0.2*	0.7	1.0	1.5	2.1	3.3	5.3	7.0	9.8*	15.3*
Other Race—Including Multiple Races	749	100	3.0	0.11	0.3*	0.6	0.9	1.5	2.5	3.9	6.0	7.5	11.1*	17.5*

N = Sample size.
SE = Standard error.
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: Based on U.S. EPA analysis of 2003–2006 NHANES.

Table 12-4. Consumer-Only Intake of Total Grains Based 2003–2006 NHANES (g/kg-day, edible portion, uncooked weight)													
				Percentiles									
Population Group	*N*	Mean	SE	1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	16,556	2.6	0.04	0.3 5	0.6	0.8	1.3	2.0	3.2	5.1	6.7	9.9	34.9*
Age Group													
Birth to 1 year	644	4.1	0.18	0.1*	0.4*	0.8*	1.8	3.5	5.9	8.1*	10.3*	13.9*	34.9*
1 to 2 years	1,050	6.4	0.16	1.6*	2.4*	3.0	4.2	5.8	8.4	10.5	12.4*	15.9*	21.1*
3 to 5 years	977	6.2	0.13	2.0*	2.4	3.3	4.4	5.9	7.6	9.6	11.1	13.2*	15.6*
6 to 12 years	2,256	4.4	0.09	0.6*	1.4	1.8	2.8	4.1	5.5	7.4	8.2	11.1*	14.5*
13 to 19 years	3,450	2.4	0.05	0.4	0.7	1.0	1.5	2.1	3.2	4.2	5.0	7.5	14.3*
20 to 49 years	4,288	2.2	0.04	0.3	0.6	0.8	1.2	1.9	2.8	3.9	4.6	7.1	15.0*
Females 13 to 49 years	4,102	1.9	0.03	0.2	0.5	0.8	1.1	1.7	2.5	3.4	3.9	5.5	9.8*
50 years and older	3,891	1.7	0.03	0.3	0.5	0.7	1.0	1.5	2.1	2.9	3.5	5.2	9.4*
Race													
Mexican American	4,341	3.0	0.05	0.4	0.8	1.1	1.6	2.4	3.9	5.9	7.2	10.6	17.8*
Non-Hispanic Black	4,236	2.4	0.04	0.2	0.5	0.7	1.1	1.8	2.9	5.0	6.9	10.3	21.1*
Non-Hispanic White	6,694	2.5	0.05	0.3	0.6	0.8	1.3	2.0	3.1	4.9	6.5	9.6	34.9*
Other Hispanic	548	2.8	0.14	0.4*	0.7	1.0	1.5	2.1	3.4	5.4	7.1	9.8*	15.3*
Other Race—Including Multiple Races	737	3.1	0.11	0.3*	0.7	0.9	1.5	2.5	3.9	6.0	7.5	11.1*	17.5*

N = Sample size.
SE = Standard error.
Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: Based on U.S. EPA analysis of 2003–2006 NHANES.

Table 12-5. Per Capita Intake of Individual Grain Products Based 2003–2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Cereal % Consuming	Cereal Mean	Cereal SE	Rice % Consuming	Rice Mean	Rice SE
Whole Population	16,783	100	3.7	0.04	88	0.2	0.01
Age Group							
Birth to 1 year	865	81	5.1	0.30	69	1.1	0.08
1 to 2 years	1,052	100	8.7	0.18	87	0.6	0.06
3 to 5 years	978	100	8.6	0.17	91	0.5	0.06
6 to 12 years	2,256	100	6.3	0.10	89	0.3	0.03
13 to 19 years	3,450	100	3.9	0.08	85	0.2	0.01
20 to 49 years	4,289	100	3.2	0.04	89	0.3	0.01
Females 13 to 49 years	4,103	100	2.9	0.04	86	0.2	0.01
50 years and older	3,893	100	2.2	0.04	89	0.1	0.01
Race							
Mexican American	4,450	100	4.3	0.07	87	0.3	0.02
Non-Hispanic Black	4,265	100	3.6	0.06	86	0.3	0.02
Non-Hispanic White	6,757	100	3.6	0.05	88	0.2	0.01
Other Hispanic	562	99	3.9	0.20	92	0.6	0.05
Other Race—Including Multiple Races	749	100	4.1	0.12	90	0.8	0.08

N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA analysis of 2003–2006 NHANES.

Table 12-6. Consumer-Only Intake of Individual Grain Products Based 2003–2006 NHANES (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Mean	SE	*N*	Mean	SE
	Cereal			Rice		
Whole Population	16,613	3.7	0.04	14,447	0.3	0.01
Age Group						
Birth to 1 year	696	6.3	0.31	552	1.5	0.10
1 to 2 years	1,051	8.7	0.18	928	0.7	0.07
3 to 5 years	978	8.6	0.17	875	0.5	0.06
6 to 12 years	2,256	6.3	0.10	2,000	0.3	0.03
13 to 19 years	3,450	3.9	0.08	2,898	0.2	0.02
20 to 49 years	4,289	3.2	0.04	3,812	0.3	0.02
Females 13 to 49 years	4,103	2.9	0.04	3,511	0.2	0.02
50 years and older	3,893	2.2	0.04	3,382	0.2	0.01
Race						
Mexican American	4,372	4.3	0.07	3,757	0.3	0.02
Non-Hispanic Black	4,244	3.6	0.06	3,645	0.3	0.02
Non-Hispanic White	6,707	3.6	0.05	5,887	0.2	0.01
Other Hispanic	550	3.9	0.20	491	0.6	0.05
Other Race—Including Multiple Races	740	4.1	0.13	667	0.8	0.08

N = Sample size.
SE = Standard error.

Source: Based on U.S. EPA analysis of 2003–2006 NHANES.

Table 12-7. Mean Grain Intake per Individual in a Day by Sex and Age (g/day as-consumed)[a] for 1977−1978					
Group Age (years)	Total Grains	Breads, Rolls, Biscuits	Other Baked Goods	Cereals, Pasta	Mixtures, Mainly Grain[b]
Males and Females					
<1	42	4	5	30	3
1 to 2	158	27	24	44	63
3 to 5	181	46	37	54	45
6 to 8	206	53	56	60	38
Males					
9 to 11	238	67	56	51	64
12 to 14	288	76	80	57	74
15 to 18	303	91	77	53	82
19 to 22	253	84	53	64	52
23 to 34	256	82	60	40	74
35 to 50	234	82	58	44	50
51 to 64	229	78	57	48	46
65 to 74	235	71	60	69	35
≥75	196	70	50	58	19
Females					
9 to 11	214	58	59	44	53
12 to 14	235	57	61	45	72
15 to 18	196	57	43	41	55
19 to 22	161	44	36	33	48
23 to 34	163	49	38	32	44
35 to 50	161	49	37	32	43
51 to 64	155	52	40	36	27
65 to 74	175	57	42	47	29
≥75	178	54	44	58	22
Males and Females—All Ages	204	62	49	44	49

[a] Based on USDA Nationwide Food Consumption Survey 1977–1978 data for 1 day.
[b] Includes mixtures containing grain as the main ingredient.

Source: USDA, 1980.

Table 12-8. Mean Grain Intakes per Individual in a Day by Sex and Age (g/day as-consumed)[a] for 1987−1988

Group Age (years)	Total Grains	Yeast Breads and Rolls	Quick Breads, Pancakes, French Toast	Cakes, Cookies, Pastries, Pies	Crackers, Popcorn, Pretzels, Corn Chips	Cereals and Pastas	Mixtures, Mostly Grain[b]
Males and Females ≤5	167	30	8	22	4	52	51
Males							
6 to 11	268	51	16	37	8	74	83
12 to 19	304	65	28	45	10	72	82
≥20	272	65	20	37	8	58	83
Females							
6 to 11	231	43	19	30	6	66	68
12 to 19	239	45	13	29	7	52	91
≥20	208	45	14	28	6	53	62
All Individuals	237	52	16	32	7	57	72

[a] Based on USDA Nationwide Food Consumption Survey 1987–1988 data for 1 day.
[b] Includes mixtures containing grain as the main ingredient.

Source: USDA, 1992.

Table 12-9. Mean Grain Intakes per Individual in a Day by Sex and Age (g/day as-consumed)[a] for 1994−1995

Group Age (years)	Total Grains		Yeast Breads and Rolls		Quick Breads, Pancakes, French Toast		Cakes, Cookies, Pastries, Pies		Crackers, Popcorn, Pretzels, Corn Chips		Cereals and Pastas		Mixtures, Mostly Grain[b]	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Males and Females ≤5	213	210	26	28	11	11	22	23	8	7	58	57	89	84
Males														
6 to 11	285	341	51	45	15	21	42	46	12	18	66	97	101	115
12 to 19	417	364	53	54	30	21	54	43	17	22	82	84	180	138
≥20	357	365	64	61	22	24	43	46	13	15	86	91	128	128
Females														
6 to 11	260	286	43	46	16	21	37	51	11	14	57	54	94	100
12 to 19	317	296	40	37	16	14	39	35	17	16	63	52	142	143
≥20	254	257	44	45	16	15	33	34	9	10	59	69	92	83
All Individuals	300	303	50	49	18	19	38	39	12	13	70	76	112	107

[a] Based on USDA CSFII 1994 and 1995 data for 1 day.
[b] Includes mixtures containing grain as the main ingredient.

Source: USDA, 1996a, b.

Table 12-10. Per Capita Consumption of Flour and Cereal Products in 1997

Food Item	**Per Capita Consumption** (g/day)[a]
Total Wheat Flour[b]	186
Rye Flour	0.7
Rice[c]	24
Total Corn Products[d]	29
Oat Products[e]	8
Barley Products[f]	0.9
Total Flour and Cereal Products[g]	249

[a] Original data were presented in lbs/year; data were converted to g/day by multiplying by a factor of 454 g/lb and dividing by 365 day/year. Consumption of most items at the processing level. Excludes quantities used in alcoholic beverages and fuel.
[b] Includes white, whole wheat, and durum flour.
[c] Milled basis.
[d] Includes corn flour and meal, hominy and grits, and corn starch.
[e] Includes rolled oats, ready-to-eat oat cereals, oat flour, and oat bran.
[f] Includes barley flour, pearl barley, and malt and malt extract used in food processing.
[g] Excludes wheat not ground into flour.

Source: USDA, 1999a.

Table 12-11. Mean Quantities of Grain Products Consumed by Children Under 20 Years of Age, by Sex and Age, Per Capita (g/day, as-consumed)[a]

Age Group (years)	Sample Size	Total[b]	Yeast, Breads, and Rolls	Cereals and Pasta				Quick Breads, Pancakes, French Toast	Cakes, Cookies, Pastries, Pies	Crackers, Popcorn, Pretzels, Corn Chips	Mixtures, Mainly Grain[c]
				Total	Ready-to-eat Cereals	Rice	Pasta				
Males and Females											
<1	1,126	56	2	29	1	2	1[d]	1	3	1	20
1	1,016	192	16	57	11	9	9	9	16	7	87
2	1,102	219	26	62	16	15	12	12	22	9	87
1 to 2	2,118	206	21	59	13	12	11	11	19	8	87
3	1,831	242	30	64	19	13	12	16	23	11	98
4	1,859	264	36	67	22	15	11	17	30	13	102
5	884	284	41	76	24	17	11	15	33	13	107
3 to 5	4,574	264	36	69	22	15	11	16	29	12	102
≤5	7,818	219	27	61	16	13	10	12	22	9	87
Males											
6 to 9	787	310	45	77	28	18	15	23	39	16	109
6 to 11	1,031	318	46	80	31	16	18	23	40	15	115
12 to 19	737	406	54	82	29	27	17	26	49	19	175
Females											
6 to 9	704	284	43	61	21	12	15	18	42	13	107
6 to 11	969	280	43	62	20	14	15	19	42	14	101
12 to 19	732	306	40	67	17	19	22	15	37	15	132
Males and Females											
≤9	9,309	250	34	64	20	14	12	16	30	12	96
≤19	11,287	298	40	69	22	17	15	18	36	14	120

[a] Based on data from 1994–1996, 1998 CSFII.

[b] Includes yeast breads, rolls, cereals, pastas, quick breads, pancakes, French toast, cakes, cookies, pastries, pies, crackers, popcorn, pretzels, corn chips, and mixtures having a grain product as a main ingredient. Excludes grain products that were ingredients in food mixtures coded as a single item and tabulated under another food group; for example, noodles in tuna-noodle casserole are tabulated under Meat, Poultry, and Fish.

[c] Includes mixtures having a grain product as a main ingredient, such as burritos, tacos, pizza, egg rolls, quiche, spaghetti with sauce, rice and pasta mixtures; frozen meals in which the main course is a grain mixture; noodle and rice soups; and baby-food macaroni and spaghetti mixtures.

[d] Estimate is not statistically reliable due to small sample size reporting intake.

Note: Consumption amounts shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 12-12. Percentage of Individuals Under 20 Years of Age Consuming Grain Products, by Sex and Age (%)[a]

Age Group (years)	Sample Size	Total[b]	Yeast, Breads and Rolls	Cereals and Pasta				Quick Breads, Pancakes, French Toast	Cakes, Cookies, Pastries, Pies	Crackers, Popcorn, Pretzels, Corn Chips	Mixtures, Mainly Grain[c]
				Total	Ready-to-eat Cereals	Rice	Pasta				
Males and Females											
<1	1,126	70.6	10.9	62.8	9.1	3.4	2.1	4.4	16.5	10.3	15.0
1	1,016	98.2[d]	48.4	70.6	45.3	11.3	9.4	23.0	47.0	39.0	47.8
2	1,102	99.0[d]	58.7	71.1	51.9	14.4	9.4	27.5	46.6	37.9	45.3
1 to 2	2,118	98.7	53.7	70.9	48.7	12.9	9.4	25.3	46.8	38.4	46.5
3	1,831	99.4[d]	64.1	69.7	53.3	11.1	8.6	28.8	46.1	38.5	49.0
4	1,859	99.5[d]	67.0	69.1	54.8	11.4	7.1	28.6	52.3	39.4	46.2
5	884	99.9[d]	69.2	70.4	54.9	11.4	6.8	25.2	52.4	32.1	47.4
3 to 5	4,574	99.6[d]	66.8	69.7	54.3	11.3	7.5	27.5	50.3	36.7	47.5
≤5	7,818	95.8	55.5	69.3	46.9	10.9	7.5	24.0	45.0	34.1	43.3
Males											
6 to 9	787	98.9[d]	69.8	62.6	50.8	10.5	7.4	28.1	52.5	36.0	44.5
6 to 11	1,031	99.0[d]	69.1	64.0	52.4	9.7	8.1	27.1	52.3	33.8	45.3
12 to 19	737	98.2[d]	62.7	44.6	33.2	10.0	5.9	24.4	41.3	27.2	46.2
Females											
6 to 9	704	99.7[d]	71.5	61.2	47.6	9.0	7.9	26.3	57.1	38.3	48.0
6 to 11	969	99.3[d]	71.0	59.3	45.6	9.4	7.1	27.1	55.0	37.1	45.7
12 to 19	732	97.6[d]	60.9	45.9	30.3	8.6	9.3	19.8	40.6	30.9	46.1
Males and Females											
≤9	9,309	97.2	61.6	66.4	47.9	10.5	7.6	25.3	48.9	35.3	44.4
≤19	11,287	97.6	62.4	57.6	41.7	9.9	7.6	24.2	46.1	32.5	45.1

a Based on data from 1994–1996, 1998 CSFII.

b Includes yeast breads, rolls, cereals, pastas, quick breads, pancakes, French toast, cakes, cookies, pastries, pies, crackers, popcorn, pretzels, corn chips, and mixtures having a grain product as a main ingredient. Excludes grain products that were ingredients in food mixtures coded as a single item and tabulated under another food group; for example, noodles in tuna-noodle casserole are tabulated under Meat, Poultry, and Fish.

c Includes mixtures having a grain product as a main ingredient, such as burritos, tacos, pizza, egg rolls, quiche, spaghetti with sauce, rice and pasta mixtures; frozen meals in which the main course is a grain mixture; noodle and rice soups; and baby-food macaroni and spaghetti mixtures.

d Estimate is not statistically reliable due to small sample size reporting intake.

Note: Percentages shown are representative of the first day of each participant's survey response.

Source: USDA, 1999b.

Table 12-13. Per Capita Intake of Total Grains Based on 1994–1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Percent Consuming	Mean	SE	Percentiles									
					1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	20,607	99.5	2.7	0.0	0.2	0.6	0.9	1.3	2.1	3.3	5.2	6.8	10.3	31.6
Age group														
Birth to 1 year	1,486	70.5	2.5	0.1	0.0	0.0	0.0	0.0	1.6	3.8	6.2	8.6	12.7	26.3
1 to 2 years	2,096	99.8	6.4	0.1	1.1	2.1	2.8	4.2	5.9	7.9	10.4	12.1	16.8	31.6
3 to 5 years	4,391	100.0	6.3	0.1	1.8	2.6	3.2	4.3	5.9	7.8	9.9	11.5	15.6	27.0
6 to 12 years	2,089	100.0	4.3	0.1	0.9	1.7	2.0	2.8	4.0	5.4	7.0	8.2	11.1	17.2
13 to 19 years	1,222	100.0	2.5	0.1	0.4	0.8	1.1	1.5	2.3	3.1	4.4	5.1	7.9	12.4
20 to 49 years	4,677	99.9	2.2	0.0	0.3	0.6	0.8	1.3	1.9	2.8	3.9	4.7	7.1	16.1
≥50 years	4,646	100.0	1.7	0.0	0.3	0.6	0.7	1.1	1.5	2.1	2.8	3.5	4.9	11.2
Season														
Fall	4,687	99.5	2.6	0.0	0.2	0.6	0.9	1.3	2.1	3.3	5.0	6.6	10.0	26.3
Spring	5,308	99.6	2.7	0.0	0.2	0.6	0.8	1.3	2.1	3.4	5.5	7.0	10.5	29.4
Summer	5,890	99.5	2.6	0.0	0.3	0.7	0.9	1.3	2.1	3.3	5.1	6.8	10.5	28.2
Winter	4,722	99.5	2.7	0.0	0.2	0.6	0.9	1.4	2.1	3.3	5.2	6.8	10.1	31.6
Race														
Asian, Pacific Islander	557	98.5	3.6	0.2	0.0	1.1	1.5	2.3	3.2	4.7	6.2	7.3	11.2	24.6
Black	2,740	99.4	2.6	0.1	0.1	0.5	0.7	1.1	1.9	3.3	5.4	7.3	11.5	29.4
American Indian, Alaskan Native	177	99.7	2.9	0.2	0.3	0.5	0.8	1.3	2.2	4.2	6.3	7.5	12.0	16.8
Other/NA	1,638	98.8	3.1	0.1	0.0	0.7	0.9	1.5	2.4	4.1	6.1	7.7	11.7	27.0
White	15,495	99.6	2.6	0.0	0.3	0.7	0.9	1.3	2.0	3.2	5.0	6.6	9.8	31.6
Region														
Midwest	4,822	99.7	2.7	0.0	0.3	0.7	0.9	1.4	2.1	3.4	5.3	7.0	10.4	23.8
Northeast	3,692	99.6	2.8	0.0	0.3	0.7	1.0	1.4	2.2	3.5	5.3	6.8	11.0	31.6
South	7,208	99.5	2.5	0.0	0.2	0.6	0.8	1.2	1.9	3.0	5.0	6.6	9.7	28.2
West	4,885	99.4	2.8	0.1	0.2	0.7	0.9	1.4	2.2	3.5	5.4	7.0	10.3	20.8
Urbanization														
Central City	6,164	99.5	2.7	0.0	0.1	0.6	0.9	1.3	2.1	3.5	5.4	7.0	10.7	29.4
Suburban	9,598	99.5	2.7	0.0	0.3	0.7	0.9	1.4	2.1	3.4	5.3	6.9	10.0	31.6
Non-metropolitan	4,845	99.6	2.4	0.1	0.3	0.6	0.8	1.2	1.9	2.9	4.8	6.3	10.4	23.8

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Population Group	*N*	Mean	SE	Percentiles									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	20,157	2.7	0.0	0.3	0.7	0.9	1.3	2.1	3.3	5.2	6.8	10.3	31.6
Age Group													
Birth to 1 year	1,048	3.6	0.1	0.1	0.3	0.6	1.4	2.8	4.8	7.4	9.2	13.4	26.3
1 to 2 years	2,092	6.4	0.1	1.2	2.1	2.8	4.2	5.9	7.9	10.4	12.1	16.8	31.6
3 to 5 years	4,389	6.3	0.1	1.8	2.6	3.2	4.3	5.9	7.8	9.9	11.5	15.6	27.0
6 to 12 years	2,089	4.3	0.1	0.9	1.7	2.0	2.8	4.0	5.4	7.0	8.2	11.1	17.2
13 to 19 years	1,222	2.5	0.1	0.4	0.8	1.1	1.5	2.3	3.1	4.4	5.1	7.9	12.4
20 to 49 years	4,673	2.2	0.0	0.3	0.6	0.8	1.3	1.9	2.8	3.9	4.7	7.1	16.1
≥50 years	4,644	1.7	0.0	0.3	0.6	0.7	1.1	1.5	2.1	2.8	3.5	4.9	11.2
Season													
Fall	4,587	2.6	0.0	0.3	0.7	0.9	1.3	2.1	3.3	5.0	6.6	10.0	26.3
Spring	5,190	2.7	0.0	0.3	0.7	0.9	1.3	2.1	3.4	5.5	7.0	10.6	29.4
Summer	5,751	2.7	0.0	0.4	0.7	0.9	1.4	2.1	3.3	5.2	6.8	10.5	28.2
Winter	4,629	2.7	0.0	0.3	0.7	0.9	1.4	2.1	3.3	5.2	6.8	10.1	31.6
Race													
Asian, Pacific Islander	527	3.7	0.2	0.8	1.2	1.6	2.3	3.2	4.7	6.2	7.3	11.2	24.6
Black	2,675	2.6	0.1	0.2	0.5	0.7	1.1	1.9	3.3	5.4	7.3	11.5	29.4
American Indian, Alaskan Native	175	3.0	0.2	0.3	0.5	0.8	1.3	2.2	4.2	6.3	7.5	12.0	16.8
Other/NA	1,570	3.2	0.1	0.5	0.7	1.0	1.5	2.4	4.1	6.2	7.7	11.7	27.0
White	15,210	2.6	0.0	0.4	0.7	0.9	1.3	2.0	3.2	5.1	6.6	9.8	31.6
Region													
Midwest	4,743	2.7	0.0	0.4	0.7	0.9	1.4	2.1	3.4	5.3	7.0	10.4	23.8
Northeast	3,628	2.8	0.0	0.4	0.8	1.0	1.4	2.2	3.5	5.3	6.8	11.0	31.6
South	7,053	2.5	0.0	0.3	0.6	0.8	1.2	1.9	3.0	5.0	6.6	9.8	28.2
West	4,733	2.8	0.1	0.4	0.7	0.9	1.4	2.2	3.5	5.4	7.0	10.3	20.8
Urbanization													
Central City	6,023	2.8	0.0	0.3	0.7	0.9	1.3	2.1	3.5	5.4	7.0	10.7	29.4
Suburban	9,378	2.7	0.0	0.4	0.7	0.9	1.4	2.1	3.4	5.3	6.9	10.0	31.6
Non-metropolitan	4,756	2.4	0.1	0.3	0.6	0.8	1.2	1.9	2.9	4.8	6.4	10.4	23.8

Table 12-14. Consumer-Only Intake of Total Grains Based on 1994–1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Table 12-15. Per Capita Intake of Individual Grain Products Based on 1994–1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	*N*	Cereal			Rice		
		Percent Consuming	Mean	SE	Percent Consuming	Mean	SE
Whole Population	20,607	99.6	3.7	0.03	86.5	0.3	0.01
Age Group							
Birth to 1 year	1,486	74.6	4.0	0.14	60.2	0.7	0.04
1 to 2 years	2,096	99.8	8.4	0.08	86.4	0.6	0.03
3 to 5 years	4,391	100.0	8.7	0.07	87.9	0.5	0.03
6 to 12 years	2,089	100.0	6.2	0.06	88.0	0.4	0.02
13 to 19 years	1,222	100.0	4.1	0.06	85.8	0.3	0.02
20 to 49 years	4,677	99.9	3.1	0.04	88.3	0.3	0.01
≥50 years	4,646	100.0	2.2	0.02	84.5	0.2	0.01
Season							
Fall	4,687	99.6	3.7	0.06	85.1	0.3	0.02
Spring	5,308	99.6	3.8	0.07	87.1	0.3	0.02
Summer	5,890	99.5	3.8	0.06	86.9	0.3	0.02
Winter	4,722	99.6	3.7	0.05	87.1	0.3	0.02
Race							
Asian, Pacific Islander	557	98.5	4.4	0.20	96.6	1.7	0.19
Black	2,740	99.5	3.8	0.12	86.3	0.3	0.02
American Indian, Alaskan Native	177	99.7	4.2	0.15	92.6	0.3	0.10
Other/NA	1,638	98.9	4.3	0.12	85.9	0.6	0.08
White	15,495	99.7	3.7	0.04	86.2	0.2	0.01
Region							
Midwest	4,822	99.7	3.9	0.09	88.2	0.2	0.02
Northeast	3,692	99.7	3.7	0.06	87.2	0.3	0.03
South	7,208	99.6	3.6	0.04	85.0	0.2	0.01
West	4,885	99.4	3.8	0.09	86.7	0.4	0.03
Urbanization							
Central City	6,164	99.6	3.8	0.06	87.2	0.4	0.02
Suburban	9,598	99.5	3.8	0.05	86.6	0.3	0.02
Non-metropolitan	4,845	99.7	3.5	0.06	85.6	0.2	0.01

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Table 12-16. Consumer-Only Intake of Individual Grain Products Based on 1994–1996, 1998 CSFII (g/kg-day, edible portion, uncooked weight)

Population Group	Cereal			Rice		
	N	Mean	SE	*N*	Mean	SE
Whole Population	20,227	3.8	0.03	17,481	0.3	0.01
Age Group						
Birth to 1 year	1,116	5.4	0.16	900	1.2	0.07
1 to 2 years	2,092	8.4	0.08	1,819	0.7	0.04
3 to 5 years	4,389	8.7	0.07	3,869	0.6	0.03
6 to 12 years	2,089	6.2	0.06	1,847	0.4	0.02
13 to 19 years	1,222	4.1	0.06	1,038	0.3	0.03
20 to 49 years	4,674	3.1	0.04	4,102	0.3	0.01
≥50 years	4,645	2.2	0.02	3,906	0.2	0.01
Season						
Fall	4,598	3.7	0.06	3,957	0.3	0.02
Spring	5,213	3.8	0.07	4,530	0.3	0.02
Summer	5,768	3.8	0.06	4,989	0.3	0.02
Winter	4,648	3.7	0.06	4,005	0.3	0.02
Race						
Asian, Pacific Islander	529	4.5	0.20	513	1.8	0.19
Black	2,683	3.8	0.12	2,346	0.4	0.02
American Indian, Alaskan Native	175	4.3	0.15	151	0.3	0.10
Other/NA	1,579	4.4	0.13	1,375	0.7	0.08
White	15,261	3.7	0.04	13,096	0.2	0.01
Region						
Midwest	4,759	3.9	0.09	4,186	0.2	0.02
Northeast	3,639	3.7	0.06	3,152	0.4	0.04
South	7,081	3.6	0.04	6,029	0.3	0.01
West	4,748	3.9	0.09	4,114	0.5	0.03
Urbanization						
Central City	6,039	3.8	0.06	5,303	0.5	0.03
Suburban	9,410	3.8	0.05	8,105	0.3	0.02
Non-metropolitan	4,778	3.6	0.06	4,073	0.2	0.02

N = Sample size.
SE = Standard error.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Table 12-17. Per Capita Intake of Breads[a] Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)

Population Group	Percent Consuming	Mean	SE	Percentile									
				1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	87.2	1.1	0.01	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	5.1	20.0
Age Group													
≤5 months	0.9	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
6 to 12 months	30.2	0.5	0.16	0.0	0.0	0.0	0.0	0.0	0.5	1.8	3.0	4.8	7.3
<1 year	14.6	0.3	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.7	4.6	7.3
1 to 2 years	77.2	2.0	0.06	0.0	0.0	0.0	0.4	1.4	2.9	4.4	6.0	8.5	20.0
3 to 5 years	86.5	2.3	0.05	0.0	0.0	0.0	0.9	2.0	3.3	4.7	5.8	8.7	13.2
6 to 11 years	87.1	1.7	0.04	0.0	0.0	0.0	0.7	1.4	2.4	3.5	4.3	6.7	11.3
12 to 19 years	86.2	1.1	0.03	0.0	0.0	0.0	0.4	0.9	1.5	2.3	2.8	4.0	7.5
20 to 39 years	88.1	0.9	0.02	0.0	0.0	0.0	0.4	0.8	1.3	2.0	2.5	3.9	6.2
40 to 69 years	90.0	0.9	0.01	0.0	0.0	0.0	0.4	0.8	1.3	1.9	2.3	3.5	8.4
≥70 years	91.6	0.9	0.02	0.0	0.0	0.2	0.4	0.8	1.3	1.9	2.3	2.9	4.3
Season													
Fall	87.4	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.4	3.1	4.9	14.6
Spring	87.1	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	5.1	11.6
Summer	87.3	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.4	3.1	5.2	17.1
Winter	86.9	1.1	0.02	0.0	0.0	0.0	0.4	0.8	1.4	2.3	3.1	5.1	20.0
Race													
Asian	69.1	0.8	0.06	0.0	0.0	0.0	0.0	0.4	1.2	1.9	2.9	4.5	14.6
Black	83.1	1.1	0.03	0.0	0.0	0.0	0.3	0.7	1.4	2.3	3.3	6.3	11.6
American Indian/Alaska Native	82.2	1.4	0.18	0.0	0.0	0.0	0.3	0.9	1.7	3.6	4.1	6.2	20.0
Other/NA	80.4	1.2	0.04	0.0	0.0	0.0	0.3	0.9	1.6	2.7	3.4	5.6	7.5
White	89.0	1.1	0.01	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.0	4.9	17.1
Region													
Midwest	89.1	1.2	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.5	3.3	5.7	12.0
Northeast	88.3	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	2.9	4.5	9.8
South	87.5	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	4.9	17.1
West	83.7	1.1	0.02	0.0	0.0	0.0	0.3	0.8	1.4	2.4	3.2	5.1	20.0
Urbanization													
Central City	85.6	1.1	0.02	0.0	0.0	0.0	0.4	0.8	1.4	2.3	3.1	5.1	13.2
Suburban	87.7	1.1	0.01	0.0	0.0	0.0	0.4	0.9	1.5	2.4	3.1	5.0	14.6
Non-metropolitan	88.5	1.1	0.02	0.0	0.0	0.0	0.4	0.9	1.5	2.3	3.1	5.0	20.0

[a] Includes breads, rolls, muffins, bagels, biscuits, cornbread, and tortillas.
SE = Standard error.
Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-18. Per Capita Intake of Sweets[a] Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)													
Population Group	Percent Consuming	Percentile											
		Mean	SE	1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	52.6	0.6	0.01	0.0 5	0.0	0.0	0.0	0.1	0.8	1.8	2.5	4.6	22.0
Age Group													
<5 months	2.5	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.6
6 to 12 months	23.0	0.3	0.14	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.0	3.6	6.4
<1 year	12.1	0.2	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	3.6	6.4
1 to 2 years	53.2	1.2	0.07	0.0	0.0	0.0	0.0	0.3	1.7	3.5	4.8	7.2	19.3
3 to 5 years	62.1	1.3	0.06	0.0	0.0	0.0	0.0	0.8	1.9	3.6	4.6	8.8	22.0
6 to 11 years	64.2	1.2	0.06	0.0	0.0	0.0	0.0	0.6	1.7	3.2	3.9	6.7	20.9
12 to 19 years	54.3	0.6	0.03	0.0	0.0	0.0	0.0	0.2	1.0	1.8	2.4	3.7	10.7
20 to 39 years	47.2	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.6	1.4	1.9	3.2	11.1
40 to 69 years	52.9	0.5	0.02	0.0	0.0	0.0	0.0	0.1	0.7	1.3	1.9	3.2	7.3
≥70 years	58.6	0.5	0.03	0.0	0.0	0.0	0.0	0.2	0.8	1.6	2.1	3.6	5.7
Season													
Fall	53.7	0.6	0.03	0.0	0.0	0.0	0.0	0.2	0.9	1.8	2.5	4.7	20.9
Spring	52.2	0.6	0.02	0.0	0.0	0.0	0.0	0.1	0.8	1.8	2.6	4.7	22.0
Summer	50.0	0.5	0.02	0.0	0.0	0.0	0.0	0.0	0.7	1.6	2.3	4.1	18.2
Winter	54.5	0.6	0.03	0.0	0.0	0.0	0.0	0.2	0.9	1.9	2.6	4.8	12.3
Race													
Asian	40.2	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.6	1.4	2.0	3.1	15.7
Black	41.4	0.5	0.04	0.0	0.0	0.0	0.0	0.0	0.6	1.5	2.3	4.7	19.3
American Indian/Alaska Native	35.3	0.4	0.11	0.0	0.0	0.0	0.0	0.0	0.3	1.7	2.1	2.8	2.9
Other/NA	35.0	0.4	0.05	0.0	0.0	0.0	0.0	0.0	0.5	1.3	1.9	4.1	7.0
White	56.3	0.6	0.01	0.0	0.0	0.0	0.0	0.2	0.9	1.8	2.5	4.7	22.0
Region													
Midwest	60.1	0.7	0.03	0.0	0.0	0.0	0.0	0.3	1.0	2.0	2.9	5.3	22.0
Northeast	55.4	0.6	0.03	0.0	0.0	0.0	0.0	0.2	0.9	1.7	2.5	4.8	12.7
South	49.1	0.6	0.02	0.0	0.0	0.0	0.0	0.0	0.8	1.7	2.3	4.4	20.9
West	47.7	0.5	0.02	0.0	0.0	0.0	0.0	0.0	0.7	1.6	2.3	3.8	15.7
Urbanization													
Central City	51.2	0.6	0.02	0.0	0.0	0.0	0.0	0.1	0.8	1.6	2.3	4.6	20.9
Suburban	54.6	0.6	0.02	0.0	0.0	0.0	0.0	0.2	0.9	1.8	2.6	4.5	12.7
Non-metropolitan	50.5	0.6	0.03	0.0	0.0	0.0	0.0	0.1	0.8	1.8	2.5	5.1	22.0

[a] Includes breakfast foods made with grains such as pancakes, waffles, and French toast.
SE = Standard error.
Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-19. Per Capita Intake of Snacks Containing Grains[a] Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)													
Population Group	Percent Consuming	Percentile											
		Mean	SE	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	43.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.2	2.6	9.1
Age Group													
≤5 months	1.0	0.0	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.7
6 to 12 months	29.0	0.3	0.08	0.0	0.0	0.0	0.0	0.0	0.2	0.9	2.2	2.5	2.8
<1 year	14.1	0.1	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.9	2.2	3.7
1 to 2 years	58.1	0.7	0.04	0.0	0.0	0.0	0.0	0.4	1.1	2.0	2.8	5.0	8.9
3 to 5 years	56.7	0.7	0.04	0.0	0.0	0.0	0.0	0.3	0.9	1.8	3.2	5.9	9.1
6 to 11 years	51.3	0.5	0.03	0.0	0.0	0.0	0.0	0.1	0.6	1.3	1.9	4.6	7.3
12 to 19 years	45.0	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	0.9	1.4	2.4	5.1
20 to 39 years	41.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.9	1.8	5.5
40 to 69 years	41.1	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.7	1.4	5.6
≥70 years	37.7	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.8	1.8
Season													
Fall	42.3	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.0	2.3	8.0
Spring	43.6	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.3	2.9	8.9
Summer	40.6	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.0	2.3	7.1
Winter	45.8	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.3	2.9	9.1
Race													
Asian	24.1	0.1	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.3	4.4
Black	29.5	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.9	2.1	7.4
American Indian/Alaska Native	38.3	0.2	0.08	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.1	3.2	4.9
Other/NA	28.4	0.2	0.03	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.8	2.4	8.7
White	47.1	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.2	2.7	9.1
Region													
Midwest	49.2	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.8	1.2	2.7	8.9
Northeast	41.9	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.2	2.7	9.1
South	41.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.1	2.4	8.0
West	40.7	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.2	2.6	8.7
Urbanization													
Central City	40.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.1	2.6	7.8
Suburban	44.6	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.2	2.7	9.1
Non-metropolitan	44.1	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.1	2.3	8.1

[a] Includes grain snacks such as crackers, salty snacks, popcorn, and pretzels.
SE = Standard error.
Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-20. Per Capita Intake of Breakfast Foods[a] Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)

Population Group	Percent Consuming	Mean	SE	Percentile									Max
				1st	5th	10th	25th	50th	75th	90th	95th	99th	
Whole Population	11.8	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.4	13.6
Age Group													
≤5 months	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 to 12 months	4.2	0.1	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	4.1
<1 year	2.0	0.1	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	4.1
1 to 2 years	20.4	0.4	0.07	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.7	4.8	13.6
3 to 5 years	20.8	0.4.	0.06	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.5	4.5	8.0
6 to 11 years	23.7	0.4	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.2	3.4	6.5
12 to 19 years	13.0	0.1	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.9	2.3	3.9
20 to 39 years	8.9	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.5	3.0
40 to 69 years	9.5	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.4	3.8
≥70 years	10.4	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7	1.2	3.5
Season													
Fall	11.6	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.3	13.6
Spring	11.6	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.3	6.4
Summer	12.8	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.4	6.0
Winter	11.3	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9	2.6	8.0
Race													
Asian	5.9	0.1	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0	2.8
Black	12.7	0.1	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.2	2.1	6.7
American Indian/Alaska Native	8.8	0.1	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.2	1.2
Other/NA	10.2	0.1	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.6	8.0
White	12.0	0.1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.4	13.6
Region													
Midwest	12.1	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1	2.6	6.7
Northeast	12.7	0.1	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	2.3	8.0
South	10.7	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	2.2	7.8
West	12.4	0.2	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.6	13.6
Urbanization													
Central City	12.0	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	2.5	13.6
Suburban	12.2	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	2.4	7.8
Non-metropolitan	10.7	0.1	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9	2.2	6.4

[a] Includes breakfast food made with grains such as pancakes, waffles, and French toast.
SE = Standard error.
Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-21. Per Capita Intake of Pasta Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)

Population Group	Percent Consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	13.0	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.2	5.1	29.1
Age Group													
≤5 months	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 to 12 months	7.5	0.1	0.22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.3	6.7
<1 year	3.5	0.1	0.15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	6.7
1 to 2 years	16.0	0.8	0.15	0.0	0.0	0.0	0.0	0.0	0.0	3.4	6.2	10.6	16.7
3 to 5 years	12.8	0.6	0.13	0.0	0.0	0.0	0.0	0.0	0.0	2.1	4.4	8.4	14.3
6 to 11 years	13.4	0.5	0.12	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.8	7.5	11.9
12 to 19 years	11.7	0.3	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	4.2	29.1
20 to 39 years	13.9	0.3	0.04	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.2	4.1	11.2
40 to 69 years	13.7	0.2	0.03	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.9	3.6	11.8
≥70 years	9.0	0.2	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.9	7.7
Season													
Fall	13.6	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.4	4.7	16.7
Spring	13.2	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.3	5.8	14.7
Summer	12.6	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.1	5.2	15.4
Winter	12.6	0.3	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	5.1	29.1
Race													
Asian	19.4	0.5	0.17	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.3	6.6	11.2
Black	7.0	0.2	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	3.6	29.1
American Indian/Alaska Native	1.8	0.1	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	3.6
Other/NA	9.6	0.2	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.5	15.4
White	14.1	0.3	0.03	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.3	5.3	16.7
Region													
Midwest	12.1	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.1	5.2	16.7
Northeast	20.1	0.5	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.9	2.8	5.9	15.4
South	9.5	0.2	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	4.4	29.1
West	13.2	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.2	5.7	14.1
Urbanization													
Central City	13.4	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.5	5.3	29.1
Suburban	14.0	0.3	0.03	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.2	5.3	16.7
Non-metropolitan	10.3	0.2	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.5	4.2	14.1

SE = Standard error.

Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-22. Per Capita Intake of Cooked Cereals Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)

Population Group	Percent Consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	10.4	0.4	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.3	7.2	72.5
Age Group													
≤5 months	0.9	0.1	0.54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
6 to 12 months	16.6	1.9	1.18	0.0	0.0	0.0	0.0	0.0	0.0	9.4	16.1	22.8	22.8
<1 year	8.3	0.9	0.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	22.8	22.8
1 to 2 years	18.4	1.6	0.29	0.0	0.0	0.0	0.0	0.0	0.0	6.9	10.7	20.6	33.9
3 to 5 years	16.0	1.3	0.28	0.0	0.0	0.0	0.0	0.0	0.0	5.3	7.9	16.1	72.5
6 to 11 years	8.7	0.5	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	9.4	24.1
12 to 19 years	5.6	0.2	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.3	10.6
20 to 39 years	6.2	0.1	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	3.3	9.2
40 to 69 years	11.6	0.3	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.9	4.4	8.7
≥70 years	24.5	0.6	0.07	0.0	0.0	0.0	0.0	0.0	0.0	2.2	3.4	5.6	10.6
Season													
Fall	12.0	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.6	8.1	45.9
Spring	9.1	0.3	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	6.4	20.9
Summer	9.3	0.3	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	6.9	72.5
Winter	11.1	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.5	7.4	44.5
Race													
Asian	4.4	0.2	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	16.1
Black	20.1	0.7	0.10	0.0	0.0	0.0	0.0	0.0	0.0	2.2	4.4	10.9	33.9
American Indian/Alaska Native	7.6	0.3	0.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.8	12.3
Other/NA	7.6	0.4	0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	10.6	72.5
White	9.3	0.3	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	6.1	45.9
Region													
Midwest	9.6	0.3	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.7	45.9
Northeast	9.0	0.3	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	5.9	72.5
South	12.4	0.4	0.06	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.6	7.9	31.7
West	9.4	0.4	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	8.0	39.5
Urbanization													
Central City	11.6	0.4	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.6	8.1	72.5
Suburban	9.9	0.3	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	6.9	45.9
Non-metropolitan	9.7	0.3	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	5.7	26.9

SE = Standard error.
Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-23. Per Capita Intake of Ready-to-Eat Cereals[a] Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)

Population Group	Percent Consuming	Mean	SE	Percentile 1st	th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	39.7	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.5	2.9	10.1
Age				5									
≤5 months	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 to 12 months	19.9	0.1	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.0	1.8	2.6
<1 year	9.3	0.1	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.7	2.6
1 to 2 years	64.9	1.0	0.04	0.0	0.0	0.0	0.0	0.7	1.5	2.5	3.3	4.9	8.8
3 to 5 years	69.8	1.1	0.04	0.0	0.0	0.0	0.0	0.9	1.7	2.6	3.3	4.8	10.1
6 to 11 years	64.0	0.8	0.03	0.0	0.0	0.0	0.0	0.6	1.2	2.0	2.5	4.0	8.0
12 to 19 years	45.7	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.6	1.1	1.5	2.2	6.4
20 to 39 years	30.5	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.0	1.7	5.3
40 to 69 years	31.8	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.9	1.4	5.2
≥70 years	47.9	0.2	0.01	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.9	1.5	2.7
Season													
Fall	39.1	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	2.9	8.8
Spring	40.1	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.5	2.9	7.7
Summer	39.6	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	3.0	7.8
Winter	39.9	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.4	2.7	10.1
Race													
Asian	25.4	0.2	0.05	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.2	2.7	4.9
Black	34.0	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.5	3.2	10.1
American Indian/Alaska Native	33.1	0.3	0.09	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.4	2.6	4.4
Other/NA	33.3	0.3	0.04	0.0	0.0	0.0	0.0	0.0	0.3	1.1	1.7	3.0	6.6
White	41.7	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.5	2.8	8.8
Region													
Midwest	42.2	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.9	8.0
Northeast	42.3	0.4	0.02	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.9	8.0
South	37.4	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.3	2.8	10.1
West	38.4	0.3	0.02	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.6	3.1	8.8
Urbanization													
Central City	40.0	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.5	2.8	10.1
Suburban	41.2	0.4	0.01	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	3.1	8.0
Non-metropolitan	35.8	0.3	0.01	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.2	2.6	8.8

[a] Includes dry ready-to-eat corn, rice, wheat, and bran cereals in the form of flakes, puffs, etc.

SE = Standard error.

Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-24. Per Capita Intake of Baby Cereals Based on 1994–1996, 1998 CSFII (g/kg-day, as-consumed)

Population Group	Percent Consuming	Mean	SE	Percentile 1st	5th	10th	25th	50th	75th	90th	95th	99th	Max
Whole Population	1.0	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	37.6
Age													
≤5 months	40.8	0.8	0.24	0.0	0.0	0.0	0.0	0.0	1.0	2.4	3.1	8.8	26.6
6 to 12 months	67.8	2.5	0.45	0.0	0.0	0.0	0.0	0.8	2.8	6.9	11.3	21.1	37.6
<1 year	53.4	1.6	0.27	0.0	0.0	0.0	0.0	0.2	1.7	4.1	7.3	19.7	37.6
1 to 2 years	6.2	0.2	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	5.8	12.5
3 to 5 years	0.3	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
6 to 11 years	0.1	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
12 to 19 years	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20 to 39 years	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40 to 69 years	0.1	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
≥70 years	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Season													
Fall	0.9	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1
Spring	1.2	0.0	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	26.6
Summer	0.8	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0
Winter	1.1	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	37.6
Race													
Asian	0.7	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
Black	1.0	0.0	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.6
American Indian/Alaska Native	0.6	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Other/NA	1.7	0.1	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	26.6
White	1.0	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0
Region													
Midwest	1.1	0.0	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	21.1
Northeast	1.2	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	12.5
South	0.9	0.0	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.6
West	0.9	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.6
Urbanization													
Central City	1.1	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	37.6
Suburban	1.1	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	21.1
Non-metropolitan	0.8	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.0

SE = Standard error.
Source: U.S. EPA analysis of the 1994–1996 CSFII.

Table 12-25. Quantity (as-consumed) of Grain Products Consumed per Eating Occasion and the Percentage of Individuals Using These Foods in 2 Days

Food category	% Indiv. using food at least once in 2 days	Quantity consumed per eating occasion (grams)		Consumers Only Quantity consumed per eating occasion at specified percentiles (grams)						
		Average	SE	5th	10th	25th	50th	75th	90th	95th
White bread	59.6	50	1	21	24	33	46	52	78	104
Whole grain and wheat bread	28.1	50	1	24	25	37	50	56	72	92
Rolls	48.0	58	1	27	33	43	48	70	89	110
Biscuits	10.9	61	1	19	19	35	57	76	104	139
Tortillas	15.5	60	1	14	21	32	48	79	107	135
Quick breads and muffins	12.5	82	2	21	28	52	60	94	142	187
Doughnuts and sweet rolls	12.4	77	1	26	36	47	65	93	133	164
Crackers	17.4	26	1	6	9	12	18	30	47	62
Cookies	30.7	40	1	9	12	20	31	50	75	96
Cake	16.2	92	3	22	28	41	77	116	181	217
Pie	8.5	150	3	52	72	102	143	168	246	300
Pancakes and waffles	10.3	85	3	21	35	42	75	109	158	205
Cooked cereal	10.3	248	6	81	117	157	233	291	455	484
Oatmeal	6.1	264	6	116	117	176	232	333	454	473
Ready-to-eat cereal	40.6	54	1	18	24	30	46	67	93	113
Corn flakes	8.1	46	1	17	22	25	37	56	75	100
Toasted oat rings	6.8	42	1	14	16	27	38	54	65	83
Rice	28.0	150	3	27	40	76	131	192	312	334
Pasta	36.0	162	3	26	43	73	133	210	318	420
Macaroni and cheese	8.5	244	9	53	81	121	191	324	477	556
Spaghetti with tomato sauce	8.0	436	15	122	124	246	371	494	740	983
Pizza	19.9	169	5	36	52	78	140	214	338	422

SE = Standard error.
Source: Smiciklas-Wright et al., 2002, (based on 1994–1996 CSFII data).

Table 12-26. Quantity (as-consumed) of Grain Products Consumed per Eating Occasion and Percentage of Individuals Using These Foods in 2 Days, by Sex and Age

Food Category	Quantity consumed per eating occasion (grams)											
	2 to 5 years			6 to 11 years			12 to 19 years					
	Male and Female (*N* = 2,109)			Male and Female (*N* = 1,432)			Male (*N* = 696)			Female (*N* = 702)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
White bread	66.9	34	[a]	67.1	42	1	61.3	56	1	57.9	47	1
Whole grain and wheat bread	24.3	37	1	20.5	44	1	14.5	60	2	17.6	53	2
Rolls	40.0	39	1	53.5	48	1	61.9	69	2	48.8	51	1
Biscuits	8.3	38	2	9.7	48	3	12.2	72	4	10.3	55	4
Tortillas	14.6	32	2	16.4	47	2	22.9	76	5	20.1	56	3
Quick breads and muffins	9.6	55	4	9.6	67	5	11.0	125	12	11.0	79	10
Doughnuts and sweet rolls	11.3	59	2	13.4	69	2	17.3	102	12	13.8	78	5
Crackers	25.4	17	1	17.2	26	2	10.6	39	5	14.2	26	3
Cookies	51.0	28	1	46.7	37	2	29.0	53	3	31.8	42	2
Cake	14.6	70	3	19.7	79	4	15.1	99	9	15.5	85	8
Pie	2.9	76	8	5.6	116	8	6.6	188	15	4.8	138[b]	12[b]
Pancakes and waffles	19.1	49	1	21.5	77	3	13.5	96	6	8.2	74	5
Cooked cereal	16.8	211	10	9.0	245	14	5.2	310[b]	29[b]	6.0	256[b]	31[b]
Oatmeal	10.4	221	9	5.7	256	19	2.4	348[b]	45[b]	2.3	321[b]	40[b]
Ready-to-eat cereal	72.9	33	1	67.3	47	1	45.6	72	3	46.3	52	2
Corn flakes	11.2	33	2	13.1	42	2	10.4	62	4	8.7	49	4
Toasted oat rings	20.6	30	1	12.5	45	2	7.3	62	5	8.1	42	3
Rice	29.6	84	3	24.6	124	6	24.2	203	10	28.8	157	10
Pasta	49.4	90	3	41.4	130	5	33.4	203	9	37.8	155	9
Macaroni and cheese	17.8	159	8	13.2	217	13	7.5	408	46	10.7	260	30
Spaghetti with tomato sauce	16.8	242	11	11.5	322	18	10.1	583	46	8.5	479	51
Pizza	23.7	86	3	32.8	108	6	39.6	205	13	30.5	143	8
Corn chips	19.6	29	2	25.6	33	2	26.9	58	5	25.1	44	3
Popcorn	11.6	20	1	12.7	31	2	7.8	54	5	10.5	37	4

Table 12-26. Quantity (as-consumed) of Grain Products Consumed per Eating Occasion and Percentage of Individuals Using These Foods in 2 Days, by Sex and Age (continued)

Food category	Quantity consumed per eating occasion (g)																	
	20 to <40 years						40 to <60 years						≥60 years					
	Male (*N* = 1,543)			Female (*N* = 1,449)			Male (*N* = 1,663)			Female (*N* = 1,694)			Male (*N* = 1,545)			Female (*N* = 1,429)		
	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE	PC	Mean	SE
White bread	63.0	63	2	54.9	47	1	59.7	59	2	55.3	46	1	59.3	51	1	54.8	41	1
Whole grain and wheat bread	25.3	63	1	25.2	48	1	32.8	57	1	32.3	46	2	39.8	48	1	43.1	41	1
Rolls	62.0	73	4	46.4	53	1	47.9	65	1	43.4	52	1	37.8	54	1	30.6	43	1
Biscuits	11.5	73	3	9.4	55	2	13.4	80	3	11.2	56	2	13.0	58	3	9.8	48	3
Tortillas	20.6	79	4	20.1	53	2	13.4	67	3	12.7	52	2	4.2	47	4	5.4	41	2
Quick breads and muffins	8.0	93	7	11.3	79	5	15.7	93	7	14.9	72	4	17.4	86	5	18.3	72	4
Doughnuts and sweet rolls	13.3	94	5	11.2	68	2	13.4	88	4	11.0	72	4	11.4	65	2	10.4	56	2
Crackers	11.9	36	3	15.6	28	2	16.6	30	1	17.5	24	1	25.6	23	1	25.9	17	1
Cookies	20.8	56	4	26.5	39	2	27.6	47	2	29.0	36	1	29.7	40	2	32.2	30	1
Cake	13.5	113	6	14.9	94	7	16.5	108	6	16.8	83	4	19.2	85	4	18.3	87	7
Pie	5.8	161	7	7.2	150	9	11.8	162	6	9.9	151	8	16.4	154	7	13.3	137	5
Pancakes and waffles	8.0	126	15	7.4	80	6	7.5	117	8	8.0	74	5	10.8	99	5	8.2	68	4
Cooked cereal	5.2	313	30	7.3	219	11	9.7	300	16	10.3	243	11	20.9	255	8	20.2	216	8
Oatmeal	2.7	360[a]	42[a]	3.7	258	17	6.0	332	16	6.2	242	10	13.6	257	10	12.9	224	10
Ready-to-eat cereal	26.9	77	3	34.7	55	1	29.8	68	2	29.7	51	1	44.6	53	1	44.0	41	1
Corn flakes	6.5	73	6	5.3	43	2	5.9	49	3	5.2	40	3	12.4	37	2	10.4	30	1
Toasted oat rings	4.2	62	4	5.4	42	2	4.8	46	2	4.1	35	2	4.3	36	3	4.9	27	2
Rice	30.8	199	9	32.1	139	6	29.4	167	5	28.8	130	4	23.1	147	6	21.4	118	5
Pasta	37.1	214	8	37.1	155	6	34.3	208	7	34.7	140	5	27.9	167	7	27.9	132	5
Macaroni and cheese	7.8	301	19	7.8	235	19	6.1	302	31	6.0	210	12	7.1	230	13	6.5	215	18
Spaghetti with tomato sauce	8.6	630	48	7.8	385	22	5.5	543	59	5.4	386	18	5.0	450	22	4.5	379	33
Pizza	23.7	253	12	20.2	150	6	13.0	220	13	14.5	147	8	5.3	187	18	4.7	109	8
Corn chips	16.2	61	5	17.9	35	2	12.8	47	4	12.0	33	2	4.8	30	3	5.3	21	2
Popcorn	8.1	63	6	9.7	35	2	9.6	50	4	10.9	39	3	6.1	52	4	7.6	34	3

[a] Indicates a SE value that is greater than 0 but less than 0.5.
[b] Indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
N = Sample size.
PC = Percent consuming at least once in 2 days.
SE = Standard error of the mean.
Source: Smiciklas-Wright et al., 2002, (based on 1994–1996 CSFII data).

Table 12-27. Consumption of Major Food Groups by Older Adults: Median Daily Servings (and Ranges) by Demographic and Health Characteristics

Subject Characteristic	*N*	Bread, Cereal, Rice and Pasta (servings/day)
Sex		[a]
Female	80	2.7 (0.9–6.5)
Male	50	3.6 (1.4–7.3)
Ethnicity		
African American	44	3.3 (1.4–6.4)
European American	47	3.2 (0.9–6.8)
Native American	39	2.9 (1.1–7.3)
Age		
70 to 74 years	42	3.3 (1.1–6.3)
75 to 79 years	36	3.0 (0.9–6.8)
80 to 84 years	36	3.2 (1.5–6.4)
≥85 years	16	3.6 (1.6–7.3)
Marital Status		
Married	49	3.3 (1.1–5.8)
Not Married	81	3.0 (0.9–7.3)
Education		
8th grade or less	37	3.1 (1.1–7.3)
9th to 12th grades	47	3.3 (1.1–6.8)
>High School	46	3.2 (0.9–6.5)
Dentures		
Yes	83	3.3 (1.1–6.4)
No	47	3.1 (0.9–7.3)
Chronic Diseases		
0	7	4.1 (2.2–6.4)
1	31	3.3 (0.9–7.3)
2	56	3.1 (1.1–5.8)
3	26	3.7 (1.1–5.8)
≥4	10	2.9 (1.4–5.3)
Weight[b]		
≤130 pounds	18	3.1 (1.1–5.4)
131 to 150 pounds	32	3.3 (0.9–5.2)
151 to 170 pounds	27	3.1 (1.4–7.3)
171 to 190 pounds	22	3.6 (1.4–6.2)
≥191 pounds	29	3.0 (1.1–6.8)

[a] $p < 0.05$.
[b] 2 missing values.
N = Number of subjects.
Source: Vitolins et al., 2002.

Table 12-28. Characteristics of the Feeding Infant and Toddlers Study (FITS) Sample Population

	Sample Size	Percentage of Sample
Sex		
Male	1,549	51.3
Female	1,473	48.7
Age of Child		
4 to 6 months	862	28.5
7 to 8 months	483	16.0
9 to 11 months	679	22.5
12 to 14 months	374	12.4
15 to 18 months	308	10.2
19 to 24 months	316	10.4
Child's Ethnicity		
Hispanic or Latino	367	12.1
Non-Hispanic or Latino	2,641	87.4
Missing	14	0.5
Child's Race		
White	2,417	80.0
Black	225	7.4
Other	380	12.6
Urbanicity		
Urban	1,389	46.0
Suburban	1,014	33.6
Rural	577	19.1
Missing	42	1.3
Household Income		
Under $10,000	48	1.6
$10,000 to $14,999	48	1.6
$15,000 to $24,999	221	7.3
$25,000 to $34,999	359	11.9
$35,000 to $49,999	723	23.9
$50,000 to $74,999	588	19.5
$75,000 to $99,999	311	10.3
$100,000 and Over	272	9.0
Missing	452	14.9
Receives WIC		
Yes	821	27.2
No	2,196	72.6
Missing	5	0.2
Sample Size (Unweighted)	3,022	100.0

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Devaney et al., 2004.

Table 12-29. Percentage of Infants and Toddlers Consuming Different Types of Grain Products						
Food Group/Food	Percentage of Infants and Toddlers Consuming at Least Once in a Day					
	4 to 6 Months	7 to 8 Months	9 to 11 Months	12 to 14 Months	15 to 18 Months	19 to 24 Months
Any Grain or Grain Product	65.8	91.5	97.5	97.8	98.6	99.2
Infant Cereals	64.8	81.2	63.8	23.9	9.2	3.1
Non-infant Cereals[a]	0.6	18.3	44.3	58.9	60.5	51.9
Not Pre-sweetened	0.5	17.0	37.0	44.5	40.6	31.9
Pre-sweetened[b]	0.0	1.8	9.0	17.7	26.4	22.7
Breads and Rolls[c]	0.6	9.9	24.5	47.3	52.7	53.1
Crackers, Pretzels, Rice Cakes	3.0	16.2	33.4	45.2	46.4	44.7
Cereal or Granola Bars	0.0	1.1	3.4	9.8	10.0	9.7
Pancakes, Waffles, French Toast	0.1	0.8	7.5	15.1	16.1	15.4
Rice and Pasta[d]	2.3	4.5	18.2	26.2	39.0	35.9
Other	0.2	0.1	2.7	2.8	2.5	4.5
Grains in Mixed Dishes	0.4	5.3	24.1	48.3	52.0	55.1
Sandwiches	0.0	1.1	8.6	21.5	25.8	25.8
Burrito, Taco, Enchilada, Nachos	0.0	0.0	1.0	4.5	2.8	2.1
Macaroni and Cheese	0.2	1.6	4.9	14.6	15.0	15.0
Pizza	0.1	0.7	2.2	6.8	9.0	9.4
Pot Pie/Hot Pocket	0.0	0.9	0.5	2.0	1.0	1.8
Spaghetti, Ravioli, Lasagna	0.1	1.8	9.9	15.3	12.1	8.8

[a] Includes both ready-to-eat and cooked cereals.
[b] Defined as cereals with more than 21.1 grams sugar per 100 grams.
[c] Does not include bread in sandwiches. Sandwiches are included in mixed dishes.
[d] Does not include rice or pasta in mixed dishes.

Source: Fox et al., 2004.

Table 12-30. Characteristics of Women, Infants, and Children (WIC) Participants and Non-Participants[a] (percentages)

	Infants 4 to 6 month		Infants 7 to 11 month		Toddlers 12 to 24 month	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Sex						
Male	55	54	55	51	57	52
Female	45	46	45	49	43	48
Child's Ethnicity		[b]		[b]		[b]
Hispanic or Latino	20	11	24	8	22	10
Non-Hispanic or Latino	80	89	76	92	78	89
Child's Race		[b]		[b]		[b]
White	69	84	63	86	67	84
Black	15	4	17	5	13	5
Other	22	11	20	9	20	11
Child in Daycare				[b]		[c]
Yes	39	38	34	46	43	53
No	61	62	66	54	57	47
Age of Mother		[b]		[b]		[b]
14 to 19 years	18	1	13	1	9	1
20 to 24 years	33	13	38	11	33	14
25 to 29 years	29	29	23	30	29	26
30 to 34 years	9	33	15	36	18	34
≥35 years	9	23	11	21	11	26
Missing	2	2	1	1	0	1
Mother's Education		[b]		[b]		[b]
11^{th} Grade or Less	23	2	15	2	17	3
Completed High School	35	19	42	20	42	19
Some Postsecondary	33	26	32	27	31	28
Completed College	7	53	9	51	9	48
Missing	2	1	2	0	1	2
Parent's Marital Status		[b]		[b]		[b]
Married	49	93	57	93	58	88
Not Married	50	7	42	7	41	11
Missing	1	1	1	0	1	1
Mother or Female Guardian Works				[b]		[c]
Yes	46	51	45	60	55	61
No	53	48	54	40	45	38
Missing	1	1	1	0	0	1

Table 12-30. Characteristics of Women, Infants, and Children (WIC) Participants and Non-Participants[a] (Percentages) (continued)

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Urbanicity		c		c		c
Urban	34	55	37	50	35	48
Suburban	36	31	31	34	35	35
Rural	28	13	30	15	28	16
Missing	2	1	2	1	2	2
Sample Size (Unweighted)	265	597	351	808	205	791

a χ^2 tests were conducted to test for statistical significance in the differences between WIC participants and non-participants within each age group for each variable. The results of χ^2 tests are listed next to the variable under the column labeled non-participants for each of the three age groups.
b = $p < 0.05$ non-participants significantly different from WIC participants on the variable.
c = $p < 0.01$ non-participants significantly different from WIC participants on the variable.

WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 12-31. Food Choices for Infants and Toddlers by Women, Infants, and Children (WIC) Participation Status

	Infants 4 to 6 months		Infants 7 to 11 months		Toddlers 12 to 24 months	
	WIC Participant	Non-Participant	WIC Participant	Non-Participant	WIC Participant	Non-Participant
Infant Cereals	69.7	62.5	74.7	69.7	13.5	9.2
Non-infant Cereals, Total	0.9	0.5	21.7	38.5[a]	58.1	56.0
Not Pre-sweetened	0.5	0.5	18.7	32.9[a]	43.7	36.3
Pre-sweetened	0.0	0.0	4.0	6.9	17.7	24.1
Grains in Combination Foods	0.9	0.1	18.8	14.7	50.3	52.9
Sample Size (unweighted)	265	597	351	808	205	791

a = $p < 0.01$ non-participants significantly different from WIC participants.
WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

Source: Ponza et al., 2004.

Table 12-32. Average Portion Sizes per Eating Occasion of Grain Products Commonly Consumed by Infants from the 2002 Feeding Infants and Toddlers Study

Food group	Reference unit	4 to 5 months (*N* = 624)	6 to 8 months (*N* = 708)	9 to 11 months (*N* = 687)
		Mean ± SE		
Infant cereal, dry	tablespoon	3.1 ± 0.14	4.5 ± 0.14	5.2 ± 0.18
Infant cereal, jarred	tablespoon	-	5.6 ± 0.26	7.4 ± 0.34
Ready-to-eat cereal	tablespoon	-	2.3 ± 0.34	3.4 ± 0.21
Crackers	ounce	-	0.2 ± 0.02	0.3 ± 0.01
Crackers	saltine	-	2.2 ± 0.14	2.7 ± 0.12
Bread	slice	-	0.5 ± 0.10	0.8 ± 0.06

- = Cell size was too small to generate a reliable estimate.
N = Number of respondents.
SE = Standard error of the mean.

Source: Fox et al., 2006.

Table 12-33. Average Portion Sizes per Eating Occasion of Grain Products Commonly Consumed by Toddlers from the 2002 Feeding Infants and Toddlers Study

Food Group	Reference Unit	12 to 14 months (*N* = 371)	15 to 18 months (*N* = 312)	19 to 24 months (*N* = 320)
		Mean ± SE		
Bread	slice	0.8 ± 0.04	0.9 ± 0.05	0.9 ± 0.05
Rolls	ounce	0.9 ± 0.11	1.0 ± 0.10	0.9 ± 0.15
Ready-to-eat cereal	cup	0.3 ± 0.02	0.5 ± 0.03	0.6 ± 0.04
Hot cereal, prepared	cup	0.6 ± 0.05	0.6 ± 0.05	0.7 ± 0.05
Crackers	ounce	0.3 ± 0.02	0.4 ± 0.02	0.4 ± 0.02
Crackers	saltine	3.3 ± 0.22	3.5 ± 0.22	3.7 ± 0.22
Pasta	cup	0.4 ± 0.04	0.4 ± 0.04	0.5 ± 0.05
Rice	cup	0.3 ± 0.04	0.4 ± 0.05	0.4 ± 0.05
Pancakes and waffles	1 (4-inch diameter)	1.0 ± 0.08	1.4 ± 0.21	1.4 ± 0.17

N = Number of respondents.
SE = Standard error of the mean.

Source: Fox et al., 2006.

Table 12-34. Percentage of Hispanic and Non-Hispanic Infants and Toddlers Consuming Different Types of Grain Products on a Given Day

	Age 4 to 5 months		Age 6 to 11 months		Age 12 to 24 months	
	Hispanic (*N* = 84)	Non-Hispanic (*N* = 538)	Hispanic (*N* = 163)	Non-Hispanic (*N* = 1,228)	Hispanic (*N* = 124)	Non-Hispanic (*N* = 871)
Any Grain or Grain Product	56.5	56.9	95.0	93.5	97.1	98.9
Infant Cereal	55.2	56.5	74.1	73.6	15.9	9.3
Non-infant Cereal	-	-	18.5[a]	29.2	45.3	57.8
Breads[b]	1.4[c]	-	18.2	15.1	44.0	52.9
Tortillas	1.4[c]	-	4.0[c]	-	6.7[a, c]	0.6[c]
Crackers, Pretzels, Rice Cakes	1.3[c]	-	27.8	22.5	35.6	46.9
Pancakes, Waffles, French Toast	-	-	1.4[c]	4.3	13.0	16.0
Rice and Pasta[d]	-	-	20.1[a]	10.3	44.3	32.9
Rice	-	-	15.9[e]	4.7	26.9[a, c]	13.0
Grains in Mixed Dishes	-	-	15.9	13.0	38.8[a]	54.4
Sandwiches	-	-	4.0[c]	4.6	24.2	24.9
Burrito, Taco, Enchilada, Nachos	-	-	1.3[c]	-	2.1[c]	3.0
Macaroni and Cheese	-	-	3.0[c]	3.1	10.1	15.5
Pizza	-	-	-	1.4	1.0[c, e]	9.7
Spaghetti, Ravioli, Lasagna	-	-	8.3[c]	4.6	9.3[c]	12.1

[a] = Significantly different from non-Hispanic at $p < 0.05$.

[b] Does not include bread in sandwiches. Sandwiches are included in mixed dishes. Includes tortillas, also shown separately.

[c] = Statistic is potentially unreliable because of a high coefficient of variation.

[d] Does not include rice or pasta in mixed dishes. Includes rice (e.g., white, brown, wild, and Spanish rice without meat) and pasta (e.g., spaghetti, macaroni, and egg noodles). Rice is also shown separately.

[e] = Significantly different from non-Hispanic at $p < 0.01$.

\- = Less than 1% of the group consumed this food on a given day.

N = Sample size.

Source: Mennella et al., 2006.

Table 12-35. Mean Moisture Content of Selected Grain Products Expressed as Percentages of Edible Portions (grams per 100 grams of edible portion)

Food	Moisture Content		Comments
	Raw	Cooked	
Barley—pearled	10.09	68.80	
Corn—grain—endosperm	10.37	-	
Corn—grain—bran	4.71	-	crude
Millet	8.67	71.41	
Oats	8.22	-	
Rice—white—long-grained	11.62	68.44	
Rye	10.95	-	
Rye—flour—medium	9.85	-	
Sorghum	9.20	-	
Wheat—hard white	9.57	-	
Wheat—germ	11.12	-	crude
Wheat—bran	9.89	-	crude
Wheat—flour—whole grain	10.27	-	

\- Indicates that the grain product was not assessed for water content under these conditions.

Source: USDA, 2007.

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13. INTAKE OF HOME-PRODUCED FOODS

13.1. INTRODUCTION

Ingestion of home-produced foods can be a pathway for exposure to environmental contaminants. Home-produced foods can become contaminated in various ways. Ambient pollutants in the air may be deposited on plants, adsorbed onto or absorbed by the plants, or dissolved in rainfall or irrigation waters that contact the plants. Pollutants also may be adsorbed onto plant roots from contaminated soil and water. Finally, the addition of pesticides, soil additives, and fertilizers to crops or gardens may result in contamination of food products. Meat and dairy products can become contaminated if animals consume contaminated soil, water, or feed crops. Farmers, as well as rural and urban residents who consume home-produced foods, may be potentially exposed if these foods become contaminated. Exposure via the consumption of home-produced foods may be a significant route of exposure for these populations (U.S. Environmental Protection Agency [EPA], 1989, 1996). For example, consumption of home-produced fruits, vegetables, game, and fish has been shown to have an effect on blood lead levels in areas where soil lead contamination exists (U.S. EPA, 1994). At Superfund sites where soil contamination is found, ingestion of home-produced foods has been considered a potential route of exposure (U.S. EPA, 1991, 1993). Assessing exposures to individuals who consume home-produced foods requires knowledge of intake rates of such foods.

Data from the 1987–1988 Nationwide Food Consumption Survey (NFCS) were used to generate intake rates for home-produced foods. The methods used to analyze the 1987–1988 NFCS data are presented in Section 13.3.

13.2. RECOMMENDATIONS

The data presented in this section may be used to assess exposure to contaminants in foods grown, raised, or caught at a specific site. Table 13-1 presents the recommended values for mean and upper percentile (i.e., 95th percentile) intake rates among consumers of the various home-produced food groups. The consumer-only data presented represent average daily intake rates of food items/groups over the 7-day survey period and do not account for variations in eating habits during the rest of the year. Thus, the recommended upper- percentile values, as well as the percentiles of the distributions presented in Section 13.3.1 may not necessarily reflect the long-term distribution of average daily intake of home-produced foods. Table 13-1 also provides mean and 95th percentile per capita intake rates for populations that garden, farm, or raise animals. Table 13-2 presents the confidence ratings for home-produced food intake.

Because the consumer-only home-produced food intake rates presented in this chapter (See Section 13.3.1) are based on foods as brought into the household and not in the form in which they are consumed, preparation loss factors should be applied as appropriate. These factors are necessary to convert intake rates to those that are representative of foods "as consumed." The per capita data presented in this chapter (See Section 13.3.2) account for preparation and post-cooking losses. Additional conversions may be necessary for both consumer-only and per capita data to ensure that the form of the food used to estimate intake (e.g., wet or dry weight) is consistent with the form used to measure contaminant concentration (see Section 13.3).

The NFCS data used to generate intake rates of home-produced foods are more than 20 years old and may not be reflective of current eating patterns among consumers of home-produced foods. Although the U.S. Department of Agriculture (USDA) and others have conducted other food consumption studies since the release of the 1987–1988 NFCS, these studies do not include information on home-produced foods.

Because the consumer-only analysis was conducted prior to the issuance of EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005), the age groups used are not entirely consistent with recent guidelines. Also, recommended home-produced food intake rates are not provided for children less than 1 year of age because the methodology used is based on the apportionment of home-produced foods used by a household among the members of that household who consume those foods. It was assumed that the diets of children under 1 year of age differ markedly from that of other household members; thus, they were not assumed to consume any portion of the home-produced food brought into the home.

Table 13-1. Summary of Recommended Values for Intake of Home-Produced Foods				
Age Group[a]	Mean (g/kg-day)	95th Percentile (g/kg-day)	Multiple Percentiles	Source
Home-Produced Fruits				
Consumers Only, Unadjusted[b]				
1 to 2 years	8.7	60.6	See Table 13-5	U.S. EPA Analysis of 1987–1988 NFCS
3 to 5 years	4.1	8.9		
6 to 11 years	3.6	15.8		
12 to 19 years	1.9	8.3		
20 to 39 years	2.0	6.8		
40 to 69 years	2.7	13.0		
≥70 years	2.3	8.7		
Per Capita for Populations that Garden or (Farm), Adjusted[c]				
1 to <2 years	1.0 (1.4)	4.8 (9.1)	NA	Phillips and Moya, 2011
2 to <3 years	1.0 (1.4)	4.8 (9.1)		
3 to <6 years	0.78 (1.0)	3.6 (6.8)		
6 to <11 years	0.40 (0.52)	1.9 (3.5)		
11 to <16 years	0.13 (0.17)	0.62 (1.2)		
16 to <21 years	0.13 (0.17)	0.62 (1.2)		
21 to <50 years	0.15 (0.20)	0.70 (1.3)		
50+ years	0.24 (0.31)	1.1 (2.1)		
Home-Produced Vegetables				
Consumers Only, Unadjusted[b]				
1 to 2 years	5.2	19.6	See Table 13-10	U.S. EPA Analysis of 1987–1988 NFCS
3 to 5 years	2.5	7.7		
6 to 11 years	2.0	6.2		
12 to 19 years	1.5	6.0		
20 to 39 years	1.5	4.9		
40 to 69 years	2.1	6.9		
≥70 years	2.5	8.2		
Per Capita for Populations that Garden or (Farm), Adjusted[c]				
1 to <2 years	1.3 (2.7)	7.1 (14)	NA	Phillips and Moya, 2011
2 to <3 years	1.3 (2.7)	7.1 (14)		
3 to <6 years	1.1 (2.3)	6.1 (12)		
6 to <11 years	0.80 (1.6)	4.2 (8.1)		
11 to <16 years	0.56 (1.1)	3.0 (5.7)		
16 to <21 years	0.56 (1.1)	3.0 (5.7)		
21 to <50 years	0.56 (1.1)	3.0 (5.7)		
50+ years	0.60 (1.2)	3.2 (6.1)		

Table 13-1. Summary of Recommended Values for Intake of Home-Produced Foods (continued)				
Age Group[a]	Mean (g/kg-day)	95th Percentile (g/kg-day)	Multiple Percentiles	Source
Home-Produced Meats				
Consumers Only, Unadjusted[b]				
1 to 2 years	3.7	10.0	See Table 13-15	U.S. EPA Analysis of 1987–1988 NFCS
3 to 5 years	3.6	9.1		
6 to 11 years	3.7	14.0		
12 to 19 years	1.7	4.3		
20 to 39 years	1.8	6.2		
40 to 69 years	1.7	5.2		
≥70 years	1.4	3.5		
Per Capita for Populations that Farm or (Raise Animals), Adjusted[c]				
1 to <2 years	1.4 (1.4)	5.8 (6.0)	NA	Phillips and Moya, 2011
2 to <3 years	1.4 (1.4)	5.8 (6.0)		
3 to <6 years	1.4 (1.4)	5.8 (6.0)		
6 to <11 years	1.0 (1.0)	4.1 (4.2)		
11 to <16 years	0.71 (0.73)	3.0 (3.1)		
16 to <21 years	0.71 (0.73)	3.0 (3.1)		
21 to <50 years	0.65 (0.66)	2.7 (2.8)		
50+ years	0.51 (0.52)	2.1 (2.2)		
Home-Produced Dairy				
Per Capita for Populations that Farm or (Raise Animals), Adjusted[c]				
1 to <2 years	11 (13)	76 (92)	NA	Phillips and Moya, 2011
2 to <3 years	11 (13)	76 (92)		
3 to <6 years	6.7 (8.3)	48 (58)		
6 to <11 years	3.9 (4.8)	28 (34)		
11 to <16 years	1.6 (2.0)	12 (14)		
16 to <21 years	1.6 (2.0)	12 (14)		
21 to <50 years	0.95 (1.2)	6.9 (8.3)		
50+ years	0.92 (1.1)	6.7 (8.0)		
Home-Caught Fish				
Consumers Only, Unadjusted[b]				
1 to 2 years	-[d]	-	See Table 13-20	U.S. EPA Analysis of 1987–1988 NFCS
3 to 5 years	-	-		
6 to 11 years	2.8	7.1		
12 to 19 years	1.5	4.7		
20 to 39 years	1.9	4.5		
40 to 69 years	1.8	4.4		
≥70 years	1.2	3.7		

a Analysis was conducted prior to Agency's issuance of *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005).
b Not adjusted to account for preparation or post-cooking losses.
c Adjusted for preparation and post-cooking losses.
d Data not presented for age groups/food groups where less than 20 observations were available.
NA = Not available.

Table 13-2. Confidence in Recommendations for Intake of Home-Produced Foods

General Assessment Factors	Rationale	Rating
Soundness		Medium (Means) Low (Distributions)
Adequacy of Approach	The NFCS survey methodology and the approach to data analysis were adequate, but individual intakes were inferred from household consumption data. The sample size was large (approximately 10,000 individuals).	
Minimal (or Defined) Bias	Non-response bias cannot be ruled out due to low response rate. Also, some biases may have occurred from using household data to estimate individual intake.	
Applicability and Utility		Low (Means and short-term distributions) Low (Long-term distributions)
Exposure Factor of Interest	The U.S. EPA analysis of the NFCS data specifically addressed home-produced intake.	
Representativeness	Data from a nationwide survey, representative of the general U.S. population was used.	
Currency	The data were collected in 1987–1988.	
Data Collection Period	Household data were collected over 1 week.	
Clarity and Completeness		High
Accessibility	The methods used to analyze the data are described in detail in this handbook; the primary data are accessible through USDA.	
Reproducibility	Sufficient details on the methods used to analyze the data are presented to allow the results to be reproduced.	
Quality Assurance	Quality assurance of NFCS data was good; quality control of the secondary data was sufficient.	
Variability and Uncertainty		Low to Medium
Variability in Population	Full distributions of home-produced intake rates were provided in the NFCS analysis. Phillips and Moya (2011) presented mean and 95th percentile values.	
Uncertainty	Sources of uncertainty include: individuals' estimates of food weights, allocation of household food to family members, and potential changes in eating patterns since these data were collected.	
Evaluation and Review		Medium
Peer Review	The study was reviewed by USDA and EPA.	
Number and Agreement of Studies	There was one key study that described the primary analysis of NFCS data and 1 key study that described a secondary analysis of the NFCS home-produced data.	
Overall Rating		**Low to Medium** (Means and short-term distributions) **Low** (Long-term distributions)

13.3. KEY STUDY FOR INTAKE OF HOME-PRODUCED FOODS

13.3.1. U.S. EPA Analysis of NFCS 1987–1988; Moya and Phillips (2001) Analysis of Consumption of Home-Produced Foods

U.S. EPA's National Center for Environmental Assessment (NCEA) analyzed USDA's 1987–1988 NFCS data to generate intake rates for home-produced foods. In addition, Moya and Phillips (2001) present a summary of these analyses. For the purposes of this study, home-produced foods were defined as home-produced fruits and vegetables, meat and dairy products derived from consumer-raised livestock or game meat, and home-caught fish.

Until 1988, USDA conducted the NFCS every 10 years to analyze the food consumption behavior and dietary status of Americans (USDA, 1992). While more recent food consumption surveys have been conducted to estimate food intake among the general population (e.g., USDA's Continuing Survey of Food Intake by Individuals [CSFII] and the National Health and Nutrition Examination Survey [NHANES]), these surveys have not collected data that can be used to estimate consumption of home-produced foods. Thus, the 1987–1988 NFCS data set is currently the best available source of information for this factor.

The 1987–1988 NFCS was conducted between April 1987 and August 1988. The survey used a statistical sampling technique designed to ensure that all seasons, geographic regions of the 48 conterminous states in the United States, and socioeconomic and demographic groups were represented (USDA, 1994). There were two components of the NFCS. The household component collected information over a 7-day period on the socioeconomic and demographic characteristics of households, as well as the types, amount, value, and sources of foods consumed by the household (USDA, 1994). Meanwhile, the individual intake component collected information on food intakes of individuals within each household over a 3-day period (USDA, 1993). The sample size for the 1987–1988 survey was approximately 4,300 households (more than 10,000 individuals; approximately 3,000 children). This was a decrease from the previous survey conducted in 1977–1978, which sampled approximately 15,000 households (more than 36,000 individuals) (USDA, 1994). The sample size was lower in the 1987–1988 survey as a result of budgetary constraints and low response rate (38% for the household survey and 31% for the individual survey; USDA, 1993).

The USDA data were adjusted by applying sample weights calculated by USDA to the data set prior to analysis. The USDA sample weights were designed to "adjust for survey non-response and other vagaries of the sample selection process" (USDA, 1987–1988). Also, the USDA weights are calculated "so that the weighted sample total equals the known population total, in thousands, for several characteristics thought to be correlated with eating behavior" (USDA, 1987–1988).

The food groups selected for analysis of home-produced food intake included major food groups (i.e., total fruits, total vegetables, total meats, total dairy, total fish and shellfish) and individual food items for which greater than 30 households reported eating the home-produced form of the item; fruits and vegetables categorized as exposed, protected, and roots; and various USDA fruit and vegetable subcategories (e.g., dark green vegetables, citrus fruits). These food groups were identified in the NFCS data base according to NFCS-defined food codes. Appendix 13A presents the codes and definitions used to determine the major food groups. Foods with these codes, for which the source was identified as home-produced, were included in the analysis. The codes and definitions for individual items in these food groups, as well as other subcategories (e.g., exposed, protected, dark green, citrus) considered to be home-produced are in Appendix 13B.

Although the individual intake component of the NFCS gives the best measure of the amount of each food group eaten by each individual in the household, it could not be used directly to measure consumption of home-produced food because the individual component does not identify the source of the food item (i.e., as home-produced or not). Therefore, an analytical method that incorporated data from both the household and individual survey components was developed to estimate individual home-produced food intake.

The household data were used to determine (1) the amount of each home-produced food items used during a week by household members, and (2) the number of meals eaten in the household by each household member during a week. Note that the household survey reports the total amount of each food item used in the household (whether by guests or household members); the amount used by household members was derived by multiplying the total amount used in the household by the proportion of all meals served in the household (during the survey week) that were consumed by household members. The individual survey data were used to generate average sex- and age-specific serving sizes for each food item. The age categories used in the analysis were as follows: 1 to 2 years, 3 to 5 years, 6 to 11 years, 12 to 19 years, 20 to 39 years, 40 to 69 years, and 70 years and older (intake rates were not calculated for children under 1 year of age; the rationale for this is discussed after equation 13-1). The serving sizes were used during subsequent analyses to generate home-produced food intake rates for individual household members. Assuming that the proportion of the household quantity of each home-produced food item/group was a function of the number of meals and the mean sex- and age-specific serving size for each family member, individual intakes of home-produced food were calculated for all members of the survey population using the following general equation:

$$w_i = w_f \left[\frac{m_i q_i}{\sum_{i=1}^{n} m_i q_i} \right] \qquad \text{(Eqn. 13-1)}$$

where:

w_i = Home-produced amount of food item/group attributed to member *i* during the week (g/week),
w_f = Total quantity of home-produced food item/group used by the family members (g/week),
m_i = Number of meals of household food consumed by member *i* during the week (meals/week), and
q_i = Serving size for an individual within the age and sex category of the member (g/meal).

Daily intake of a home-produced food group was determined by dividing the weekly value (w_i) by 7. Intake rates were indexed to the self-reported body weight of the survey respondent and reported in units of g/kg-day. Intake rates were not calculated for children less than 1 year of age because their diet differs markedly from that of other household members, and, thus, the assumption that all members share all foods would be invalid for this age group.

For the major food groups (i.e., fruits, vegetables, meats, dairy, and fish) and individual foods consumed by at least 30 households, distributions of home-produced intake among consumers were generated for the entire data set and for the following subcategories: age groups, urbanization categories, seasons, racial classifications, regions, and responses to a questionnaire.

Consumers were defined as members of survey households who reported consumption of the food item/group of interest during the 1-week survey period.

In addition, for the major food groups, distributions were generated for each region by season, urbanization, and responses to the questionnaire. Table 13-3 presents the codes, definitions, and a description of the data included in each of the subcategories. Intake rates were not calculated for food items/groups for which less than 30 households reported home-produced usage because the number of observations may be inadequate for generating distributions that would be representative of that segment of consumers. Fruits and vegetables were also classified as exposed, protected, or roots, as shown in Appendix 13B. *Exposed foods* are those that are grown above ground and are likely to be contaminated by pollutants deposited on surfaces of the foods that are eaten. *Protected products* are those that have outer protective coatings that are typically removed before consumption.

Distributions of intake were tabulated for these food classes for the same subcategories listed previously. Distributions were also tabulated for the following USDA food classifications: dark green vegetables, deep yellow vegetables, other vegetables, citrus fruits, and other fruits. Finally, the percentages of total intake of the food items/groups consumed within survey households that can be attributed to home production were tabulated. The percentage of intake that was home-produced was calculated as the ratio of total intake of the home-produced food item/group by the survey population to the total intake of all forms of the food by the survey population.

Percentiles of average daily intake derived from short-time intervals (e.g., 7 days) will not, in general, be reflective of long-term patterns. This is especially true in regards to consumption of many home-produced products (e.g., fruits, vegetables), where a strong seasonal component often is associated with their use. For the major food categories, to try to derive the long-term distribution of average daily intake rates from the short-term data available here, an approach was developed that attempted to account for seasonal variability in consumption. This approach used regional "seasonally adjusted distributions" to approximate regional long-term distributions and then combined these regional adjusted distributions (in proportion to the weights for each region) to obtain a U.S. adjusted distribution that approximated the U.S. long-term distribution. See Moya and Phillips (2001) for details.

The percentiles of the seasonally adjusted distribution for a given region were generated by averaging the corresponding percentiles of each of the four seasonal distributions of the region. More formally, the seasonally adjusted distribution for each region is such that its inverse cumulative distribution function is the average of the inverse cumulative distribution functions of each of the seasonal distributions of that region. The use of regional seasonally adjusted distributions to approximate regional long-term distributions is based on the assumption that each individual consumes the same regional percentile levels for each season and consumes at a constant weekly rate throughout a given season. For instance, if the 60th percentile weekly intake level in the South is 14.0 grams in the summer and 7.0 grams in each of the three other seasons, then the individual in the South with an average weekly intake of 14.0 grams during the summer is assumed to have an intake of 14.0 grams for each week of the summer and an intake of 7.0 grams for each week of the other seasons.

Note that the seasonally adjusted distributions were generated using the overall distributions (i.e., both consumers and non-consumers). However, because all the other distributions presented in this section are based on consumers only, the percentiles for the adjusted distributions have been revised to reflect the percentiles among consumers only. Given the assumption about how each individual consumes, the percentage consuming for the seasonally adjusted distributions gives an estimate of the percentage of the population consuming the specified food category at any time during the year.

The intake data presented in this chapter for consumers of home-produced foods and the total number of individuals surveyed may be used to calculate the mean and the percentiles of the distribution of home-produced food consumption in the overall population (consumers and non-consumers) as follows:

Assuming that IR_p is the home-produced intake rate of the food group at the p^{th} percentile and N_c is the weighted number of individuals consuming the home-produced food item, and N_T is the weighted total number of individuals surveyed, then N_T - N_c is the weighted number of individuals who reported zero consumption of the food item. In addition, there are ($p / 100 \times N_c$) individuals below the p^{th} percentile. Therefore, the percentile that corresponds to a particular intake rate (IR_p) for the overall distribution of home-produced food consumption (including consumers and non-consumers) can be obtained by:

$$p^{th}_{overall} = 100 \times \frac{\left(\frac{p}{100} \times N_c + \left(N_T - N_c \right) \right)}{N_T} \quad \text{(Eqn. 13-2)}$$

For example, the percentile of the overall population that is equivalent to the 50th percentile consumer-only intake rate for home-produced fruits would be calculated as follows:

From Table 13-5, the 50th percentile home-produced fruit intake rate (IR_{50}) is 1.07 g/kg-day. The weighted number of individuals consuming fruits (N_c) is 14,744,000. From Table 13-4, the weighted total number of individuals surveyed (N_T) is 188,019,000. The number of individuals consuming fruits below the 50th percentile is

$p / 100 \times N_c = (0.5) \times (14{,}744{,}000)$
$= 7{,}372{,}000$

The number of individuals that did not consume fruit during the survey period is

$N_T - N_c = 188{,}019{,}000 – 14{,}744{,}000$
$= 173{,}275{,}000$

The total number of individuals with home-produced intake rates at or below 1.07 g/kg-day is

$(p / 100 \times N_c) + (N_T - N_c) = 7{,}372{,}000$
$+ 173{,}275{,}000$
$= 180{,}647{,}000$

The percentile of the overall population that is represented by this intake rate is

$p^{th}_{overall}$ $100 \times (180{,}647{,}000 / 188{,}019{,}000)$
96^{th} *percentile*

Therefore, an intake rate of 1.07 g/kg-day of home-produced fruit corresponds to the 96th percentile of the overall population.

Following this same procedure, 5.97 g/kg-day, which is the 90th percentile of the consumers-only population, corresponds to the 99th percentile of the overall population. Likewise, 0.063 g/kg-day, which is the 1st percentile of the consumers-only population, corresponds to the 92nd percentile of the overall population. Note that the consumers-only distribution corresponds to the tail of the distribution for the overall population. Consumption rates below the 92nd percentile are very close to zero. The mean intake rate for the overall population can be calculated by multiplying the mean intake rate among consumers by the proportion of individuals consuming the home-produced food item N_c / N_T.

Table 13-4 displays the weighted numbers N_T and the unweighted total survey sample sizes for each subcategory and overall. Note that the total unweighted number of observations in Table 13-4 (9,852) is somewhat lower than the number of observations reported by USDA; this study only used observations for family members for which age and body weight were specified.

The intake rate distributions (among consumers) for total home-produced fruits, vegetables, meats, fish, and dairy products are shown, respectively, in Tables 13-5 through 13-29. These tables also show the proportion of respondents consuming the item during the (1-week) survey period. Home-produced vegetables were the most commonly consumed of the major food groups (18.3%), followed by fruit (7.8%), meat (4.9%), fish (2.1%), and dairy products (0.7%). The intake rates for the major food groups varied according to region, age, urbanization code, race, and responses to survey questions. In general, intake rates of home-produced foods were higher among populations in non-metropolitan and suburban areas and lowest in central city areas. Results of the regional analyses indicate that intake of home-produced fruits, vegetables, meat, and dairy products was generally highest for individuals in the Midwest and South regions and lowest for those in the Northeast region. Intake rates of home-caught fish were generally highest among consumers in the South. Home-produced intake was generally higher among individuals who indicated that they operate a farm, grow their own vegetables, raise animals, and catch their own fish. The results of the seasonal analyses for all regions combined indicate that, in general, home-produced fruits and vegetables were eaten at a higher rate in summer and home-caught fish was consumed at a higher rate in spring; however, seasonal intake varied based on individual regions. Table 13-30 presents seasonally adjusted intake rate distributions for the major food groups.

Tables 13-31 through 13-57 show distributions of intake for individual home-produced food items for households that reported consuming the home-produced form of the food during the survey period. Intake rate distributions among consumers for home-produced foods categorized as exposed fruits and vegetables, protected fruits and vegetables, and root vegetables are presented in Tables 13-58 through 13-62; the intake distributions for various USDA classifications (e.g., dark green vegetables) are presented in Tables 13-63 through 13-67. The results are presented in units of g/kg-day. Table 13-68 presents the fraction of household intake attributed to home-produced forms of the food items/groups evaluated. Thus, use of these data in calculating potential dose does not require the body-weight factor to be included in the denominator of the average daily dose in equation 1-2 in Chapter 1. Note that converting these intake rates into units of g/day by multiplying by a single average body weight is inappropriate, because individual intake rates were indexed to the reported body weights of the survey respondents.

As mentioned previously, the intake rates derived in this section are based on the amount of household food consumption. As measured by the NFCS, the amount of food consumed by the household is a measure of consumption in an economic sense (i.e., a measure of the weight of food brought into the household that has been consumed [used up] in some manner). In addition to food being consumed by persons, food may be used up by spoiling, by being discarded (e.g., inedible parts), through cooking processes, and other methods.

USDA estimated preparation losses for various foods (USDA, 1975). For meats, a net cooking loss, which includes dripping and volatile losses, and a net post-cooking loss, which involves losses from cutting, bones, excess fat, scraps and juices, were derived for a variety of cuts and cooking methods. For each meat type, U.S. EPA has averaged these losses across all cuts and cooking methods to obtain a mean net cooking loss and a mean net post-cooking loss. Table 13-69 provides mean percentage values for all meats and fish. For individual fruits and vegetables, USDA (1975) also gave cooking and post-cooking losses. These data, averaged across all types of fruits and vegetables to give mean net cooking and post-cooking losses, also are provided in Table 13-69.

The formula presented in equation 13-3 can be used to convert the home-produced intake rates tabulated here to rates reflecting actual consumption:

$$I_A = I \times (1 - L_1) \times (1 - L_2) \qquad \text{(Eqn. 13-3)}$$

where:

I_A	=	the adjusted intake rate,
I	=	the tabulated intake rate,
L_1	=	the cooking or preparation loss, and
L_2	=	the post-cooking loss.

Corrections based on post-cooking losses only apply to fruits that are eaten in cooked forms. For raw forms of the fruits, paring or preparation loss data should be used to correct for losses from the removal of skin, peel, core, caps, pits, stems, and defects, or from the draining of liquids from canned or frozen forms. To obtain preparation losses for food categories, the preparation losses of the individual foods making up the category can be averaged.

In calculating ingestion exposure, assessors should use consistent forms (e.g., as consumed or dry weight) in combining intake rates with contaminant concentrations (see Chapter 9).

The USDA NFCS data set is the largest publicly available source of information on home-produced food consumption habits in the United States. The advantages of using this data set are that it is expected to be representative of the U.S. population and that it provides information on a wide variety of food groups. However, the data collected by the USDA NFCS are based on short-term dietary recall, and the intake distributions generated from this data set may not accurately reflect long-term intake patterns, particularly with the tails (extremes) of the distributions. Also, the two survey components (i.e., household and individual) do not define food items/groups in a consistent manner; as a result, some errors may be introduced into these analyses because the two survey components are linked. The results presented in this chapter also may be biased by assumptions that are inherent in the analytical method utilized. The analytical method may not capture all high-end consumers within households because average serving sizes are used in calculating the proportion of home-produced food consumed by each household member. Thus, for instance, in a two-person household in which one member had high intake and another had low intake, the method used would assume that both members had an equal and moderate level of intake. In addition, the analyses assume that all family members consume a portion of the home-produced food used within the household. However, not all family members may consume each home-produced food item, and serving sizes allocated in this instance may not be entirely representative of the portion of household foods consumed by each family member. As was mentioned earlier, no analyses were performed for children under 1 year of age.

The preparation loss factors discussed previously are intended to convert intake rates based on "household consumption" to rates reflective of what individuals actually consume. However, these factors do not include losses to spoilage, feeding to pets, food thrown away, and other methods. It also should be noted that because this analysis is based on the 1987–1988 NFCS, it may not reflect recent changes in food consumption patterns. The low response rate associated with the 1987–1988 NFCS also contributes to the uncertainty of the home-produced intake rates generated using these data.

13.3.2. Phillips and Moya (2011)—Estimation of Age-Specific Per Capita Home-Produced Food Intake Among Populations That Garden, Farm, or Raise Animals

Phillips and Moya (2011) used the consumer intake data for home-produced fruits, vegetables, meats, and dairy products from the analysis described in Section 13.3.1 to estimate per capita intake rates for the populations that garden, farm, or raise animals. The consumer-only intake values in Section 13.3.1 are based on short-term dietary survey data and may be appropriate for estimating short-term intake, but may over-estimate exposure over longer time periods. Also, the intake rates in Section 13.3.1 represent intake of foods brought into the household and have not been adjusted to account for preparation losses and post-cooking losses. Phillips and Moya (2011) converted the distribution of consumer-only intake rates for populations that garden, farm, and raise animals to the distribution of per capita rates using equation 13-2 and adjusted these data to account for preparation losses and post-cooking losses using equation 13-3. Data for households that garden, farm, or raise animals were used because they were assumed to represent both households who ate home-produced foods during the survey period as well as those who did not eat home-produced foods during the survey period, but may eat these foods at some other time during the year. Also, the data in Section 13.3.1 for the populations that garden, farm, or raise animals are not provided by age group, but represent data for all ages of the survey population combined. Phillips and Moya (2011) calculated age-specific intake rates using ratios of age-specific dietary intake to total population intake rates, based on survey data for intake of total fruits, vegetables, meats, and dairy from all sources (i.e., both home-produced and commercial sources) from the 1994-1996, 1998 CSFII, as described in Chapters 9 and 11.

The age groups used are those recommended in U.S. EPA (2005). Age-specific intake mean and 95th percentile intake rates were estimated as: age-specific ratio × mean (or 95th percentile) per capita intake for the total population, where the age-specific ratio = age-specific mean per capita total intake (g/kg-day)/ total population mean per capita total intake (g/kg-day). Table 13-70 provides the both the adjusted and unadjusted estimated mean and 95th per-capita intake rates for the total populations that garden, farm, and raise animals. Table 13-70 also provides age-specific per capita intake rates based on data that have been adjusted to account for preparation and post-cooking losses.

The advantages of this analysis are that it provides data for populations that may be of particular interest because they may represent the high-end of the per capita home-produced food intake distribution (Phillips and Moya, 2011), and that age-specific intake rates are provided for the age groups recommended by U.S. EPA (2005). However, it should be noted that these estimates are based on data that are more than 20 years old and may not reflect recent changes in consumption patterns. Also, the data for children less than 1 year of age are considered to be less certain than for other age groups because the diets of children in this age range would be expected to be highly variable (Phillips and Moya, 2011). Other limitations associated with this analysis are the same as those described in Section 13.3.1 for the analysis of the NFCS data.

13.4. RELEVANT STUDY FOR INTAKE OF HOME-PRODUCED FOODS

13.4.1. National Gardening Association (2009)

According to a survey by the National Gardening Association (2009), an estimated 36 million (or 31%) of U.S. households participated in food gardening in 2008. Food gardening includes growing vegetables, berries, fruit, and herbs. Of the estimated 36 million food-gardening households, 23% participated in vegetable gardening, 12% participated in herb gardening, 10% participated in growing fruit trees, and 6% grew berries. Table 13-71 contains demographic data on food gardening in 2008 by sex, age, education, household income, and household size. Table 13-72 contains information on the types of vegetables grown by home gardeners in 2008. Tomatoes, cucumbers, peppers, beans, carrots, summer squash, onions, lettuce, peas, and corn are among the vegetables grown by the largest percentage of gardeners.

13.5. REFERENCES FOR CHAPTER 13

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Table 13-3. Subcategory Codes, Definitions, and Descriptions		
Code	Definition	Description
		Region[a]
1	Northeast	Includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.
2	Midwest	Includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.
3	South	Includes Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.
4	West	Includes Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.
		Urbanization
1	Central City	Cities with populations of 50,000 or more that is the main city within the metropolitan statistical area (MSA).
2	Suburban	An area that is generally within the boundaries of an MSA but is not within the legal limit of the central city.
3	Non-metropolitan	An area that is not within an MSA.
		Race
1	--	White (Caucasian)
2	--	Black
3	--	Asian and Pacific Islander
4	--	Native American, Aleuts, and Eskimos
5, 8, 9	Other/NA	Don't know, no answer, some other race
		Responses to Survey Questions
Grow	Question 75	Did anyone in the household grow any vegetables or fruit for use in the household?
Raise Animals	Question 76	Did anyone in the household produce any animal products such as milk, eggs, meat, or poultry for home use in your household?
Fish/Hunt	Question 77	Did anyone in the household catch any fish or shoot game for home use?
Farm	Question 79	Did anyone in the household operate a farm or ranch?
		Season
Spring	-	April, May, June
Summer	-	July, August, September
Fall	-	October, November, December
Winter	-	January, February, March

[a] Alaska and Hawaii were not included.

Source: USDA, 1987–1988.

Table 13-4. Weighted and Unweighted Number of Observations (Individuals) for NFCS Data Used in Analysis of Food Intake

	All Regions		Northeast		Midwest		South		West	
	wgtd	unwgtd	wgtd	unwgtd	wgtd	unwgtd	wgtd	unwgtd	wgtd	unwgtd
Total	188,019,000	9,852	41,167,000	2,018	46,395,000	2,592	64,331,000	3,399	36,066,000	1,841
Age (years)										
< 1	2,814,000	156	545,000	29	812,000	44	889,000	51	568,000	32
1 to 2	5,699,000	321	1,070,000	56	1,757,000	101	1,792,000	105	1,080,000	59
3 to 5	8,103,000	461	1,490,000	92	2,251,000	133	2,543,000	140	1,789,000	95
6 to 11	16,711,000	937	3,589,000	185	4,263,000	263	5,217,000	284	3,612,000	204
12 to 19	20,488,000	1,084	4,445,000	210	5,490,000	310	6,720,000	369	3,833,000	195
20 to 39	61,606,000	3,058	12,699,000	600	15,627,000	823	21,786,000	1,070	11,494,000	565
40 to 69	56,718,000	3,039	13,500,000	670	13,006,000	740	19,635,000	1,080	10,577,000	549
≥ 70	15,880,000	796	3,829,000	176	3,189,000	178	5,749,000	300	3,113,000	142
Season										
Fall	47,667,000	1,577	9,386,000	277	14,399,000	496	13,186,000	439	10,696,000	365
Spring	46,155,000	3,954	10,538,000	803	10,657,000	1,026	16,802,000	1,437	8,158,000	688
Summer	45,485,000	1,423	9,460,000	275	10,227,000	338	17,752,000	562	7,986,000	246
Winter	48,712,000	2,898	11,783,000	663	11,112,000	732	16,591,000	961	9,226,000	542
Urbanization										
Central City	56,352,000	2,217	9,668,000	332	17,397,000	681	17,245,000	715	12,042,000	489
Non-metropolitan	45,023,000	3,001	5,521,000	369	14,296,000	1,053	19,100,000	1,197	6,106,000	382
Suburban	86,584,000	4,632	25,978,000	1,317	14,702,000	858	27,986,000	1,487	17,918,000	970
Race										
Asian	2,413,000	114	333,000	13	849,000	37	654,000	32	577,000	32
Black	21,746,000	1,116	3,542,000	132	2,794,000	126	13,701,000	772	1,709,000	86
Native American	1,482,000	91	38,000	4	116,000	6	162,000	8	1,166,000	73
Other/NA	4,787,000	235	1,084,000	51	966,000	37	1,545,000	86	1,192,000	61
White	157,531,000	8,294	36,170,000	1,818	41,670,000	2,386	48,269,000	2,501	31,422,000	1,589
Response to Questionnaire										
Do you garden?	6,8152,000	3,744	12,501,000	667	22,348,000	1,272	20,518,000	1,136	12,725,000	667
Do you raise animals?	10,097,000	631	1,178,000	70	3,742,000	247	2,603,000	162	2,574,000	152
Do you hunt?	20,216,000	1,148	3,418,000	194	6,948,000	411	6,610,000	366	3,240,000	177
Do you fish?	39,733,000	2,194	5,950,000	321	12,621,000	725	13,595,000	756	7,567,000	392
Do you farm?	7,329,000	435	830,000	42	2,681,000	173	2,232,000	130	1,586,000	90

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-5. Consumer-Only Intake of Home-Produced Fruits (g/kg-day)—All Regions Combined

Population Group	Nc wgtd	Nc Unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	14,744,000	817	7.84	2.68	0.19	0.06	0.17	0.28	0.50	1.07	2.37	5.97	11.10	24.00	60.60
Age (years)															
1 to 2	360,000	23	6.32	8.74	3.10	0.96	1.09	1.30	1.64	3.48	7.98	19.30	60.60	60.60	60.60
3 to 5	550,000	34	6.79	4.07	1.48	0.01	0.01	0.36	0.98	1.92	2.73	6.02	8.91	48.30	48.30
6 to 11	1,044,000	75	6.25	3.59	0.68	0.01	0.19	0.40	0.70	1.31	3.08	11.80	15.80	32.20	32.20
12 to 19	1,189,000	67	5.80	1.94	0.37	0.09	0.13	0.27	0.44	0.66	2.35	6.76	8.34	18.50	18.50
20 to 39	3,163,000	164	5.13	1.95	0.33	0.08	0.13	0.20	0.37	0.70	1.77	4.17	6.84	16.10	37.00
40 to 69	5,633,000	309	9.93	2.66	0.30	0.06	0.19	0.29	0.47	1.03	2.33	5.81	13.00	23.80	53.30
≥ 70	2,620,000	134	16.50	2.25	0.23	0.04	0.22	0.38	0.61	1.18	2.35	5.21	8.69	11.70	15.30
Season															
Fall	3,137,000	108	6.58	1.57	0.16	0.26	0.30	0.39	0.57	1.04	1.92	3.48	4.97	10.60	10.60
Spring	2,963,000	301	6.42	1.58	0.14	0.09	0.20	0.25	0.42	0.86	1.70	4.07	5.10	8.12	31.70
Summer	4,356,000	145	9.58	3.86	0.64	0.01	0.09	0.16	0.45	1.26	3.31	10.90	14.60	53.30	60.60
Winter	4,288,000	263	8.80	3.08	0.34	0.04	0.17	0.27	0.56	1.15	2.61	8.04	15.30	24.90	48.30
Urbanization															
Central City	3,668,000	143	6.51	2.31	0.26	0.04	0.18	0.33	0.57	1.08	2.46	5.34	10.50	14.30	19.30
Non-metropolitan	4,118,000	278	9.15	2.41	0.31	0.06	0.13	0.23	0.45	1.15	2.42	4.46		24.00	53.30
Suburban	6,898,000	394	7.97	3.07	0.32	0.13	0.23	0.30	0.49	0.99	2.33	7.26	8.34 15.20	37.00	60.60
Race															
Black	450,000	20	2.07	1.87	0.85	0.13	0.28	0.46	0.61	1.13	1.53	2.29	2.29	19.30	19.30
White	14,185,000	793	9.00	2.73	0.19	0.07	0.18	0.28	0.51	1.07	2.46	6.10	11.70	24.00	60.60
Response to Questionnaire															
Households who garden	12,742,000	709	18.70	2.79	0.21	0.06	0.18	0.29	0.53	1.12	2.50	6.10	11.80	24.90	60.60
Households who farm	1,917,000	112	26.16	2.58	0.26	0.07	0.28	0.41	0.75	1.61	3.62	5.97	7.82	15.80	15.80

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987–1988 NFCS.)

Table 13-6. Consumer-Only Intake of Home-Produced Fruits (g/kg-day)—Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,279,000	72	3.11	0.93	0.22	0.08	0.08	0.16	0.31	0.49	0.78	1.29	2.16	11.70	11.70
Season															
Fall	260,000	8	2.77	*	*	*	*	*	*	*	*	*	*	*	*
Spring	352,000	31	3.34	0.88	0.23	0.09	0.16	0.17	0.29	0.49	0.88	1.83	2.16	7.13	7.13
Summer	271,000	9	2.86	*	*	*	*	*	*	*	*	*	*	*	*
Winter	396,000	24	3.36	0.71	0.11	0.18	0.21	0.23	0.29	0.54	0.88	1.38	1.79	2.75	2.75
Urbanization															
Central City	50,000	3	0.52	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	176,000	10	3.19	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	1,053,000	59	4.05	1.05	0.26	0.18	0.23	0.29	0.44	0.54	0.81	1.29	2.75	11.70	11.70
Response to Questionnaire															
Households who garden	983,000	59	7.86	1.04	0.26	0.09	0.18	0.21	0.38	0.54	0.88	1.38	2.75	11.70	11.70
Households who farm	132,000	4	15.90	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-7. Consumer-Only Intake of Home-Produced Fruits (g/kg-day)—Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	4,683,000	302	10.09	3.01	0.41	0.04	0.13	0.24	0.47	1.03	2.31	6.76	13.90	53.30	60.60
Season															
Fall	1,138,000	43	7.90	1.54	0.19	0.26	0.30	0.47	0.61	1.07	1.92	3.48	4.34	5.33	5.33
Spring	1,154,000	133	10.83	1.69	0.28	0.09	0.21	0.26	0.42	0.92	1.72	2.89	4.47	16.00	31.70
Summer	1,299,000	44	12.70	7.03	1.85	0.06	0.09	0.13	0.43	1.55	8.34	16.10	37.00	60.60	60.60
Winter	1,092,000	82	9.83	1.18	0.18	0.03	0.06	0.15	0.36	0.61	1.42	2.61	3.73	10.90	10.90
Urbanization															
Central City	1,058,000	42	6.08	1.84	0.39	0.04	0.10	0.26	0.52	1.07	1.90	2.82	9.74	10.90	10.90
Non-metropolitan	1,920,000	147	13.43	2.52	0.54	0.06	0.11	0.15	0.40	1.03	2.07	4.43		53.30	53.30
Suburban	1,705,000	113	11.60	4.29	0.87	0.09	0.20	0.31	0.48	0.76	3.01	13.90	18.00	60.60	60.60
												6.84			
Response to Questionnaire															
Households who garden	4,060,000	267	18.17	3.27	0.47	0.04	0.10	0.20	0.45	1.07	2.37	7.15	14.60	53.30	60.60
Households who farm	694,000	57	25.89	2.59	0.30	0.06	0.19	0.41	1.26	1.63	3.89	6.76	8.34	11.10	11.10

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-8. Consumer-Only Intake of Home-Produced Fruits (g/kg-day)—South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	4,148,000	208	6.45	2.97	0.30	0.11	0.24	0.36	0.60	1.35	3.01	8.18	14.10	23.80	24.00
Season															
Fall	896,000	29	6.80	1.99	0.44	0.39	0.43	0.45	0.65	1.13	1.96	4.97	8.18	10.60	10.60
Spring	620,000	59	3.69	2.05	0.26	0.16	0.28	0.31	0.45	1.06	4.09	5.01	6.58	7.05	7.05
Summer	1,328,000	46	7.48	2.84	0.65	0.08	0.16	0.27	0.44	1.31	2.83	6.10	14.30	24.00	24.00
Winter	1,304,000	74	7.86	4.21	0.65	0.11	0.24	0.38	0.89	1.88	3.71	14.10	19.70	23.80	23.80
Urbanization															
Central City	1,066,000	39	6.18	3.33	0.54	0.24	0.39	0.46	0.83	2.55	4.77	8.18	10.60	14.30	14.30
Non-metropolitan	1,548,000	89	8.10	2.56	0.39	0.08	0.27	0.34	0.61	1.40	2.83	5.97	10.40	24.00	24.00
Suburban	1,534,000	80	5.48	3.14	0.60	0.11	0.16	0.28	0.51	1.10	2.29	11.80	15.50	23.80	23.80
Response to Questionnaire															
Households who garden	3,469,000	174	16.91	2.82	0.29	0.16	0.28	0.38	0.65	1.39	2.94	6.10	14.10	21.10	24.00
Households who farm	296,000	16	13.26	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-9. Consumer-Only Intake of Home-Produced Fruits (g/kg-day)—West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	p1	p5	p10	p25	p50	p75	p90	p95	p99	MAX
Total	4,574,000	233	12.68	2.62	0.31	0.15	0.28	0.33	0.62	1.20	2.42	5.39	10.90	24.90	48.30
Season															
Fall	843,000	28	7.88	1.47	0.25	0.29	0.29	0.30	0.48	1.04	2.15	2.99	4.65	5.39	5.39
Spring	837,000	78	10.26	1.37	0.16	0.17	0.20	0.25	0.51	0.98	1.61	2.95	5.29	6.68	7.02
Summer	1,398,000	44	17.51	2.47	0.47	0.19	0.28	0.40	0.62	1.28	3.14	7.26	10.90	13.00	13.00
Winter	1,496,000	83	16.22	4.10	0.79	0.07	0.30	0.33	0.77	1.51	3.74	11.10	18.50	48.30	48.30
Urbanization															
Central City	1,494,000	59	12.41	1.99	0.42	0.07	0.24	0.34	0.53	0.86	2.04	4.63	9.52	19.30	19.30
Non-metropolitan	474,000	32	7.76	2.24	0.53	0.18	0.28	0.42	0.63	0.77	2.64	4.25	10.90	10.90	10.90
Suburban	2,606,000	142	14.54	3.04	0.46	0.18	0.28	0.31	0.71	1.39	3.14	5.81	10.30	32.20	48.30
Response to Questionnaire															
Households who garden	4,170,000	207	32.77	2.76	0.34	0.10	0.28	0.31	0.63	1.20	2.54	5.81	10.90	24.90	48.30
Households who farm	795,000	35	50.13	1.85	0.26	0.28	0.28	0.60	0.71	1.26	2.50	4.63	5.00	6.81	6.81

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-10. Consumer-Only Intake of Home-Produced Vegetables (g/kg-day)—All Regions Combined

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	34,392,000	1,855	18.29	2.08	0.07	0.00	0.11	0.18	0.45	1.11	2.47	5.20	7.54	15.50	27.00
Age															
1 to 2	951,000	53	16.69	5.20	0.85	0.02	0.25	0.38	1.23	3.27	5.83	13.10	19.60	27.00	27.00
3 to 5	1,235,000	76	15.24	2.46	0.28	0.00	0.05	0.39	0.71	1.25	3.91	6.35	7.74	10.60	12.80
6 to 11	3,024,000	171	18.10	2.02	0.25	0.01	0.10	0.16	0.40	0.89	2.21	4.64	6.16	17.60	23.60
12 to 19	3,293,000	183	16.07	1.48	0.14	0.00	0.06	0.15	0.32	0.81	1.83	3.71	6.03	7.71	9.04
20 to 39	8,593,000	437	13.95	1.47	0.10	0.02	0.08	0.16	0.27	0.76	1.91	3.44	4.92	10.50	20.60
40 to 69	12,828,000	700	22.62	2.07	0.10	0.01	0.12	0.21	0.53	1.18	2.47	5.12	6.94	14.90	22.90
≥ 70	4,002,000	211	25.20	2.51	0.19	0.01	0.15	0.24	0.58	1.37	3.69	6.35	8.20	12.50	15.50
Season															
Fall	11,026,000	394	23.13	1.88	0.13	0.05	0.11	0.18	0.41	0.98	2.11	4.88	6.94	12.50	18.90
Spring	6,540,000	661	14.17	1.36	0.07	0.00	0.04	0.14	0.32	0.70	1.63	3.37	5.21	8.35	23.60
Summer	11,081,000	375	24.36	2.86	0.19	0.07	0.16	0.22	0.71	1.62	3.44	6.99	9.75	18.70	27.00
Winter	5,745,000	425	11.79	1.79	0.11	0.00	0.04	0.16	0.47	1.05	2.27	3.85	6.01	10.60	20.60
Urbanization															
Central City	6,183,000	228	10.97	1.40	0.12	0.01	0.07	0.15	0.30	0.75	1.67	3.83	4.67	9.96	16.60
Non-metropolitan	13,808,000	878	30.67	2.68	0.12	0.02	0.16	0.26	0.60	1.45	3.27	6.35	9.33	17.50	27.00
Suburban	14,341,000	747	16.56	1.82	0.09	0.00	0.11	0.16	0.39	0.96	2.18	4.32	6.78	12.50	20.60
Race															
Black	1,872,000	111	8.61	1.78	0.23	0.00	0.08	0.14	0.44	0.93	2.06	4.68	5.70	8.20	18.90
White	31,917,000	1,714	20.26	2.10	0.07	0.01	0.11	0.18	0.45	1.12	2.48	5.18	7.68	15.50	27.00
Response to Questionnaire															
Households who garden	30,217,000	1,643	44.34	2.17	0.07	0.01	0.11	0.19	0.48	1.18	2.68	5.35	7.72	15.50	23.60
Households who farm	4,319,000	262	58.93	3.29	0.25	0.00	0.16	0.29	0.85	1.67	3.61	8.88	11.80	17.60	23.60

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987–1988 NCFS.)

Table 13-11. Consumer-Only Intake of Home-Produced Vegetables (g/kg-day)—Northeast															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	4,883,000	236	11.86	1.78	0.17	0.00	0.08	0.14	0.28	0.75	1.89	6.03	7.82	12.70	14.90
Season															
Fall	1,396,000	41	14.87	1.49	0.41	0.08	0.13	0.17	0.27	0.58	1.17	6.64	9.97	10.20	10.20
Spring	1,204,000	102	11.43	0.82	0.11	0.00	0.00	0.04	0.17	0.46	0.95	2.26	3.11	6.52	6.78
Summer	1,544,000	48	16.32	2.83	0.47	0.11	0.15	0.16	0.74	1.29	3.63	7.82	9.75	14.90	14.90
Winter	739,000	45	6.27	1.67	0.27	0.00	0.00	0.09	0.26	1.25	2.77	3.63	6.10	8.44	8.44
Urbanization															
Central City	380,000	14	3.93	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	787,000	48	14.25	3.05	0.54	0.00	0.05	0.11	0.20	2.18	4.61	9.04		14.90	14.90
Suburban	3,716,000	174	14.30	1.59	0.17	0.00	0.08	0.14	0.28	0.72	1.64	4.82	6.80	10.20	10.20
Response to Questionnaire													12.70		
Households who garden	4,381,000	211	35.05	1.92	0.18	0.00	0.08	0.14	0.31	0.88	2.18	6.16	7.82	12.70	14.90
Households who farm	352,000	19	42.41	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-12. Consumer-Only Intake of Home-Produced Vegetables (g/kg-day)—Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	12,160,000	699	26.21	2.26	0.12	0.02	0.08	0.18	0.49	1.15	2.58	5.64	7.74	17.50	23.60
Season															
Fall	4,914,000	180	34.13	1.84	0.18	0.01	0.07	0.16	0.42	1.03	2.10	5.27	6.88	13.10	13.10
Spring	2,048,000	246	19.22	1.65	0.15	0.06	0.15	0.22	0.46	0.91	1.72	4.49	5.83	12.80	23.60
Summer	3,319,000	115	32.45	3.38	0.39	0.11	0.16	0.30	0.85	2.07	3.94	7.72	14.00	19.60	22.90
Winter	1,879,000	158	16.91	2.05	0.26	0.00	0.02	0.07	0.36	0.88	2.13	5.32	7.83	16.70	20.60
Urbanization															
Central City	3,177,000	113	18.26	1.36	0.19	0.00	0.06	0.11	0.25	0.71	1.67	3.94	5.50	9.96	16.60
Non-metropolitan	5,344,000	379	37.38	2.73	0.19	0.02	0.11	0.26	0.60	1.31	3.15	7.19	10.60	17.50	23.60
Suburban	3,639,000	207	24.75	2.35	0.22	0.03	0.15	0.22	0.64	1.39	2.75	4.87	7.18	19.60	20.60
Response to Questionnaire															
Households who garden	10,927,000	632	48.89	2.33	0.13	0.02	0.10	0.18	0.50	1.18	2.74	5.81	7.75	16.70	23.60
Households who farm	1,401,000	104	52.26	3.97	0.43	0.14	0.34	0.55	0.87	2.18	5.24	10.60	14.40	17.50	23.60

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-13. Consumer-Only Intake of Home-Produced Vegetables (g/kg-day)—South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	11,254,000	618	17.49	2.19	0.12	0.03	0.16	0.24	0.56	1.24	2.69	4.92	7.43	17.00	27.00
Season															
Fall	2,875,000	101	21.80	2.07	0.28	0.10	0.11	0.19	0.52	1.14	2.69	4.48	6.02	15.50	18.90
Spring	2,096,000	214	12.47	1.55	0.11	0.01	0.09	0.26	0.53	0.94	2.07	3.58	4.81	8.35	10.30
Summer	4,273,000	151	24.07	2.73	0.32	0.11	0.17	0.25	0.62	1.54	3.15	5.99	9.70	23.60	27.00
Winter	2,010,000	152	12.12	1.88	0.14	0.00	0.16	0.35	0.64	1.37	2.69	3.79	5.35	7.47	8.36
Urbanization															
Central City	1,144,000	45	6.63	1.10	0.16	0.01	0.10	0.15	0.26	0.62	1.37	2.79	3.70	4.21	4.58
Non-metropolitan	6,565,000	386	34.37	2.78	0.18	0.05	0.22	0.35	0.71	1.66	3.31	5.99	9.56	18.90	27.00
Suburban	3,545,000	187	12.67	1.44	0.11	0.00	0.11	0.20	0.40	0.93	1.72	3.61	5.26	8.20	8.20
Response to Questionnaire															
Households who garden	9,447,000	522	46.04	2.27	0.12	0.03	0.16	0.26	0.61	1.37	3.02	5.18	7.43	15.50	23.60
Households who farm	1,609,000	91	72.09	3.34	0.46	0.00	0.13	0.23	1.03	1.72	3.15	9.56	11.80	23.60	23.60

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-14. Consumer-Only Intake of Home-Produced Vegetables (g/kg-day)—West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	6,035,000	300	16.73	1.81	0.14	0.01	0.10	0.17	0.38	0.90	2.21	4.64	6.21	11.40	15.50
Season															
Fall	1,841,000	72	17.21	2.01	0.29	0.10	0.15	0.20	0.48	1.21	2.21	4.85	7.72	12.50	12.50
Spring	1,192,000	99	14.61	1.06	0.17	0.00	0.01	0.05	0.20	0.36	0.91	3.37	5.54	8.60	8.60
Summer	1,885,000	59	23.6	2.39	0.37	0.07	0.10	0.25	0.55	1.37	3.23	4.67	8.36	15.50	15.50
Winter	1,117,000	70	12.11	1.28	0.17	0.01	0.15	0.20	0.48	0.77	1.43	2.81	5.12	7.57	7.98
Urbanization															
Central City	1,482,000	56	12.31	1.80	0.28	0.03	0.07	0.16	0.48	1.10	2.95	4.64	4.85	11.40	11.40
Non-metropolitan	1,112,000	65	18.21	1.52	0.22	0.00	0.01	0.20	0.27	0.68	2.13	4.13	5.12	8.16	8.16
Suburban	3,441,000	179	19.20	1.90	0.20	0.01	0.10	0.15	0.39	0.93	2.20	4.63	7.98	12.50	15.50
Response to Questionnaire															
Households who garden	5,402,000	276	42.45	1.91	0.00	0.01	0.10	0.17	0.43	1.07	2.37	4.67	6.21	12.50	15.50
Households who farm	957,000	48	60.34	2.73	0.00	0.12	0.41	0.47	0.77	1.42	3.27	6.94	10.90	15.50	15.50

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-15. Consumer-Only Intake of Home-Produced Meats (g/kg-day)—All Regions Combined															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	9,257,000	569	4.92	2.21	0.11	0.12	0.24	0.37	0.66	1.39	2.89	4.89	6.78	14.00	23.20
Age															
1 to 2	276,000	22	4.84	3.65	0.61	0.39	0.95	0.95	1.19	2.66	4.72	8.68	10.00	11.50	11.50
3 to 5	396,000	26	4.89	3.61	0.51	0.80	0.80	1.51	2.17	2.82	3.72	7.84	9.13	13.00	13.00
6 to 11	1,064,000	65	6.37	3.65	0.45	0.37	0.65	0.72	1.28	2.09	4.71	8.00	14.00	15.30	15.30
12 to 19	1,272,000	78	6.21	1.70	0.17	0.19	0.32	0.47	0.62	1.23	2.35	3.66	4.34	6.78	7.51
20 to 39	2,732,000	158	4.43	1.82	0.15	0.12	0.19	0.30	0.53	1.11	2.65	4.52	6.23	9.17	10.90
40 to 69	2,872,000	179	5.06	1.72	0.11	0.02	0.21	0.34	0.58	1.17	2.38	3.67	5.16	5.90	7.46
≥ 70	441,000	28	2.78	1.39	0.23	0.09	0.09	0.13	0.55	1.01	1.81	2.82	3.48	7.41	7.41
Season															
Fall	2,852,000	107	5.98	1.57	0.14	0.12	0.21	0.35	0.52	1.11	2.27	3.19	4.41	6.78	7.84
Spring	1,726,000	197	3.74	2.37	0.15	0.24	0.32	0.45	0.78	1.69	3.48	5.00	6.67	10.10	13.00
Summer	2,368,000	89	5.21	3.10	0.38	0.02	0.19	0.41	0.85	1.77	4.34	7.01	10.50	22.30	22.30
Winter	2,311,000	176	4.74	1.98	0.17	0.14	0.24	0.37	0.65	1.33	2.43	3.96	6.40	10.90	23.20
Urbanization															
Central City	736,000	28	1.31	1.15	0.18	0.18	0.19	0.21*	0.44	0.72	1.58	2.69	3.40	3.64	3.64
Non-metropolitan	4,932,000	315	10.95	2.70	0.18	0.12	0.26	0.41	0.75	1.63	3.41	6.06		15.30	23.20
Suburban	3,589,000	226	4.15	1.77	0.10	0.03	0.29	0.37	0.68	1.33	2.49	3.66 8.47	4.71	7.20	10.10
Race															
Black	128,000	6	0.59	*		*	*	*	*		*	*	*	*	*
White	8,995,000	556	5.71	2.26	0.11	0.09	0.26	0.39	0.68	1.41	2.91	5.00	7.01	14.00	23.20
Response to Questionnaire															
Households who raise animals	5,256,000	343	52.06	2.80	0.15	0.21	0.39	0.62	1.03	1.94	3.49	5.90	7.84	14.00	23.20

* Intake data not provided for subpopulations for which there were less than 20 observations.
SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987–1988 NFCS.)

Table 13-16. Consumer-Only Intake of Home-Produced Meats (g/kg-day)—Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,113,000	52	2.70	1.46	0.21	0.29	0.34	0.35	0.64	0.89	1.87	2.68	2.89	10.90	10.90
Season															
Fall	569,000	18	6.06	*	*	*	*	*	*		*	*	*	*	*
Spring	66,000	8	0.63	*	*	*	*	*	*		*	*	*	*	*
Summer	176,000	6	1.86	*	*	*	*	*	* *		*	*	*	*	*
Winter	302,000	20	2.56	2.02	0.56	0.29	0.31	0.43	0.62	1.11	2.38	2.93	7.46	10.90	10.90
Urbanization									*						
Central City	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Non-metropolitan	391,000	17	7.08	*	*	*	*	*	*		*	*	*	*	*
Suburban	722,000	35	2.78	1.49	0.15	0.29	0.35	0.43	0.68	1.39	2.34	2.68	2.89	3.61	3.61
Response to Questionnaire									*						
Households who raise animals	509,000	25	43.21	2.03	0.39	0.62	0.65	0.65	0.88	1.62	2.38	2.93	7.46	10.90	10.90
Households who farm	373,000	15	44.94	*	*	*	*	*	*		*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.
SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-17. Consumer-Only Intake of Home-Produced Meats (g/kg-day)—Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	3,974,000	266	8.57	2.55	0.18	0.13	0.26	0.39	0.66	1.40	3.39	5.75	7.20	15.30	22.30
Season															
Fall	1,261,000	49	8.76	1.76	0.23	0.21	0.26	0.37	0.50	1.19	2.66	3.49	6.06	6.78	6.78
Spring	940,000	116	8.82	2.58	0.22	0.24	0.31	0.41	0.73	1.98	3.67	5.14	7.79	11.50	13.00
Summer	930,000	38	9.09	4.10	0.75	0.09	0.13	0.58	0.89	2.87	5.42	8.93	15.30	22.30	22.30
Winter	843,000	63	7.59	2.00	0.24	0.12	0.24	0.33	0.65	1.36	2.69	4.11	5.30	8.10	12.20
Urbanization															
Central City	460,000	18	2.64	*	*	*	*	*		*	*	*	*	*	*
Non-metropolitan	2,477,000	175	17.33	3.15	0.26	0.09	0.30	0.43	0.82	2.38	4.34	6.15		15.30	22.30
Suburban	1,037,000	73	7.05	1.75	0.20	0.29	0.37	0.41	0.66	1.11	2.03	4.16	9.17 5.39	7.20	10.10
Response to Questionnaire															
Households who raise animals	2,165,000	165	57.86	3.20	0.22	0.26	0.39	0.58	1.07	2.56	4.42	6.06	9.13	15.30	15.30
~~Households who farm~~	1,483,000	108	55.32	3.32	0.29	0.37	0.54	0.59	1.07	2.75	4.71	6.78	9.17	15.30	15.30

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-18. Consumer-Only Intake of Home-Produced Meats (g/kg-day)—South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,355,000	146	3.66	2.24	0.19	0.02	0.16	0.30	0.72	1.53	3.07	5.07	6.71	14.00	14.00
Season															
Fall	758,000	28	5.75	1.81	0.29	0.12	0.16	0.19	0.82	1.53	2.38	3.19	4.41	7.84	7.84
Spring	511,000	53	3.04	2.33	0.27	0.19	0.30	0.50	0.75	1.80	2.82	5.16	6.71	7.51	7.51
Summer	522,000	18	2.94	*	*	*	*	*	*	*		*	*	*	*
Winter	564,000	47	3.40	1.80	0.25	0.04	0.20	0.25	0.72	1.40	2.17	3.55	4.58	8.47	8.47
Urbanization										*					
Central City	40,000	1	0.23	*	*	*	*	*	*	*		*	*	*	*
Non-metropolitan	1,687,000	97	8.83	2.45	0.26	0.12	0.19	0.40	0.78	1.61	3.19	6.09		14.00	14.00
Suburban	628,000	48	2.24	1.79	0.23	0.02	0.03	0.04	0.63	1.40	2.31	4.56	7.84 4.61	6.40	6.40
Response to Questionnaire															
Households who raise animals	1,222,000	74	46.95	3.16	0.32	0.26	0.67	0.84	1.34	2.11	3.79	6.67	8.47	14.00	14.00
~~Households who farm~~	1,228,000	72	55.02	2.85	0.32	0.20	0.50	0.60	1.01	1.93	3.48	6.23	8.47	14.00	14.00

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-19. Consumer-Only Intake of Home-Produced Meats (g/kg-day)—West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,815,000	105	5.03	1.89	0.21	0.15	0.23	0.39	0.66	1.42	2.49	3.66	4.71	8.00	23.20
Season															
Fall	264,000	12	2.47	*	*	*	*	*	*	*		*	*	*	*
Spring	209,000	20	2.56	1.86	0.23	0.30	0.43	0.87	1.22	1.56	2.43	3.48	4.20	4.20	4.20
Summer	740,000	27	9.27	2.20	0.32	0.19	0.41	0.54	1.07	1.69	3.27	4.44	4.71	8.00	8.00
Winter	602,000	46	6.53	2.11	0.46	0.14	0.36	0.43	0.67	1.19	2.35	3.64	7.02	23.20	23.20
Urbanization															
Central City	236,000	9	1.96	*	*	*	*	*	*	*		*	*	*	*
Non-metropolitan	377,000	26	6.17	2.10	0.70	0.33	0.33	0.41	0.67	1.19	1.77	3.72		23.20	23.20
Suburban	1,202,000	70	6.71	1.95	0.20	0.15	0.23	0.37	0.78	1.52	2.71	4.20 4.97	4.71	8.00	8.00
Response to Questionnaire															
Households who raise animals	1,360,000	79	52.84	2.12	0.27	0.15	0.23	0.39	0.82	1.56	2.71	4.20	4.97	8.00	23.20
Households who farm	758,000	48	47.79	2.41	0.43	0.14	0.33	0.47	0.79	1.55	2.91	4.71	7.02	23.20	23.20

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-20. Consumer-Only Intake of Home-Caught Fish (g/kg-day)—All Regions Combined															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	3,914,000	239	2.08	2.07	0.24	0.08	0.09	0.20	0.23	0.43	1.00	2.17	4.68	7.83	15.50
Age															
1 to 2	82,000	6	1.44	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	142,000	11	1.75	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	382,000	29	2.29	2.78	0.84	0.16	0.16	0.18	0.23	0.55	1.03	3.67	7.05	7.85	25.30
12 to 19	346,000	21	1.69	1.52	0.41	0.20	0.20	0.20	0.20	0.31	0.98	1.79	4.68	6.67	8.44
20 to 39	962,000	59	1.56	1.91	0.33	0.08	0.08	0.09	0.12	0.44	1.06	2.18	4.46	9.57	13.00
40 to 69	1,524,000	86	2.69	1.79	0.26	0.09	0.09	0.21	0.28	0.35	0.99	1.99	4.43	6.56	10.80
≥ 70	450,000	24	2.83	1.22	0.23	0.10	0.10	0.23	0.23	0.57	0.76	1.56	3.73	3.73	5.12
Season															
Fall	1,220,000	45	2.56	1.31	0.22	0.18	0.18	0.20	0.21	0.32	0.92	1.79	2.64	3.73	6.56
Spring	1,112,000	114	2.41	3.08	0.56	0.10	0.12	0.31	0.34	0.56	1.27	2.64	6.68	10.80	37.30
Summer	911,000	29	2.00	1.88	0.42	0.08	0.08	0.09	0.20	0.30	0.76	3.19	4.43	5.65	9.57
Winter	671,000	51	1.38	2.05	0.37	0.09	0.09	0.11	0.16	0.51	1.06	2.09	5.89	7.85	13.10
Urbanization															
Central City	999,000	46	1.77	1.79	0.34	0.09	0.09	0.16	0.28	0.61	1.07	1.85	3.73	9.57	9.57
Non-metropolitan	1,174,000	94	2.61	3.15	0.57	0.10	0.12	0.31	0.36	0.57	1.88	3.86	6.52	7.83	37.30
Suburban	1,741,000	99	2.01	1.50	0.23	0.08	0.08	0.18	0.20	0.29	0.59	1.38	4.37	7.05	10.80
Race															
Black	593,000	41	2.73	1.81	0.37	0.18	0.18	0.20	0.29	0.32	0.98	2.17	4.68	9.57	9.57
White	3,228,000	188	2.05	2.07	0.28	0.08	0.08	0.16	0.23	0.39	1.00	2.16	4.99	6.68	16.10
Response to Questionnaire															
Households who fish	3,553,000	220	8.94	2.22	0.26	0.08	0.08	0.18	0.23	0.47	1.09	2.23	5.61	7.85	16.10

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987–1988 NFCS.)

Table 13-21. Consumer-Only Intake of Home-Caught Fish (g/kg-day)—Northeast

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	334,000	12	0.81	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	135,000	4	1.44	*	*	*	*	*	*	*	*	*	*	*	*
Spring	14,000	2	0.13	*	*	*	*	*	*	*	*	*	*	*	*
Summer	132,000	3	1.40	*	*	*	*	*	*	*	*	*	*	*	*
Winter	53,000	3	0.45	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City		0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Non-metropolitan	42,000	4	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	292,000	8	1.12	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who fish	334,000	12	5.61	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-22. Consumer-Only Intake of Home-Caught Fish (g/kg-day)—Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,113,000	71	2.40	2.13	0.42	0.08	0.08	0.20	0.23	0.47	1.03	1.95	6.10	6.56	16.10
Season															
Fall	362,000	13	2.51	*	*	*	*	*	*		*	*	*	*	*
Spring	224,000	27	2.10	3.45	1.22	0.12	0.12	0.12	0.31	0.49	0.82	1.67	15.50	16.10	25.30
Summer	264,000	8	2.58	*	*	*	*	*	*		*	*	*	*	*
Winter	263,000	23	2.37	2.38	0.53	0.51	0.51	0.51	0.55	1.03	1.56	2.13	5.89	6.10	13.10
Urbanization									*						
Central City	190,000	9	1.09	*		*	*	*	*		*	*	*	*	*
Non-metropolitan	501,000	40	3.50	3.42	0.72	0.12	0.12	0.33	0.47	0.53	1.88	5.65		13.10	25.30
Suburban	422,000	22	2.87	0.91	0.18	0.08	0.08	0.08	0.20	0.30	0.55	1.28 6.56	2.09	2.78	3.73
Response to Questionnaire															
~~Households who fish~~	956,000	60	7.57	2.35	0.49	0.08	0.08	0.12	0.23	0.47	1.12	2.16	6.52	6.56	25.30

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-23. Consumer-Only Intake of Home-Caught Fish (g/kg-day)—South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,440,000	101	2.24	2.74	0.48	0.09	0.09	0.20	0.29	0.51	1.48	3.37	5.61	8.44	37.30
Season															
Fall	274,000	11	2.08	*	*	*	*	*	*	*		*	*	*	*
Spring	538,000	58	3.20	4.00	0.94	0.31	0.31	0.39	0.45	0.87	1.94	3.71	8.33	13.00	45.20
Summer	376,000	14	2.12	*	*	*	*	*	*	* *		*	*	*	*
Winter	252,000	18	1.52	*	*	*	*	*	*	* *		*	*	*	*
Urbanization															
Central City	281,000	16	1.63	*	*	*	*	*	*	* *		*	*	*	*
Non-metropolitan	550,000	41	2.88	3.33	1.06	0.29	0.29	0.34	0.51	1.12	1.94	3.19			45.20
Suburban	609,000	44	2.18	2.73	0.50	0.20	0.20	0.28	0.29	0.43 *	1.08	4.37 4.43	8.33 6.67	10.40	13.00
Response to Questionnaire															
~~Households who fish~~	1,280,000	95	9.42	3.00	0.51	0.09	0.09	0.20	0.28	0.71	1.93	3.67	6.68	8.44	37.30

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-24. Consumer-Only Intake of Home-Caught Fish (g/kg-day)—West

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,027,000	55	2.85	1.57	0.27	0.10	0.16	0.20	0.24	0.44	0.84	1.79	3.73	5.67	9.57
Season															
Fall	449,000	17	4.20	*	*	*	*	*	*	*	*		*	*	*
Spring	336,000	27	4.12	1.35	0.29	0.10	0.10	0.24	0.33	0.44	0.61	1.68	4.68	5.61	5.67
Summer	139,000	4	1.74	*	*	*	*	*	*	*	*		*	*	*
Winter	103,000	7	1.12	*	*	*	*	*	*	*	*		*	*	*
Urbanization															
Central City	528,000	21	4.38	2.03	0.53	0.33	0.33	0.43	0.53	0.71	1.45	1.85	3.73	9.57	9.57
Non-metropolitan	81,000	9	1.33	*	*	*	*	*	*	*	*		*	*	*
Suburban	418,000	25	2.33	1.09	0.25	0.18	0.18	0.20	0.21	0.31	0.59	1.21	2.90	4.68	5.61
Response to Questionnaire															
Households who fish	983,000	53	12.99	1.63	0.28	0.10	0.16	0.20	0.22	0.55	0.96	1.79	3.73	5.67	9.57

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-25. Consumer-Only Intake of Home-Produced Dairy (g/kg-day)—All Regions															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,409,000	89	0.75	14.00	1.62	0.18	0.45	0.51	3.18	10.20	19.50	34.20	44.00	72.60	111.00
Age															
1 to 2	79,000	6	1.39	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	57,000	5	0.70	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	264,000	16	1.58	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	84,000	5	0.41	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	612,000	36	0.99	7.41	1.02	0.21	0.40	0.45	1.89	6.46	12.10	15.40	19.50	23.00	23.00
40 to 69	216,000	16	0.38	*	*	*	*	*	*	*	*	*	*	*	*
≥ 70	77,000	3	0.48	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	211,000	7	0.44	*	*	*	*	*	*	*	*	*	*	*	*
Spring	253,000	27	0.55	17.80	4.27	0.63	0.65	0.67	5.06	12.20	19.50	50.90	80.10	111.00	111.00
Summer	549,000	22	1.21	15.30	2.73	0.45	0.45	0.51	5.36	10.60	25.10	34.90	36.70	46.80	46.80
Winter	396,000	33	0.81	8.08	1.99	0.18	0.21	0.28	0.74	5.47	11.50	19.80	20.40	72.60	72.60
Urbanization															
Central City	115,000	7	0.20	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	988,000	59	2.19	16.80	2.10	0.48	0.96	1.89	6.74	10.80	20.40	34.90	44.00	80.10	111.00
Suburban	306,000	23	0.35	9.86	2.38	0.40	0.40	0.45	0.57	5.36	13.10	28.10	28.90	50.90	50.90
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	1,382,000	86	0.88	14.30	1.65	0.18	0.45	0.51	3.82	10.30	19.50	34.20	44.00	80.10	111.00
Response to Questionnaire															
Households who raise animals	1,228,000	80	12.16	15.90	1.73	0.18	0.40	1.89	6.13	10.80	19.60	34.90	44.00	80.10	111.00
Households who farm	1,020,000	63	13.92	17.10	1.99	0.40	0.74	3.18	9.06	12.10	20.40	34.90	44.00	80.10	111.00

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Moya and Phillips, 2001. (Based on EPA's analyses of the 1987–1988 NFCS.)

Table 13-26. Consumer-Only Intake of Home-Produced Dairy (g/kg-day)—Northeast

Population Group	Nc gtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	312,000	16	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	48,000	2	0.51	*	*	*	*	*	*	*	*	*	*	*	*
Spring	36,000	4	0.34	*	*	*	*	*	*	*	*	*	*	*	*
Summer	116,000	4	1.23	*	*	*	*	*	*	*	*	*	*	*	*
Winter	112,000	6	0.95	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Non-metropolitan	240,000	10	4.35	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	72,000	6	0.28	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who raise animals	312,000	16	26.49	*	*	*	*	*	*	*	*	*	*	*	*
Households who farm	312,000	16	37.59	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-27. Consumer-Only Intake of Home-Produced Dairy (g/kg-day)—Midwest

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	594,000	36	1.28	18.60	3.15	0.45	0.45	1.97	8.27	12.40	23.00	44.00	46.80	111.00	111.00
Season															
Fall	163,000	5	1.13	*	*	*	*	*	*	*	*	*	*	*	*
Spring	94,000	12	0.88	*	*	*	*	*	*	*	*	*	*	*	*
Summer	252,000	11	2.46	*	*	*	*	*	*	*	*	*	*	*	*
Winter	85,000	8	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	43,000	1	0.25	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	463,000	31	3.24	23.30	3.40	4.25	8.27	9.06	12.10	16.00	31.40	44.00	46.80	111.00	111.00
Suburban	88,000	4	0.60	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who raise animals	490,000	32	13.09	22.30	3.33	4.25	5.36	8.27	10.80	15.40	31.40	44.00	46.80	111.00	111.00
Households who farm	490,000	32	18.28	22.30	3.33	4.25	5.36	8.27	10.80	15.40	31.40	44.00	46.80	111.00	111.00

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-28. Consumer-Only Intake of Home-Produced Dairy (g/kg-day)—South

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	242,000	17	0.38	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Spring	27,000	3	0.16	*	*	*	*	*	*	*	*	*	*	*	*
Summer	131,000	5	0.74	*	*	*	*	*	*	*	*	*	*	*	*
Winter	84,000	9	0.51	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	27,000	3	0.16	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	215,000	14	1.13	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Response to Questionnaire															
Households who raise animals	215,000	14	8.26	*	*	*	*	*	*	*	*	*	*	*	*
Households who farm	148,000	8	6.63	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-29. Consumer-Only Intake of Home-Produced Dairy (g/kg-day)—West															
Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	261,000	20	0.72	10.00	2.75	0.18	0.18	0.21	0.51	6.10	13.30	28.10	28.90	50.90	50.90
Season															
Fall	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Spring	96,000	8	1.18	*	*	*	*	*	*	*	*	*	*	*	*
Summer	50,000	2	0.63	*	*	*	*	*	*	*	*	*	*	*	*
Winter	115,000	10	1.25	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	45,000	3	0.37	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	70,000	4	1.15	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	146,000	13	0.81	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who raise animals	211,000	18	8.20	*	*	*	*	*	*	*	*	*	*	*	*
Households who farm	70,000	7	4.41	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-30. Seasonally Adjusted Consumer-Only Home-Produced Intake (g/kg-day)

Population Group	Percent Consuming	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total Vegetable											
Northeast	16.50	0.00	0.02	0.04	0.20	0.46	1.37	3.32	5.70	8.78	10.10
Midwest	33.25	0.00	0.04	0.08	0.29	0.81	1.96	4.40	7.41	1.31	20.10
South	24.00	0.00	0.03	0.06	0.21	0.61	1.86	3.95	5.63	12.00	16.20
West	23.75	0.00	0.02	0.04	0.11	0.49	1.46	2.99	5.04	8.91	11.20
All Regions	24.60	0.01	0.03	0.06	0.22	0.64	1.80	4.00	6.08	11.70	20.10
Total Fruit											
Northeast	3.50	0.00	0.02	0.05	0.17	0.36	0.66	1.48	3.00	5.10	5.63
Midwest	12.75	0.00	0.01	0.01	0.14	0.79	2.98	5.79	9.52	22.20	27.10
South	8.00	0.01	0.03	0.11	0.38	0.95	2.10	6.70	10.20	14.90	16.40
West	17.75	0.00	0.06	0.09	0.29	0.69	1.81	4.75	8.54	14.50	18.40
All Regions	10.10	0.00	0.02	0.06	0.25	0.75	2.35	5.61	9.12	17.60	27.10
Total Meat											
Northeast	6.25	0.00	0.03	0.08	0.13	0.21	0.70	1.56	1.91	4.09	4.80
Midwest	9.25	0.00	0.04	0.22	0.05	1.61	3.41	5.25	7.45	11.90	13.60
South	5.75	0.01	0.03	0.05	0.19	0.53	1.84	3.78	4.95	8.45	9.45
West	9.50	0.00	0.03	0.10	0.24	0.56	1.30	2.29	3.38	7.20	9.10
All Regions	7.40	0.00	0.04	0.09	0.22	0.66	1.96	4.05	5.17	9.40	13.60

Source: Moya and Phillips, 2001. (Based on U.S. EPA's analyses of the 1987–1988 NFCS.)

Table 13-31. Consumer-Only Intake of Home-Produced Apples (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	5,306,000	272	2.82	1.19	0.08	0.08	0.23	0.28	0.45	0.82	1.47	2.38	3.40	5.42	10.10
Age															
1 to 2	199,000	12	3.49	*	*	*	*	*	*	*		*	*	*	*
3 to 5	291,000	16	3.59	*	*	*	*	*	*	*		*	*	*	*
6 to 11	402,000	25	2.41	1.28	0.19	0.47	0.47	0.56	0.74	0.96	1.29	2.98	4.00	4.00	4.00
12 to 19	296,000	12	1.44	*	*	*	*	*	*	*		*	*	*	*
20 to 39	1,268,000	61	2.06	0.80	0.11	0.19	0.23	0.26	0.30	0.60	0.92	1.55	1.97	5.42	5.42
40 to 69	1,719,000	90	3.03	0.96	0.14	0.06	0.09	0.26	0.40	0.65	1.08	1.59	2.38	9.83	9.83
≥ 70	1,061,000	52	6.68	1.45	0.14	0.20	0.26	0.45	0.63	1.18	1.82	3.40	3.62	4.20	4.20
Season															
Fall	1,707,000	60	3.58	1.28	0.12	0.26	0.30	0.32	0.58	1.03	1.66	2.69	3.40	4.25	4.25
Spring	639,000	74	1.38	0.95	0.11	0.19	0.24	0.28	0.38	0.57	1.10	2.00	2.78	5.87	5.87
Summer	1,935,000	68	4.25	1.12	0.17	0.06	0.09	0.19	0.40	0.69	1.41	2.29	2.98	9.83	9.83
Winter	1,025,000	70	2.10	1.30	0.18	0.19	0.23	0.32	0.57	0.88	1.59	2.75	3.40	10.10	10.10
Urbanization															
Central City	912,000	30	1.62	1.24	0.26	0.23	0.26	0.39	0.51	0.92	1.59	2.19	2.26	10.10	10.10
Non-metropolitan	2,118,000	122	4.70	1.27	0.13	0.06	0.12	0.25	0.41	0.90	1.55	2.92	3.48	9.83	9.83
Suburban	2,276,000	120	2.63	1.09	0.09	0.19	0.24	0.29	0.44	0.77	1.29	2.29	3.40	5.42	5.42
Race															
Black	84,000	4	0.39	*	*	*	*	*	*	*		*	*	*	*
White	5,222,000	268	3.31	1.18	0.08	0.08	0.23	0.28	0.45	0.80	1.41	2.38	3.40	5.42	10.10
Region															
Midwest	2,044,000	123	4.41	1.38	0.15	0.22	0.29	0.30	0.52	0.92	1.61	2.69	3.40	9.83	10.10
Northeast	442,000	18	1.07	*	*	*	*	*	*	*		*	*	*	*
South	1,310,000	65	2.04	1.10	0.11	0.20	0.24	0.30	0.44	0.92	1.38	1.90	2.98	4.00	4.91
West	1,510,000	66	4.19	1.20	0.13	0.06	0.19	0.26	0.47	0.79	1.82	2.75	3.62	4.25	4.25
Response to Questionnaire															
Households who garden	4,707,000	246	6.91	1.21	0.08	0.13	0.25	0.30	0.47	0.82	1.47	2.38	3.40	5.87	10.10
Households who farm	1,299,000	68	17.72	1.39	0.13	0.06	0.36	0.54	0.70	0.96	1.58	2.99	4.00	4.91	5.87

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-32. Consumer-Only Intake of Home-Produced Asparagus (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	763,000	66	0.41	0.56	0.05	0.10	0.14	0.19	0.28	0.40	0.71	1.12	1.63	1.97	1.97
Age															
1 to 2	8,000	1	0.14	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	25,000	3	0.31	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	31,000	3	0.19	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	70,000	5	0.34	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	144,000	11	0.23	*	*	*	*	*	*	*	*	*	*	*	*
40 to 69	430,000	38	0.76	0.47	0.05	0.11	0.11	0.18	0.23	0.40	0.60	0.88	1.24	1.75	1.75
≥ 70	55,000	5	0.35	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	62,000	2	0.13	*	*	*	*	*	*	*	*	*	*	*	*
Spring	608,000	59	1.32	0.61	0.06	0.10	0.16	0.19	0.30	0.45	0.88	1.18	1.63	1.97	1.97
Summer	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Winter	93,000	5	0.19	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	190,000	9	0.34	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	215,000	27	0.48	0.76	0.12	0.10	0.11	0.14	0.23	0.54	1.24	1.75	1.92	1.97	1.97
Suburban	358,000	30	0.41	0.43	0.04	0.11	0.17	0.18	0.28	0.37	0.58	0.70	0.93	1.12	1.12
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	763,000	66	0.48	0.56	0.05	0.10	0.14	0.19	0.28	0.40	0.71	1.12	1.63	1.97	1.97
Region															
Midwest	368,000	33	0.79	0.48	0.06	0.10	0.11	0.14	0.23	0.40	0.61	0.93	1.12	1.97	1.97
Northeast	270,000	20	0.66	0.72	0.10	0.18	0.23	0.23	0.37	0.60	0.93	1.24	1.63	1.92	1.92
South	95,000	9	0.15	*	*	*	*	*	*	*	*	*	*	*	*
West	30,000	4	0.08	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	669,000	59	0.98	0.53	0.06	0.10	0.14	0.18	0.28	0.40	0.70	1.12	1.63	1.97	1.97
Households who farm	157,000	16	2.14	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-33. Consumer-Only Intake of Home-Produced Beef (g/kg-day)

Population Group	Nc wgtd	Nc Unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	4,958,000	304	2.64	2.45	0.15	0.18	0.37	0.47	0.88	1.61	3.07	5.29	7.24	13.30	19.40
Age															
1 to 2	110,000	8	1.93	*	*	*	*	*	*		*	*	*	*	*
3 to 5	234,000	13	2.89	*	*	*	*	*	*		*	*	*	*	*
6 to 11	695,000	38	4.16	3.77	0.59	0.35	0.66	0.75	1.32	2.11	4.43	11.40	12.50	13.30	13.30
12 to 19	656,000	41	3.20	1.72	0.16	0.38	0.48	0.51	0.90	1.51	2.44	3.53	3.57	4.28	4.28
20 to 39	1,495,000	83	2.43	2.06	0.20	0.27	0.35	0.39	0.68	1.59	2.73	4.88	6.50	8.26	8.26
40 to 69	1,490,000	105	2.63	1.84	0.14	0.18	0.36	0.46	0.83	1.52	2.38	4.10	5.39	5.90	5.90
≥ 70	188,000	11	1.18	*	*	*	*	*	*		*	*	*	*	*
Season															
Fall	1,404,000	55	2.95	1.55	0.17	0.18	0.35	0.36	0.52	1.33	2.01	2.86	3.90	7.24	7.24
Spring	911,000	108	1.97	2.32	0.16	0.27	0.39	0.51	1.04	1.96	3.29	4.22	5.23	8.62	9.28
Summer	1,755,000	69	3.86	3.48	0.41	0.10	0.61	0.75	1.02	2.44	4.43	7.51	11.40	18.70	18.70
Winter	888,000	72	1.82	1.95	0.28	0.04	0.38	0.39	0.67	1.33	2.14	4.23	5.39	19.40	19.40
Urbanization															
Central City	100,000	5	0.18	*	*	*	*	*	*		*	*	*	*	*
Non-metropolitan	3,070,000	194	6.82	2.80	0.22	0.18	0.38	0.50	0.86	1.81	3.57	6.03	8.44	18.70	19.40
Suburban	1,788,000	105	2.07	1.93	0.15	0.27	0.38	0.42	0.91	1.52	2.44	4.06	5.10	7.51	9.28
Race															
Black	0	0	0.00	-	-	-	-	-	-		-	-	-	-	-
White	4,950,000	303	3.14	2.45	0.15	0.18	0.37	0.47	0.88	1.61	3.07	5.29	7.24	13.30	19.40
Region															
Midwest	2,261,000	161	4.87	2.83	0.23	0.18	0.35	0.42	0.85	2.01	3.66	5.90	8.39	18.70	18.70
Northeast	586,000	25	1.42	1.44	0.21	0.35	0.35	0.47	0.74	1.06	1.68	2.62	2.62	6.03	6.03
South	1,042,000	61	1.62	2.45	0.35	0.10	0.39	0.58	0.82	1.59	2.41	6.36	7.24	13.30	13.30
West	1,069,000	57	2.96	2.20	0.28	0.31	0.38	0.56	1.04	1.60	2.86	4.06	4.42	7.51	19.40
Response to Questionnaire															
Households who raise animals	3,699,000	239	36.63	2.66	0.16	0.18	0.39	0.66	1.04	1.83	3.48	5.39	7.51	12.50	19.40
Households who farm	2,850,000	182	38.89	2.63	0.20	0.27	0.39	0.59	0.90	1.64	3.25	5.39	7.51	11.30	19.40

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-34. Consumer-Only Intake of Home-Produced Beets (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,214,000	125	1.18	0.51	0.05	0.03	0.07	0.11	0.19	0.40	0.59	1.03	1.36	3.69	4.08
Age															
1 to 2	27,000	2	0.47	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	51,000	4	0.63	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	167,000	10	1.00	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	227,000	13	1.11	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	383,000	22	0.62	0.38	0.06	0.08	0.08	0.12	0.14	0.29	0.56	1.00	1.00	1.12	1.12
40 to 69	951,000	51	1.68	0.43	0.04	0.05	0.07	0.07	0.21	0.40	0.55	0.93	1.15	1.40	1.40
≥ 70	408,000	23	2.57	0.58	0.09	0.03	0.03	0.05	0.27	0.45	0.91	1.36	1.36	1.59	1.59
Season															
Fall	562,000	21	1.18	0.55	0.09	0.03	0.05	0.05	0.26	0.36	0.95	1.36	1.36	1.40	1.40
Spring	558,000	55	1.21	0.47	0.09	0.07	0.08	0.11	0.14	0.27	0.45	0.87	1.59	4.08	4.08
Summer	676,000	22	1.49	0.39	0.05	0.08	0.12	0.12	0.18	0.40	0.55	0.62	0.91	0.91	0.91
Winter	418,000	27	0.86	0.73	0.15	0.07	0.07	0.07	0.28	0.52	0.83	1.13	2.32	3.69	3.69
Urbanization															
Central City	651,000	27	1.16	0.52	0.12	0.11	0.14	0.18	0.26	0.40	0.55	0.91	1.12	3.69	3.69
Non-metropolitan	758,000	51	1.68	0.58	0.09	0.05	0.07	0.07	0.18	0.39	0.66	1.36	1.40	4.08	4.08
Suburban	805,000	47	0.93	0.45	0.06	0.03	0.05	0.08	0.14	0.40	0.56	0.93	1.00	2.32	2.32
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	2,186,000	124	1.39	0.52	0.05	0.03	0.07	0.11	0.21	0.40	0.59	1.03	1.36	3.69	4.08
Region															
Midwest	885,000	53	1.91	0.63	0.08	0.05	0.11	0.18	0.32	0.45	0.91	1.15	1.36	3.69	3.69
Northeast	230,000	13	0.56	*	*	*	*	*	*	*	*	*	*	*	*
South	545,000	31	0.85	0.45	0.12	0.07	0.08	0.08	0.18	0.26	0.48	0.66	0.94	4.08	4.08
West	554,000	28	1.54	0.40	0.08	0.03	0.05	0.07	0.12	0.29	0.55	0.62	0.70	2.32	2.32
Response to Questionnaire															
Households who garden	2,107,000	120	3.09	0.53	0.05	0.03	0.07	0.10	0.21	0.40	0.61	1.03	1.36	3.69	4.08
Households who farm	229,000	11	3.12	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-35. Consumer-Only Intake of Home-Produced Broccoli (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,745,000	80	0.93	0.42	0.05	0.08	0.08	0.16	0.20	0.29	0.46	0.82	0.97	2.48	3.02
Age															
1 to 2	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
3 to 5	13,000	1	0.16	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	187,000	9	1.12	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	102,000	4	0.50	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	486,000	19	0.79	*	*	*	*	*	*	*	*	*	*	*	*
40 to 69	761,000	37	1.34	0.41	0.07	0.08	0.11	0.16	0.22	0.35	0.46	0.61	0.82	3.02	3.02
≥ 70	196,000	10	1.23	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	624,000	20	1.31	0.29	0.04	0.08	0.08	0.08	0.18	0.23	0.38	0.45	0.53	0.82	0.82
Spring	258,000	27	0.56	0.54	0.12	0.05	0.15	0.17	0.27	0.33	0.59	1.25	2.37	3.02	3.02
Summer	682,000	22	1.50	0.51	0.11	0.08	0.13	0.18	0.22	0.40	0.66	0.89	0.97	2.48	2.48
Winter	181,000	11	0.37	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	165,000	5	0.29	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	647,000	34	1.44	0.42	0.04	0.05	0.13	0.17	0.22	0.37	0.59	0.75	0.89	0.97	0.97
Suburban	933,000	41	1.08	0.43	0.08	0.08	0.08	0.14	0.21	0.24	0.44	0.68	2.37	2.48	3.02
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	1,719,000	79	1.09	0.42	0.05	0.08	0.08	0.16	0.20	0.29	0.46	0.82	0.97	2.48	3.02
Region															
Midwest	792,000	38	1.71	0.26	0.06	0.08	0.08	0.08	0.18	0.21	0.28	0.34	0.40	3.02	3.02
Northeast	427,000	19	1.04	*	*	*	*	*	*	*	*	*	*	*	*
South	373,000	16	0.58	*	*	*	*	*	*	*	*	*	*	*	*
West	153,000	7	0.42	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,729,000	78	2.54	0.42	0.05	0.08	0.08	0.16	0.20	0.29	0.46	0.82	0.97	2.48	3.02
Households who farm	599,000	29	8.17	0.47	0.08	0.05	0.08	0.15	0.20	0.31	0.66	0.89	0.97	3.02	3.02

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-36. Consumer-Only Intake of Home-Produced Cabbage (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,019,000	89	1.07	1.03	0.10	0.11	0.20	0.32	0.42	0.78	1.33	1.97	2.35	5.43	5.43
Age															
1 to 2	14,000	2	0.25	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	29,000	1	0.36	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	61,000	3	0.37	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	203,000	9	0.99	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	391,000	16	0.63	*	*	*	*	*	*	*	*	*	*	*	*
40 to 69	966,000	44	1.70	1.14	0.18	0.22	0.22	0.33	0.41	0.71	1.41	1.82	5.29	5.43	5.43
≥ 70	326,000	13	2.05	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	570,000	21	1.20	1.28	0.32	0.19	0.19	0.20	0.39	0.54	1.49	5.29	5.43	5.43	5.43
Spring	126,000	15	0.27	*	*	*	*	*	*	*	*	*	*	*	*
Summer	1,142,000	39	2.51	0.97	0.09	0.20	0.22	0.33	0.56	0.83	1.24	1.79	2.35	2.77	2.77
Winter	181,000	14	0.37	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	157,000	5	0.28	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,079,000	48	2.40	0.94	0.09	0.20	0.32	0.34	0.45	0.71	1.33	1.79	2.35	2.77	2.77
Suburban	783,000	36	0.90	1.26	0.21	0.03	0.22	0.33	0.45	1.05	1.37	2.17	5.29	5.43	5.43
Race															
Black	7,000	1	0.03	*	*	*	*	*	*	*	*	*	*	*	*
White	1,867,000	83	1.19	1.05	0.11	0.11	0.20	0.25	0.41	0.79	1.37	1.97	2.35	5.43	5.43
Region															
Midwest	884,000	37	1.91	0.74	0.07	0.11	0.19	0.22	0.36	0.60	1.10	1.29	1.49	1.82	1.98
Northeast	277,000	11	0.67	*	*	*	*	*	*	*	*	*	*	*	*
South	616,000	32	0.96	1.11	0.13	0.03	0.20	0.22	0.45	0.85	1.79	2.17	2.35	2.77	2.77
West	242,000	9	0.67	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,921,000	86	2.82	1.07	0.10	0.11	0.20	0.32	0.45	0.79	1.37	1.97	2.35	5.43	5.43
Households who farm	546,000	26	7.45	1.00	0.12	0.20	0.21	0.35	0.59	0.83	1.37	1.79	2.35	2.35	2.35

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-37. Consumer-Only Intake of Home-Produced Carrots (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	4,322,000	193	2.30	0.44	0.04	0.04	0.06	0.09	0.18	0.33	0.53	0.80	1.08	2.21	7.79
Age															
1 to 2	51,000	4	0.89	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	53,000	3	0.65	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	299,000	14	1.79	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	389,000	17	1.90	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	1,043,000	46	1.69	0.28	0.03	0.04	0.05	0.08	0.12	0.20	0.41	0.56	0.76	1.19	1.19
40 to 69	1,848,000	82	3.26	0.43	0.03	0.04	0.07	0.12	0.22	0.37	0.55	0.78	1.01	1.53	2.21
≥ 70	574,000	24	3.61	0.44	0.06	0.07	0.18	0.20	0.26	0.37	0.54	0.96	1.08	1.08	1.08
Season															
Fall	1,810,000	66	3.80	0.46	0.10	0.09	0.11	0.12	0.20	0.31	0.51	0.78	1.08	1.71	7.79
Spring	267,000	28	0.58	0.56	0.10	0.14	0.15	0.20	0.22	0.39	0.61	0.99	2.11	2.94	2.94
Summer	1,544,000	49	3.39	0.39	0.04	0.04	0.05	0.07	0.16	0.38	0.51	0.84	0.96	1.19	1.19
Winter	701,000	50	1.44	0.44	0.07	0.04	0.04	0.06	0.16	0.23	0.64	1.05	1.53	3.06	3.06
Urbanization															
Central City	963,000	29	1.71	0.28	0.04	0.04	0.06	0.08	0.16	0.21	0.39	0.53	0.59	0.96	0.96
Non-metropolitan	1,675,000	94	3.72	0.52	0.09	0.04	0.05	0.07	0.20	0.33	0.51	0.96	1.19	7.79	7.79
Suburban	1,684,000	70	1.94	0.45	0.04	0.07	0.09	0.12	0.20	0.38	0.64	0.80	1.09	1.71	1.71
Race															
Black	107,000	7	0.49	*	*	*	*	*	*	*	*	*	*	*	*
White	3,970,000	178	2.52	0.41	0.03	0.04	0.08	0.11	0.19	0.33	0.53	0.78	1.01	1.59	3.06
Region															
Midwest	2,001,000	97	4.31	0.46	0.04	0.04	0.08	0.14	0.20	0.37	0.54	0.96	1.10	2.11	3.06
Northeast	735,000	29	1.79	0.41	0.09	0.04	0.05	0.06	0.09	0.15	0.64	1.09	1.71	2.21	2.21
South	378,000	20	0.59	0.63	0.36	0.04	0.04	0.05	0.15	0.27	0.41	0.50	0.99	7.79	7.79
West	1,208,000	47	3.35	0.37	0.03	0.07	0.09	0.14	0.19	0.33	0.46	0.76	0.84	0.96	0.96
Response to Questionnaire															
Households who garden	4,054,000	182	5.95	0.40	0.03	0.04	0.07	0.09	0.18	0.33	0.51	0.76	1.08	1.71	3.06
Households who farm	833,000	40	11.37	0.36	0.06	0.09	0.09	0.11	0.18	0.23	0.46	0.62	1.19	2.11	2.94

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Table 13-38. Consumer-Only Intake of Home-Produced Corn (g/kg-day)															
Total	6,891,000	421	3.67	0.89	0.06	0.05	0.12	0.17	0.24	0.48	0.91	1.88	3.37	7.44	9.23
Age															
1 to 2	205,000	13	3.60	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	313,000	24	3.86	1.25	0.26	0.33	0.33	0.40	0.60	1.00	1.21	1.67	5.35	5.35	5.35
6 to 11	689,000	43	4.12	0.93	0.17	0.11	0.12	0.19	0.25	0.51	1.08	3.13	3.37	4.52	4.52
12 to 19	530,000	32	2.59	0.59	0.10	0.10	0.11	0.14	0.21	0.34	0.71	1.55	1.88	1.88	1.88
20 to 39	1,913,000	108	3.11	0.60	0.06	0.07	0.14	0.15	0.21	0.37	0.71	1.53	2.04	3.70	3.70
40 to 69	2,265,000	142	3.99	0.86	0.11	0.11	0.15	0.17	0.26	0.52	0.88	1.42	3.22	7.44	7.44
≥ 70	871,000	53	5.48	0.94	0.26	0.04	0.05	0.11	0.19	0.36	0.76	1.34	6.49	9.23	9.23
Season															
Fall	2,458,000	89	5.16	0.54	0.08	0.04	0.11	0.14	0.19	0.32	0.55	1.27	1.42	5.35	5.69
Spring	1,380,000	160	2.99	0.64	0.06	0.14	0.17	0.19	0.26	0.45	0.77	1.21	1.57	5.15	6.68
Summer	1,777,000	62	3.91	1.82	0.26	0.07	0.18	0.34	0.64	0.94	2.13	4.52	6.84	9.23	9.23
Winter	1,276,000	110	2.62	0.55	0.05	0.11	0.12	0.15	0.22	0.41	0.61	1.16	1.47	2.04	3.94
Urbanization															
Central City	748,000	27	1.33	0.74	0.14	0.04	0.04	0.05	0.18	0.55	0.93	2.04	2.23	3.04	3.04
Non-metropolitan	4,122,000	268	9.16	0.96	0.08	0.07	0.12	0.17	0.25	0.53	1.00	2.13	3.38	7.44	8.97
Suburban	2,021,000	126	2.33	0.80	0.13	0.11	0.15	0.17	0.24	0.40	0.65	1.34	1.71	9.23	9.23
Race															
Black	188,000	9	0.86	*	*	*	*	*	*	*	*	*	*	*	*
White	6,703,000	412	4.26	0.89	0.07	0.05	0.12	0.16	0.24	0.48	0.88	1.88	3.22	7.44	9.23
Region															
Midwest	2,557,000	188	5.51	0.93	0.10	0.04	0.12	0.17	0.25	0.46	0.93	2.28	3.22	6.84	7.44
Northeast	586,000	33	1.42	0.61	0.08	0.10	0.17	0.19	0.24	0.38	0.88	1.34	1.71	1.71	1.71
South	2,745,000	153	4.27	0.87	0.10	0.07	0.12	0.17	0.28	0.56	0.94	1.55	3.37	5.69	8.97
West	1,003,000	47	2.78	1.00	0.28	0.11	0.15	0.15	0.18	0.40	0.75	2.23	6.49	9.23	9.23
Response to Questionnaire															
Households who garden	6233000	387	9.15	0.88	0.06	0.05	0.14	0.17	0.24	0.50	0.91	1.82	3.13	6.84	9.23
Households who farm	1739000	114	23.73	1.20	0.18	0.04	0.11	0.17	0.23	0.38	0.97	3.37	6.49	9.23	9.23

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-39. Consumer-Only Intake of Home-Produced Cucumbers (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	3,994,000	141	2.12	1.02	0.16	0.03	0.07	0.11	0.24	0.54	1.13	2.11	2.79	13.40	13.70
Age															
1 to 2	132,000	5	2.32	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	107,000	4	1.32	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	356,000	12	2.13	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	254,000	10	1.24	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	864,000	29	1.40	0.50	0.09	0.03	0.05	0.06	0.18	0.31	0.62	1.35	1.49	2.12	2.12
40 to 69	1,882,000	68	3.32	1.33	0.30	0.04	0.07	0.18	0.39	0.68	1.29	2.11	3.27	13.70	13.70
≥ 70	399,000	13	2.51	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	370,000	12	0.78	*	*	*	*	*	*	*	*	*	*	*	*
Spring	197,000	15	0.43	*	*	*	*	*	*	*	*	*	*	*	*
Summer	3,427,000	114	7.53	1.06	0.18	0.00	0.07	0.11	0.24	0.52	1.13	2.12	2.79	13.40	13.70
Winter	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Urbanization															
Central City	640,000	18	1.14	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,530,000	64	3.40	1.74	0.34	0.10	0.12	0.19	0.39	1.06	1.67	3.09	4.50	13.70	13.70
Suburban	1,824,000	59	2.11	0.67	0.08	0.00	0.07	0.16	0.28	0.50	0.83	1.34	1.73	3.27	3.27
Race															
Black	86,000	2	0.40	*	*	*	*	*	*	*	*	*	*	*	*
White	3,724,000	132	2.36	0.94	0.16	0.03	0.06	0.10	0.22	0.50	1.03	1.49	2.40	13.40	13.70
Region															
Midwest	969,000	31	2.09	1.00	0.39	0.03	0.04	0.05	0.14	0.45	1.03	2.35	2.45	13.40	13.40
Northeast	689,000	22	1.67	1.92	0.68	0.23	0.28	0.28	0.48	0.68	1.53	4.18	11.70	13.70	13.70
South	1,317,000	54	2.05	0.89	0.11	0.00	0.12	0.18	0.29	0.75	1.28	1.73	2.13	4.50	4.50
West	1,019,000	34	2.83	0.60	0.11	0.07	0.07	0.10	0.21	0.43	0.70	1.29	2.11	3.27	3.27
Response to Questionnaire															
Households who garden	3,465,000	123	5.08	1.05	0.18	0.03	0.07	0.10	0.28	0.52	1.13	2.11	2.79	13.40	13.70
Households who farm	710,000	29	9.69	0.70	0.11	0.00	0.00	0.14	0.19	0.39	1.27	1.49	1.71	2.09	2.09

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-40. Consumer-Only Intake of Home-Produced Eggs (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,075,000	124	1.10	0.73	0.10	0.07	0.15	0.18	0.27	0.47	0.90	1.36	1.69	6.58	13.50
Age															
1 to 2	21,000	3	0.37	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	20,000	2	0.25	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	170,000	12	1.02	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	163,000	14	0.80	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	474,000	30	0.77	0.63	0.09	0.07	0.07	0.22	0.30	0.42	0.81	1.32	1.93	2.50	2.50
40 to 69	718,000	43	1.27	0.59	0.06	0.14	0.14	0.15	0.32	0.51	0.84	1.30	1.36	1.38	1.38
≥ 70	489,000	18	3.08	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	542,000	18	1.14	*	*	*	*	*	*	*	*	*	*	*	*
Spring	460,000	54	1.00	1.31	0.29	0.16	0.33	0.39	0.50	0.67	1.31	2.10	3.26	13.50	13.50
Summer	723,000	26	1.59	0.50	0.08	0.07	0.14	0.14	0.26	0.33	0.54	1.36	1.51	1.65	1.65
Winter	350,000	26	0.72	0.86	0.10	0.17	0.18	0.22	0.40	0.75	1.17	1.62	1.93	1.93	1.93
Urbanization															
Central City	251,000	9	0.45	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,076,000	65	2.39	0.73	0.12	0.07	0.14	0.17	0.26	0.47	0.92	1.34	1.65	6.58	9.16
Suburban	748,000	50	0.86	0.85	0.20	0.14	0.15	0.21	0.38	0.59	1.17	1.36	1.85	13.50	13.50
Race															
Black	63,000	9	0.29	*	*	*	*	*	*	*	*	*	*	*	*
White	2,012,000	115	1.28	0.74	0.11	0.07	0.15	0.18	0.27	0.48	0.90	1.36	1.69	6.58	13.50
Region															
Midwest	665,000	37	1.43	0.79	0.20	0.07	0.14	0.14	0.22	0.34	1.08	1.51	2.10	9.16	9.16
Northeast	87,000	7	0.21	*	*	*	*	*	*	*	*	*	*	*	*
South	823,000	44	1.28	0.54	0.06	0.15	0.18	0.20	0.26	0.36	0.60	1.18	1.62	1.93	1.93
West	500,000	36	1.39	0.92	0.28	0.17	0.21	0.21	0.46	0.67	1.05	1.36	1.36	13.50	13.50
Response to Questionnaire															
Households who raise animals	1,824,000	113	18.06	0.75	0.11	0.07	0.15	0.17	0.26	0.48	0.90	1.36	1.85	6.58	13.50
Households who farm	741,000	44	10.11	0.90	0.17	0.15	0.17	0.18	0.27	0.67	1.19	1.65	1.85	6.58	9.16

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-41. Consumer-Only Intake of Home-Produced Game (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,707,000	185	1.44	0.97	0.06	0.00	0.12	0.21	0.40	0.71	1.22	2.27	2.67	3.61	4.59
Age															
1 to 2	89,000	8	1.56	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	94,000	8	1.16	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	362,000	28	2.17	1.09	0.14	0.12	0.23	0.43	0.63	0.76	1.48	2.67	2.85	2.90	2.90
12 to 19	462,000	27	2.25	1.04	0.14	0.21	0.21	0.29	0.63	0.85	1.22	1.99	3.13	3.13	3.13
20 to 39	844,000	59	1.37	0.82	0.11	0.10	0.12	0.19	0.30	0.63	1.09	1.57	2.50	4.59	4.59
40 to 69	694,000	41	1.22	0.96	0.14	0.12	0.17	0.29	0.34	0.51	1.41	2.51	3.19	3.61	3.61
≥ 70	74,000	7	0.47	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	876,000	31	1.84	1.00	0.16	0.12	0.15	0.22	0.43	0.63	1.19	2.50	3.13	3.19	3.19
Spring	554,000	68	1.20	0.91	0.09	0.00	0.10	0.17	0.44	0.75	1.22	1.75	2.52	3.61	3.61
Summer	273,000	9	0.60	*	*	*	*	*	*	*	*	*	*	*	*
Winter	1,004,000	77	2.06	1.07	0.11	0.00	0.00	0.17	0.39	0.82	1.52	2.20	2.67	4.59	4.59
Urbanization															
Central City	506,000	20	0.90	0.69	0.13	0.00	0.00	0.19	0.28	0.63	0.77	1.48	1.99	2.34	2.34
Non-metropolitan	1,259,000	101	2.80	0.95	0.09	0.00	0.12	0.17	0.32	0.66	1.19	2.27	3.03	4.59	4.59
Suburban	942,000	64	1.09	1.15	0.10	0.00	0.26	0.40	0.52	0.82	1.52	2.51	2.85	3.13	3.61
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	2,605,000	182	1.65	0.98	0.06	0.00	0.12	0.20	0.38	0.73	1.38	2.34	2.85	3.61	4.59
Region															
Midwest	1,321,000	97	2.85	0.88	0.08	0.00	0.08	0.22	0.34	0.61	1.10	1.99	2.51	4.59	4.59
Northeast	394,000	20	0.96	1.13	0.22	0.29	0.29	0.32	0.43	0.77	1.41	3.13	3.13	3.61	3.61
South	609,000	47	0.95	1.26	0.13	0.00	0.12	0.15	0.63	1.09	1.93	2.38	3.19	3.19	3.19
West	383,000	21	1.06	0.63	0.07	0.12	0.15	0.19	0.40	0.63	0.77	1.12	1.22	1.52	1.52
Response to Questionnaire															
Households who hunt	2,357,000	158	11.66	1.04	0.07	0.00	0.14	0.28	0.44	0.75	1.44	2.38	2.90	3.61	4.59

* Intake data not provided for subpopulations for which there were less than 20 observations.
- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-42. Consumer-Only Intake of Home-Produced Lettuce (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,520,000	80	0.81	0.39	0.03	0.00	0.04	0.09	0.17	0.28	0.55	0.84	1.03	1.05	1.28
Age															
1 to 2	54,000	4	0.95	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	25,000	2	0.31	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	173,000	7	1.04	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	71,000	3	0.35	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	379,000	17	0.62	*	*	*	*	*	*	*	*	*	*	*	*
40 to 69	485,000	26	0.86	0.48	0.06	0.12	0.12	0.12	0.22	0.49	0.68	0.89	1.05	1.28	1.28
≥ 70	317,000	20	2.00	0.45	0.07	0.05	0.07	0.11	0.22	0.29	0.57	1.03	1.03	1.03	1.03
Season															
Fall	214,000	8	0.45	*	*	*	*	*	*	*	*	*	*	*	*
Spring	352,000	35	0.76	0.45	0.05	0.05	0.07	0.12	0.20	0.45	0.58	0.80	0.99	1.28	1.28
Summer	856,000	30	1.88	0.30	0.04	0.02	0.03	0.05	0.14	0.23	0.42	0.60	0.81	0.89	0.89
Winter	98,000	7	0.20	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	268,000	8	0.48	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	566,000	36	1.26	0.37	0.05	0.02	0.03	0.04	0.12	0.29	0.55	0.81	0.89	1.28	1.28
Suburban	686,000	36	0.79	0.35	0.04	0.00	0.09	0.10	0.15	0.23	0.49	0.77	0.99	1.05	1.05
Race															
Black	51,000	3	0.23	*	*	*	*	*	*	*	*	*	*	*	*
White	1,434,000	75	0.91	0.38	0.03	0.00	0.04	0.09	0.16	0.28	0.55	0.89	1.03	1.05	1.28
Region															
Midwest	630,000	33	1.36	0.38	0.06	0.02	0.03	0.04	0.16	0.23	0.57	0.94	1.03	1.03	1.03
Northeast	336,000	16	0.82	*	*	*	*	*	*	*	*	*	*	*	*
South	305,000	20	0.47	0.35	0.06	0.00	0.00	0.13	0.16	0.28	0.48	0.58	1.04	1.28	1.28
West	249,000	11	0.69	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,506,000	78	2.21	0.39	0.03	0.00	0.04	0.09	0.17	0.28	0.55	0.84	1.03	1.05	1.28
Households who farm	304,000	18	4.15	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-43. Consumer-Only Intake of Home-Produced Lima Beans (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,917,000	109	1.02	0.45	0.04	0.00	0.09	0.12	0.19	0.29	0.55	0.99	1.69	1.86	1.91
Age															
1 to 2	62,000	3	1.09	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	35,000	2	0.43	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	95,000	7	0.57	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	108,000	6	0.53	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	464,000	20	0.75	0.38	0.07	0.03	0.11	0.13	0.18	0.23	0.49	0.94	1.10	1.10	1.10
40 to 69	757,000	44	1.33	0.45	0.06	0.09	0.11	0.12	0.20	0.29	0.56	0.87	1.71	1.91	1.91
≥ 70	361,000	25	2.27	0.52	0.11	0.08	0.19	0.19	0.23	0.29	0.64	1.86	1.86	1.86	1.86
Season															
Fall	375,000	14	0.79	*	*	*	*	*	*	*	*	*	*	*	*
Spring	316,000	39	0.68	0.42	0.06	0.08	0.09	0.13	0.23	0.31	0.55	0.75	1.31	1.91	1.91
Summer	883,000	29	1.94	0.50	0.10	0.00	0.09	0.12	0.17	0.29	0.49	1.53	1.71	1.86	1.86
Winter	343,000	27	0.70	0.53	0.06	0.00	0.03	0.11	0.31	0.54	0.76	0.86	0.87	1.69	1.69
Urbanization															
Central City	204,000	8	0.36	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,075,000	69	2.39	0.30	0.03	0.03	0.09	0.12	0.17	0.21	0.32	0.49	0.77	1.69	1.91
Suburban	638,000	32	0.74	0.75	0.10	0.00	0.08	0.09	0.32	0.68	0.99	1.71	1.86	1.86	1.86
Race															
Black	213,000	9	0.98	*	*	*	*	*	*	*	*	*	*	*	*
White	1,704,000	100	1.08	0.38	0.03	0.00	0.09	0.11	0.18	0.25	0.49	0.86	0.99	1.53	1.91
Region															
Midwest	588,000	36	1.27	0.43	0.06	0.00	0.00	0.11	0.25	0.31	0.42	0.99	1.53	1.69	1.69
Northeast	68,000	6	0.17	*	*	*	*	*	*	*	*	*	*	*	*
South	1,261,000	67	1.96	0.47	0.06	0.03	0.10	0.13	0.18	0.25	0.63	1.10	1.71	1.86	1.91
West	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Response to Questionnaire															
Households who garden	1,610,000	97	2.36	0.45	0.04	0.03	0.09	0.12	0.18	0.29	0.53	0.94	1.71	1.86	1.91
Households who farm	62,000	6	0.85	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-44. Consumer-Only Intake of Home-Produced Okra (g/kg-day)															
Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,696,000	82	0.90	0.39	0.04	0.00	0.05	0.10	0.15	0.30	0.46	0.78	1.21	1.53	1.53
Age															
1 to 2	53,000	2	0.93	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	68,000	3	0.84	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	218,000	11	1.30	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	194,000	9	0.95	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	417,000	18	0.68	*	*	*	*	*	*	*	*	*	*	*	*
40 to 69	587,000	32	1.03	0.40	0.05	0.07	0.11	0.14	0.25	0.31	0.46	0.78	1.14	1.14	1.14
≥ 70	130,000	6	0.82	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	228,000	9	0.48	*	*	*	*	*	*	*	*	*	*	*	*
Spring	236,000	24	0.51	0.39	0.06	0.03	0.05	0.07	0.11	0.41	0.60	0.78	1.00	1.07	1.07
Summer	1,144,000	41	2.52	0.39	0.06	0.00	0.05	0.10	0.14	0.30	0.44	1.15	1.53	1.53	1.53
Winter	88,000	8	0.18	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	204,000	6	0.36	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,043,000	55	2.32	0.37	0.05	0.00	0.03	0.08	0.15	0.26	0.44	0.78	1.53	1.53	1.53
Suburban	449,000	21	0.52	0.51	0.07	0.07	0.10	0.11	0.31	0.46	0.60	1.14	1.15	1.15	1.15
Race															
Black	236,000	13	1.09	*	*	*	*	*	*	*	*	*	*	*	*
White	1,419,000	68	0.90	0.43	0.04	0.00	0.07	0.10	0.18	0.33	0.52	1.14	1.21	1.53	1.53
Region															
Midwest	113,000	7	0.24	*	*	*	*	*	*	*	*	*	*	*	*
Northeast															
South	1,443,000	70	2.24	0.37	0.04	0.00	0.05	0.08	0.14	0.26	0.44	0.75	1.21	1.53	1.53
West	140,000	5	0.39	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,564,000	77	2.29	0.38	0.04	0.00	0.05	0.10	0.15	0.30	0.45	1.07	1.21	1.53	1.53
Households who farm	233,000	14	3.18	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-45. Consumer-Only Intake of Home-Produced Onions (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	6,718,000	370	3.57	0.30	0.02	0.00	0.01	0.03	0.09	0.21	0.38	0.61	0.91	1.49	3.11
Age															
1 to 2	291,000	17	5.11	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	178,000	9	2.20	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	530,000	31	3.17	0.30	0.06	0.01	0.01	0.03	0.11	0.23	0.38	0.61	1.36	1.36	1.36
12 to 19	652,000	37	3.18	0.21	0.04	0.01	0.01	0.01	0.06	0.14	0.26	0.57	0.76	0.91	0.91
20 to 39	1,566,000	78	2.54	0.29	0.03	0.01	0.04	0.06	0.09	0.19	0.30	0.64	0.94	1.49	1.49
40 to 69	2,402,000	143	4.23	0.25	0.02	0.00	0.00	0.01	0.08	0.17	0.36	0.55	0.69	1.11	1.41
≥ 70	1,038,000	52	6.54	0.43	0.09	0.00	0.01	0.03	0.14	0.29	0.46	0.56	2.68	3.11	3.11
Season															
Fall	1,557,000	59	3.27	0.38	0.07	0.00	0.03	0.06	0.12	0.26	0.44	0.60	0.78	3.11	3.11
Spring	1,434,000	147	3.11	0.20	0.02	0.00	0.01	0.03	0.06	0.11	0.26	0.43	0.52	1.41	1.77
Summer	2,891,000	101	6.36	0.31	0.03	0.01	0.02	0.04	0.11	0.23	0.38	0.69	0.97	1.49	1.49
Winter	836,000	63	1.72	0.29	0.04	0.00	0.00	0.01	0.03	0.20	0.46	0.64	0.92	1.36	1.36
Urbanization															
Central City	890,000	37	1.58	0.22	0.03	0.00	0.01	0.03	0.07	0.19	0.30	0.52	0.56	0.56	0.56
Non-metropolitan	2,944,000	177	6.54	0.32	0.02	0.01	0.03	0.07	0.14	0.26	0.43	0.63	0.91	1.49	1.77
Suburban	2,884,000	156	3.33	0.29	0.04	0.00	0.01	0.01	0.06	0.13	0.36	0.64	0.97	3.11	3.11
Race															
Black	253,000	16	1.16	*	*	*	*	*	*	*	*	*	*	*	*
White	6,266,000	345	3.98	0.31	0.02	0.00	0.01	0.03	0.09	0.22	0.39	0.62	0.94	1.77	3.11
Region															
Midwest	2,487,000	143	5.36	0.27	0.02	0.00	0.04	0.06	0.10	0.22	0.34	0.56	0.72	1.34	1.34
Northeast	876,000	52	2.13	0.23	0.04	0.00	0.00	0.01	0.01	0.11	0.35	0.64	1.05	1.36	1.41
South	1,919,000	107	2.98	0.33	0.03	0.00	0.03	0.04	0.15	0.25	0.39	0.69	1.08	1.49	1.77
West	1,436,000	68	3.98	0.33	0.07	0.00	0.01	0.02	0.06	0.15	0.39	0.55	0.97	3.11	3.11
Response to Questionnaire															
Households who garden	6,441,000	356	9.45	0.30	0.02	0.00	0.01	0.03	0.09	0.21	0.38	0.61	0.92	1.77	3.11
Households who farm	1,390,000	81	18.97	0.38	0.04	0.03	0.04	0.05	0.11	0.28	0.52	0.94	1.11	1.49	1.49

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-46. Consumer-Only Intake of Home-Produced Other Berries (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,626,000	99	0.86	0.48	0.04	0.00	0.05	0.09	0.23	0.38	0.59	1.07	1.28	2.21	2.21
Age															
1 to 2	41,000	2	0.72	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	53,000	3	0.65	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	106,000	10	0.63	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	79,000	5	0.39	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	309,000	20	0.50	0.39	0.06	0.08	0.09	0.09	0.13	0.33	0.55	0.79	1.07	1.07	1.07
40 to 69	871,000	51	1.54	0.49	0.06	0.08	0.10	0.13	0.25	0.39	0.61	0.77	1.28	2.21	2.21
≥ 70	159,000	7	1.00	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	379,000	13	0.80	*	*	*	*	*	*	*	*	*	*	*	*
Spring	287,000	29	0.62	0.31	0.04	0.05	0.05	0.08	0.18	0.25	0.41	0.54	0.72	1.07	1.07
Summer	502,000	18	1.10	*	*	*	*	*	*	*	*	*	*	*	*
Winter	458,000	39	0.94	0.54	0.07	0.00	0.10	0.16	0.23	0.39	0.62	1.07	1.95	2.08	2.08
Urbanization															
Central City	378,000	15	0.67	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	466,000	37	1.04	0.64	0.09	0.00	0.09	0.10	0.25	0.44	1.02	1.31	2.21	2.21	2.21
Suburban	722,000	45	0.83	0.45	0.05	0.09	0.13	0.16	0.26	0.38	0.54	0.59	0.90	2.08	2.08
Race															
Black	76,000	4	0.35	*	*	*	*	*	*	*	*	*	*	*	*
White	1,490,000	93	0.95	0.50	0.04	0.05	0.09	0.10	0.25	0.40	0.60	1.07	1.31	2.21	2.21
Region															
Midwest	736,000	56	1.59	0.46	0.06	0.00	0.08	0.09	0.13	0.30	0.59	1.12	1.28	2.21	2.21
Northeast	211,000	11	0.51	*	*	*	*	*	*	*	*	*	*	*	*
South	204,000	12	0.32	*	*	*	*	*	*	*	*	*	*	*	*
West	415,000	18	1.15	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,333,000	84	1.96	0.47	0.05	0.01	0.00	0.09	0.20	0.35	0.55	1.07	1.28	2.21	2.21
Households who farm	219,000	16	2.99	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-47. Consumer-Only Intake of Home-Produced Peaches (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,941,000	193	1.56	1.67	0.17	0.05	0.17	0.23	0.47	0.90	1.88	3.79	6.36	12.30	22.30
Age															
1 to 2	103,000	8	1.81	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	65,000	6	0.80	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	329,000	26	1.97	3.11	0.63	0.10	0.10	0.14	0.63	1.13	6.36	8.53	8.53	11.50	11.50
12 to 19	177,000	13	0.86	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	573,000	35	0.93	1.17	0.17	0.05	0.06	0.23	0.47	0.81	1.30	2.92	2.99	5.27	5.27
40 to 69	1,076,000	70	1.90	1.53	0.28	0.06	0.19	0.24	0.56	0.89	1.61	2.63	4.43	12.30	12.30
≥ 70	598,000	33	3.77	1.01	0.20	0.09	0.14	0.18	0.28	0.82	1.19	1.60	3.79	7.13	7.13
Season															
Fall	485,000	19	1.02	*	*	*	*	*	*	*	*	*	*	*	*
Spring	756,000	91	1.64	1.67	0.30	0.05	0.06	0.10	0.28	0.77	1.45	4.44	6.77	22.30	22.30
Summer	1,081,000	35	2.38	2.26	0.48	0.17	0.23	0.36	0.57	1.12	2.99	6.36	8.53	12.30	12.30
Winter	619,000	48	1.27	1.25	0.10	0.04	0.24	0.56	0.78	1.04	1.71	2.35	2.60	3.56	3.56
Urbanization															
Central City	429,000	12	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,110,000	99	2.47	1.87	0.26	0.06	0.26	0.39	0.65	1.02	2.18	3.86	6.36	11.50	22.30
Suburban	1,402,000	82	1.62	1.47	0.18	0.05	0.14	0.20	0.46	0.92	1.87	3.79	4.43	7.37	7.37
Race															
Black	39,000	1	0.18	*	*	*	*	*	*	*	*	*	*	*	*
White	2,861,000	191	1.82	1.70	0.17	0.05	0.17	0.23	0.50	0.90	1.96	3.79	6.36	12.30	22.30
Region															
Midwest	824,000	75	1.78	1.39	0.29	0.18	0.22	0.26	0.46	0.74	1.19	3.06	3.56	11.50	22.30
Northeast	75,000	5	0.18	*	*	*	*	*	*	*	*	*	*	*	*
South	852,000	51	1.32	1.67	0.26	0.04	0.14	0.18	0.64	1.02	1.96	3.83	6.36	8.53	8.53
West	1,190,000	62	3.30	1.80	0.33	0.05	0.14	0.23	0.47	0.86	1.94	4.43	7.37	12.30	12.30
Response to Questionnaire															
Households who garden	2,660,000	174	3.90	1.75	0.19	0.05	0.17	0.26	0.53	0.93	1.96	3.79	6.36	12.30	22.30
Households who farm	769,000	54	10.49	1.56	0.25	0.07	0.18	0.23	0.46	0.90	2.02	2.99	6.36	8.53	8.53

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-48. Consumer-Only Intake of Home-Produced Pears (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,513,000	94	0.80	0.94	0.10	0.10	0.18	0.24	0.43	0.68	1.09	1.60	2.76	5.16	5.16
Age															
1 to 2	24,000	3	0.42	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	45,000	3	0.56	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	145,000	10	0.87	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	121,000	7	0.59	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	365,000	23	0.59	0.62	0.06	0.11	0.32	0.38	0.43	0.50	0.68	1.22	1.24	1.24	1.24
40 to 69	557,000	33	0.98	0.66	0.06	0.10	0.11	0.33	0.42	0.65	0.92	1.10	1.13	1.51	1.51
≥ 70	256,000	15	1.61	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	308,000	11	0.65	*	*	*	*	*	*	*	*	*	*	*	*
Spring	355,000	39	0.77	0.69	0.08	0.10	0.11	0.18	0.34	0.60	0.87	1.15	1.83	2.54	2.54
Summer	474,000	16	1.04	*	*	*	*	*	*	*	*	*	*	*	*
Winter	376,000	28	0.77	1.48	0.28	0.11	0.11	0.38	0.65	0.95	1.38	4.82	5.16	5.16	5.16
Urbanization															
Central City	222,000	11	0.39	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	634,000	44	1.41	0.78	0.09	0.33	0.35	0.42	0.44	0.57	0.81	1.56	1.86	2.88	2.88
Suburban	657,000	39	0.76	0.85	0.12	0.10	0.11	0.18	0.39	0.73	1.10	1.50	2.57	4.79	4.79
Race															
Black	51,000	3	0.23	*	*	*	*	*	*	*	*	*	*	*	*
White	1,462,000	91	0.93	0.97	0.10	0.11	0.24	0.35	0.44	0.70	1.09	1.60	2.88	5.16	5.16
Region															
Midwest	688,000	57	1.48	0.87	0.09	0.22	0.34	0.38	0.44	0.65	1.04	1.60	2.57	4.79	4.79
Northeast	18,000	2	0.04	*	*	*	*	*	*	*	*	*	*	*	*
South	377,000	13	0.59	*	*	*	*	*	*	*	*	*	*	*	*
West	430,000	22	1.19	1.14	0.29	0.10	0.11	0.11	0.36	0.75	1.13	2.76	4.82	5.16	5.16
Response to Questionnaire															
Households who garden	1,312,000	85	1.93	0.95	0.10	0.10	0.18	0.35	0.43	0.68	1.09	1.56	2.88	5.16	5.16
Households who farm	528,000	35	7.20	1.09	0.21	0.11	0.22	0.38	0.43	0.61	1.09	2.76	4.82	5.16	5.16

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-49. Consumer-Only Intake of Home-Produced Peas (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	4,252,000	226	2.26	0.51	0.03	0.05	0.10	0.14	0.23	0.32	0.62	1.04	1.46	2.66	2.89
Age															
1 to 2	163,000	9	2.86	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	140,000	7	1.73	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	515,000	26	3.08	0.61	0.09	0.15	0.15	0.22	0.30	0.39	0.90	1.35	1.40	2.06	2.06
12 to 19	377,000	22	1.84	0.41	0.04	0.06	0.13	0.16	0.24	0.36	0.50	0.71	0.82	0.82	0.82
20 to 39	1,121,000	52	1.82	0.41	0.06	0.10	0.12	0.14	0.18	0.25	0.41	0.85	1.36	2.71	2.71
40 to 69	1,366,000	80	2.41	0.46	0.05	0.07	0.10	0.12	0.23	0.30	0.61	1.00	1.30	2.36	2.36
≥ 70	458,000	26	2.88	0.33	0.06	0.03	0.03	0.05	0.18	0.27	0.37	1.00	1.00	1.46	1.46
Season															
Fall	1,239,000	41	2.60	0.30	0.03	0.03	0.05	0.12	0.21	0.26	0.35	0.60	0.71	1.00	1.00
Spring	765,000	78	1.66	0.44	0.04	0.06	0.11	0.12	0.19	0.33	0.52	0.92	1.40	2.06	2.06
Summer	1,516,000	51	3.33	0.59	0.07	0.07	0.13	0.17	0.22	0.39	0.82	1.35	1.60	2.66	2.66
Winter	732,000	56	1.50	0.75	0.09	0.12	0.18	0.21	0.27	0.54	0.95	1.54	2.36	2.89	2.89
Urbanization															
Central City	558,000	19	0.99	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	2,028,000	126	4.50	0.48	0.04	0.08	0.14	0.17	0.25	0.35	0.58	1.04	1.36	1.89	2.89
Suburban	1,666,000	81	1.92	0.51	0.05	0.07	0.12	0.13	0.23	0.39	0.68	1.00	1.30	2.28	2.36
Race															
Black	355,000	19	1.63	*	*	*	*	*	*	*	*	*	*	*	*
White	3,784,000	203	2.40	0.50	0.03	0.03	0.10	0.13	0.22	0.33	0.60	1.00	1.40	2.66	2.89
Region															
Midwest	1,004,000	55	2.16	0.40	0.07	0.03	0.05	0.10	0.14	0.25	0.35	0.88	1.54	2.71	2.89
Northeast	241,000	14	0.59	*	*	*	*	*	*	*	*	*	*	*	*
South	2,449,000	132	3.81	0.57	0.04	0.13	0.17	0.20	0.26	0.37	0.68	1.24	1.60	2.66	2.66
West	558,000	25	1.55	0.38	0.06	0.07	0.07	0.10	0.22	0.27	0.48	0.90	0.94	1.40	1.40
Response to Questionnaire															
Households who garden	3,980,000	214	5.84	0.51	0.03	0.03	0.10	0.14	0.23	0.32	0.63	1.04	1.54	2.66	2.89
Households who farm	884,000	55	12.06	0.46	0.06	0.03	0.05	0.09	0.21	0.35	0.52	0.90	1.40	1.60	2.89

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	5,153,000	208	2.74												
Age															
1 to 2	163,000	6	2.86	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	108,000	5	1.33	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	578,000	26	3.46	0.23	0.04	0.00	0.00	0.03	0.09	0.16	0.30	0.43	0.77	0.85	0.85
12 to 19	342,000	16	1.67	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	1,048,000	40	1.70	0.22	0.06	0.02	0.03	0.06	0.09	0.12	0.22	0.40	0.62	2.48	2.48
40 to 69	2,221,000	88	3.92	0.25	0.03	0.01	0.03	0.05	0.08	0.17	0.32	0.48	0.74	1.50	1.50
≥ 70	646,000	25	4.07	0.26	0.06	0.02	0.02	0.02	0.07	0.14	0.24	0.92	0.94	1.07	1.07
Season															
Fall	1,726,000	53	3.62	0.20	0.03	0.00	0.03	0.04	0.09	0.17	0.24	0.35	0.40	1.07	1.07
Spring	255,000	28	0.55	0.30	0.07	0.00	0.02	0.04	0.07	0.15	0.32	1.09	1.20	1.53	1.53
Summer	2,672,000	94	5.87												
Winter	500,000	33	1.03												
Urbanization															
Central City	865,000	30	1.53	0.25	0.04	0.04	0.06	0.07	0.11	0.18	0.27	0.36	0.94	1.10	1.10
Non-metropolitan	1,982,000	89	4.40	0.24	0.04	0.01	0.02	0.03	0.07	0.12	0.27	0.54	0.77	2.48	2.48
Suburban	2,246,000	87	2.59	0.25	0.03	0.00	0.03	0.04	0.09	0.16	0.29	0.49	0.97	1.50	1.53
Race															
Black	127,000	6	0.58	*	*	*	*	*	*	*	*	*	*	*	*
White	4,892,000	198	3.11	0.25	0.02	0.02	0.03	0.04	0.09	0.15	0.29	0.49	0.92	1.81	2.48
Region															
Midwest	1,790,000	74	3.86	0.23	0.04	0.01	0.02	0.03	0.06	0.15	0.26	0.39	0.85	2.48	2.48
Northeast	786,000	31	1.91												
South	1,739,000	72	2.70	0.23	0.03	0.03	0.07	0.08	0.11	0.17	0.27	0.43	0.53	1.81	1.81
West	778,000	29	2.16	0.21	0.05	0.02	0.02	0.03	0.04	0.09	0.25	0.54	0.92	1.07	1.07
Response to Questionnaire															
Households who garden	4,898,000	199	7.19	0.24	0.02	0.00	0.02	0.03	0.08	0.15	0.29	0.48	0.85	1.50	2.48
Households who farm	867,000	35	11.83	0.30	0.08	0.00	0.03	0.03	0.07	0.17	0.36	0.60	0.85	2.48	2.48

Table 13-50. Consumer-Only Intake of Home-Produced Peppers (g/kg-day)

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-51. Consumer-Only Intake of Home-Produced Pork (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,732,000	121	0.92	1.23	0.10	0.09	0.14	0.31	0.54	0.90	1.71	2.73	3.37	4.93	7.41
Age															
1 to 2	38,000	5	0.67	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	26,000	3	0.32	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	129,000	11	0.77	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	291,000	20	1.42	1.28	0.24	0.31	0.32	0.34	0.52	0.89	1.75	3.69	3.69	4.29	4.29
20 to 39	511,000	32	0.83	1.21	0.18	0.11	0.28	0.41	0.55	0.79	1.43	2.90	3.08	4.93	4.93
40 to 69	557,000	38	0.98	1.02	0.12	0.12	0.18	0.22	0.41	0.81	1.71	1.78	2.28	3.16	3.16
≥ 70	180,000	12	1.13	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	362,000	13	0.76	*	*	*	*	*	*	*	*	*	*	*	*
Spring	547,000	59	1.19	1.13	0.13	0.11	0.14	0.22	0.35	0.90	1.50	2.68	3.68	4.29	4.29
Summer	379,000	15	0.83	*	*	*	*	*	*	*	*	*	*	*	*
Winter	444,000	34	0.91	1.40	0.24	0.13	0.26	0.38	0.50	0.88	2.21	3.08	4.93	7.41	7.41
Urbanization															
Central City	90,000	2	0.16	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	1,178,000	77	2.62	1.39	0.13	0.09	0.22	0.41	0.62	0.97	1.75	3.16	3.69	4.93	7.41
Suburban	464,000	42	0.54	0.88	0.12	0.11	0.12	0.18	0.33	0.59	1.10	2.28	2.73	2.90	2.90
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	1,732,000	121	1.10	1.23	0.10	0.09	0.14	0.31	0.54	0.90	1.71	2.73	3.37	4.93	7.41
Region															
Midwest	844,000	64	1.82	1.06	0.12	0.09	0.12	0.21	0.50	0.67	1.20	2.68	3.37	3.69	3.73
Northeast	97,000	5	0.24	*	*	*	*	*	*	*	*	*	*	*	*
South	554,000	32	0.86	1.35	0.15	0.18	0.26	0.34	0.81	1.26	1.75	2.44	3.08	4.29	4.29
West	237,000	20	0.66	1.15	0.31	0.13	0.32	0.38	0.44	0.73	1.10	1.75	2.73	7.41	7.41
Response to Questionnaire															
Households who raise animals	1,428,000	100	14.14	1.34	0.10	0.14	0.32	0.41	0.59	0.97	1.75	2.90	3.37	4.29	4.93
Households who farm	1,218,000	82	16.62	1.30	0.11	0.22	0.34	0.41	0.59	0.92	1.71	3.08	3.69	4.93	4.93

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-52. Consumer-Only Intake of Home-Produced Poultry (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	1,816,000	105	0.97	1.57	0.12	0.20	0.30	0.42	0.64	1.23	2.19	3.17	3.83	5.33	6.17
Age															
1 to 2	91,000	8	1.60	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	70,000	5	0.86	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	205,000	12	1.23	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	194,000	12	0.95	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	574,000	33	0.93	1.17	0.15	0.17	0.40	0.40	0.56	1.15	1.37	1.80	2.93	4.59	4.59
40 to 69	568,000	30	1.00	1.51	0.24	0.20	0.20	0.30	0.49	0.77	2.69	3.29	4.60	5.15	5.15
≥ 70	80,000	3	0.50	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	562,000	23	1.18	1.52	0.18	0.41	0.42	0.46	0.81	1.39	2.23	2.69	3.17	3.17	3.17
Spring	374,000	34	0.81	1.87	0.28	0.17	0.23	0.30	0.52	1.38	3.29	4.60	5.15	5.33	5.33
Summer	312,000	11	0.69	*	*	*	*	*	*	*	*	*	*	*	*
Winter	568,000	37	1.17	1.55	0.20	0.20	0.20	0.43	0.60	1.23	2.18	2.95	3.47	6.17	6.17
Urbanization															
Central City	230,000	8	0.41	*	*	*	*	*	*	*	*	*	*	*	*
Non-metropolitan	997,000	56	2.21	1.48	0.13	0.20	0.28	0.41	0.67	1.19	2.10	3.17	3.29	3.86	5.33
Suburban	589,000	41	0.68	1.94	0.23	0.23	0.27	0.43	0.62	1.59	2.69	4.59	4.83	6.17	6.17
Race															
Black	44,000	2	0.20	*	*	*	*	*	*	*	*	*	*	*	*
White	1,772,000	103	1.12	1.57	0.12	0.20	0.30	0.42	0.62	1.23	2.19	3.17	3.86	5.33	6.17
Region															
Midwest	765,000	41	1.65	1.60	0.14	0.41	0.42	0.56	0.98	1.39	2.19	2.70	3.17	3.86	5.33
Northeast	64,000	4	0.16	*	*	*	*	*	*	*	*	*	*	*	*
South	654,000	38	1.02	1.67	0.25	0.17	0.20	0.30	0.46	0.91	2.11	4.59	4.83	6.17	6.17
West	333,000	22	0.92	1.24	0.18	0.27	0.27	0.43	0.56	1.02	1.89	2.45	2.93	2.93	2.93
Response to Questionnaire															
Households who raise animals	1,333,000	81	13.20	1.58	0.12	0.23	0.41	0.47	0.71	1.37	2.19	2.93	3.29	5.33	6.17
Households who farm	917,000	59	12.51	1.54	0.18	0.20	0.23	0.30	0.60	1.06	2.18	3.47	4.83	6.17	6.17

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-53. Consumer-Only Intake of Home-Produced Pumpkins (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,041,000	87	1.09	0.78	0.07	0.13	0.18	0.24	0.32	0.56	1.07	1.47	1.79	3.02	4.48
Age															
1 to 2	73,000	4	1.28	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	18,000	2	0.22	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	229,000	9	1.37	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	244,000	10	1.19	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	657,000	26	1.07	0.80	0.13	0.18	0.18	0.30	0.38	0.48	1.03	1.73	2.67	2.67	2.67
40 to 69	415,000	20	0.73	0.82	0.16	0.29	0.29	0.32	0.37	0.52	0.96	1.47	3.02	3.02	3.02
≥ 70	373,000	15	2.35	*	*	*	*	*	*	*	*	*	*	*	*
Season															
Fall	1,345,000	49	2.82	0.82	0.09	0.13	0.18	0.28	0.37	0.61	1.17	1.73	1.79	3.02	3.02
Spring	48,000	6	0.10	*	*	*	*	*	*	*	*	*	*	*	*
Summer	405,000	13	0.89	*	*	*	*	*	*	*	*	*	*	*	*
Winter	243,000	19	0.50	*	*	*	*	*	*	*	*	*	*	*	*
Urbanization															
Central City	565,000	20	1.00	0.63	0.11	0.18	0.18	0.24	0.28	0.38	0.94	1.24	1.33	2.24	2.24
Non-metropolitan	863,000	44	1.92	0.64	0.10	0.13	0.17	0.19	0.31	0.51	0.67	1.22	1.45	4.48	4.48
Suburban	613,000	23	0.71	1.10	0.13	0.29	0.29	0.30	0.47	1.04	1.47	1.79	2.67	2.67	2.67
Race															
Black	22,000	1	0.10	*	*	*	*	*	*	*	*	*	*	*	*
White	2,019,000	86	1.28	0.78	0.07	0.13	0.18	0.24	0.32	0.56	1.10	1.47	1.79	3.02	4.48
Region															
Midwest	1,370,000	54	2.95	0.82	0.10	0.13	0.23	0.24	0.32	0.57	1.04	1.73	2.67	3.02	4.48
Northeast	15,000	1	0.04	*	*	*	*	*	*	*	*	*	*	*	*
South	179,000	10	0.28	*	*	*	*	*	*	*	*	*	*	*	*
West	477,000	22	1.32	0.79	0.10	0.18	0.19	0.31	0.37	0.74	1.17	1.47	1.51	1.51	1.51
Response to Questionnaire															
Households who garden	1,987,000	85	2.92	0.77	0.07	0.13	0.18	0.24	0.32	0.56	1.04	1.46	1.79	3.02	4.48
Households who farm	449,000	18	6.13	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-54. Consumer-Only Intake of Home-Produced Snap Beans (g/kg-day)

Population Group	Nc wgtd	Nc Unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	12,308,000	739	6.55	0.80	0.03	0.06	0.15	0.19	0.34	0.57	1.04	1.58	2.01	3.90	9.96
Age															
1 to 2	246,000	17	4.32	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	455,000	32	5.62	1.49	0.24	0.00	0.00	0.35	0.90	1.16	1.66	3.20	4.88	6.90	6.90
6 to 11	862,000	62	5.16	0.90	0.12	0.00	0.20	0.22	0.32	0.64	1.21	1.79	2.75	4.81	5.66
12 to 19	1,151,000	69	5.62	0.64	0.06	0.00	0.16	0.22	0.32	0.50	0.81	1.34	1.79	2.72	2.72
20 to 39	2,677,000	160	4.35	0.61	0.04	0.07	0.13	0.16	0.26	0.50	0.79	1.24	1.64	2.05	4.26
40 to 69	4,987,000	292	8.79	0.72	0.03	0.10	0.16	0.23	0.36	0.56	0.86	1.45	1.77	2.70	4.23
≥ 70	1,801,000	100	11.34	0.92	0.12	0.06	0.07	0.15	0.37	0.64	1.22	1.70	2.01	9.96	9.96
Season															
Fall	3,813,000	137	8.00	0.81	0.08	0.06	0.15	0.18	0.27	0.54	1.18	1.52	2.01	4.82	9.96
Spring	2,706,000	288	5.86	0.90	0.05	0.03	0.15	0.22	0.37	0.59	1.11	1.72	2.85	5.66	6.90
Summer	2,946,000	98	6.48	0.63	0.05	0.00	0.12	0.16	0.33	0.50	0.85	1.30	1.70	2.05	2.63
Winter	2,843,000	216	5.84	0.86	0.05	0.11	0.18	0.24	0.42	0.62	1.12	1.72	2.02	3.85	7.88
Urbanization															
Central City	2,205,000	78	3.91	0.60	0.06	0.06	0.07	0.16	0.26	0.51	0.71	1.23	1.54	1.93	3.35
Non-metropolitan	5,696,000	404	12.65	0.96	0.05	0.09	0.18	0.23	0.37	0.68	1.19	1.89	2.70	4.88	9.96
Suburban	4,347,000	255	5.02	0.70	0.04	0.10	0.14	0.19	0.34	0.52	0.93	1.36	1.77	2.98	6.08
Race															
Black	634,000	36	2.92	0.76	0.14	0.25	0.25	0.28	0.30	0.48	1.04	1.30	1.34	5.98	5.98
White	11,519,000	694	7.31	0.81	0.03	0.07	0.15	0.19	0.35	0.57	1.06	1.63	2.01	3.90	9.96
Region															
Midwest	4,651,000	307	10.02	0.86	0.06	0.07	0.15	0.19	0.34	0.55	0.99	1.70	2.47	4.88	9.96
Northeast	990,000	52	2.40	0.57	0.07	0.00	0.10	0.11	0.18	0.49	0.82	1.28	1.36	1.97	3.09
South	4,755,000	286	7.39	0.88	0.04	0.13	0.21	0.25	0.40	0.68	1.22	1.72	2.01	3.23	5.98
West	1,852,000	92	5.14	0.59	0.04	0.07	0.14	0.18	0.27	0.51	0.74	1.20	1.52	2.19	2.19
Response to Questionnaire															
Households who garden	11,843,000	700	17.38	0.79	0.03	0.06	0.15	0.19	0.33	0.56	1.02	1.60	2.01	3.85	9.96
Households who farm	2,591,000	157	35.35	0.80	0.05	0.06	0.13	0.19	0.41	0.66	1.12	1.54	1.98	2.96	4.23

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-55. Consumer-Only Intake of Home-Produced Strawberries (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,057,000	139	1.09	0.65	0.05	0.04	0.08	0.12	0.26	0.47	0.82	1.47	1.77	2.72	4.83
Age															
1 to 2	30,000	2	0.53	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	66,000	6	0.81	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	153,000	15	0.92	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	201,000	11	0.98	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	316,000	22	0.51	0.32	0.06	0.08	0.08	0.11	0.12	0.21	0.46	0.82	0.97	1.56	1.56
40 to 69	833,000	55	1.47	0.64	0.06	0.02	0.07	0.18	0.36	0.58	0.94	1.42	1.47	2.37	2.37
≥ 70	449,000	27	2.83	0.64	0.11	0.04	0.04	0.09	0.26	0.47	0.70	1.66	1.89	2.72	2.72
Season															
Fall	250,000	8	0.52	*	*	*	*	*	*	*	*	*	*	*	*
Spring	598,000	66	1.30	0.83	0.10	0.08	0.09	0.18	0.28	0.47	0.97	1.93	2.54	4.83	4.83
Summer	388,000	11	0.85	*	*	*	*	*	*	*	*	*	*	*	*
Winter	821,000	54	1.69	0.51	0.06	0.02	0.04	0.11	0.21	0.39	0.60	1.27	1.46	2.37	2.37
Urbanization															
Central City	505,000	23	0.90	0.75	0.12	0.04	0.04	0.09	0.38	0.49	1.33	1.47	1.69	2.37	2.37
Non-metropolitan	664,000	52	1.47	0.62	0.11	0.02	0.07	0.08	0.13	0.39	0.81	1.66	2.16	4.83	4.83
Suburban	888,000	64	1.03	0.62	0.06	0.08	0.18	0.22	0.35	0.53	0.70	1.27	1.56	2.97	2.97
Race															
Black	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
White	2,057,000	139	1.31	0.65	0.05	0.04	0.08	0.12	0.26	0.47	0.82	1.47	1.77	2.72	4.83
Region															
Midwest	1,123,000	76	2.42	0.69	0.08	0.02	0.07	0.08	0.18	0.42	1.00	1.66	1.93	2.97	4.83
Northeast	382,000	25	0.93	0.64	0.10	0.09	0.16	0.18	0.26	0.47	0.87	1.46	1.83	2.16	2.16
South	333,000	23	0.52	0.67	0.08	0.13	0.21	0.38	0.52	0.62	0.70	1.00	1.00	2.72	2.72
West	219,000	15	0.61	*	*	*	*	*	*	*	*	*	*	*	*
Response to Questionnaire															
Households who garden	1,843,000	123	2.70	0.64	0.05	0.04	0.08	0.12	0.23	0.45	0.82	1.46	1.77	2.54	4.83
Households who farm	87,000	9	1.19	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Sandard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-56. Consumer-Only Intake of Home-Produced Tomatoes (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	16,737,000	743	8.90	1.18	0.05	0.08	0.15	0.23	0.39	0.74	1.46	2.50	3.54	7.26	19.30
Age															
1 to 2	572,000	26	10.04	3.14	0.53	0.73	0.86	0.93	1.23	1.66	4.00	7.26	10.70	10.70	10.70
3 to 5	516,000	26	6.37	1.61	0.27	0.50	0.51	0.51	0.75	1.25	1.65	3.00	6.25	6.25	6.25
6 to 11	1,093,000	51	6.54	1.63	0.27	0.22	0.31	0.39	0.53	0.76	1.66	5.20	5.70	9.14	9.14
12 to 19	1,411,000	61	6.89	0.72	0.09	0.00	0.00	0.18	0.27	0.52	0.85	1.67	1.94	3.39	3.39
20 to 39	4,169,000	175	6.77	0.85	0.10	0.07	0.13	0.15	0.25	0.52	1.00	1.83	2.10	5.52	19.30
40 to 69	6,758,000	305	11.92	1.05	0.05	0.11	0.17	0.28	0.40	0.75	1.41	2.40	3.05	4.50	5.00
≥ 70	1,989,000	89	12.53	1.26	0.09	0.11	0.24	0.30	0.48	1.14	1.77	2.51	2.99	3.67	3.67
Season															
Fall	5,516,000	201	11.57	1.02	0.09	0.07	0.14	0.22	0.34	0.60	1.34	2.24	2.87	6.25	10.70
Spring	1,264,000	127	2.74	0.84	0.06	0.14	0.19	0.24	0.37	0.63	1.11	1.75	2.00	3.79	5.28
Summer	8,122,000	279	17.86	1.30	0.09	0.11	0.17	0.24	0.41	0.80	1.55	3.05	4.05	7.26	10.90
Winter	1,835,000	136	3.77	1.37	0.18	0.09	0.21	0.29	0.50	0.83	1.49	2.48	3.38	8.29	19.30
Urbanization															
Central City	2,680,000	90	4.76	1.10	0.13	0.00	0.15	0.23	0.35	0.75	1.51	2.16	2.95	7.26	8.29
Non-metropolitan	7,389,000	378	16.41	1.26	0.07	0.11	0.22	0.26	0.42	0.76	1.47	2.77	3.85	6.87	10.70
Suburban	6,668,000	275	7.70	1.13	0.09	0.08	0.14	0.18	0.37	0.67	1.38	2.35	3.32	5.52	19.30
Race															
Black	743,000	28	3.42	0.61	0.09	0.00	0.00	0.07	0.24	0.51	0.90	1.18	1.55	1.66	1.66
White	15,658,000	703	9.94	1.22	0.06	0.11	0.17	0.24	0.41	0.76	1.49	2.55	3.59	7.26	19.30
Region															
Midwest	6,747,000	322	14.54	1.18	0.09	0.06	0.15	0.21	0.36	0.68	1.41	2.51	3.69	6.87	19.30
Northeast	2,480,000	87	6.02	1.17	0.16	0.08	0.14	0.15	0.35	0.75	1.38	2.44	3.52	10.90	10.90
South	4,358,000	202	6.77	1.15	0.09	0.00	0.21	0.25	0.42	0.75	1.43	2.32	3.67	6.82	9.14
West	3,152,000	132	8.74	1.23	0.10	0.18	0.24	0.28	0.41	0.77	1.84	2.78	3.08	7.26	7.26
Response to Questionnaire															
Households who garden	14,791,000	661	21.70	1.21	0.06	0.08	0.15	0.23	0.41	0.76	1.50	2.51	3.52	7.26	19.30
Households who farm	2,269,000	112	30.96	1.42	0.16	0.00	0.18	0.23	0.42	0.77	1.86	3.55	5.20	9.14	9.14

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-57. Consumer-Only Intake of Home-Produced White Potatoes (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	5,895,000	281	3.14	1.66	0.11	0.00	0.19	0.31	0.55	1.27	2.07	3.11	4.76	9.52	12.80
Age															
1 to 2	147,000	10	2.58	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	119,000	6	1.47	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	431,000	24	2.58	2.19	0.39	0.00	0.00	0.41	0.72	1.76	3.10	5.94	6.52	6.52	6.52
12 to 19	751,000	31	3.67	1.26	0.19	0.07	0.19	0.26	0.38	1.22	1.80	2.95	3.11	4.14	4.14
20 to 39	1,501,000	66	2.44	1.24	0.12	0.16	0.16	0.20	0.48	1.00	1.62	2.54	3.08	4.29	5.09
40 to 69	1,855,000	95	3.27	1.86	0.23	0.13	0.26	0.35	0.70	1.31	2.04	3.43	5.29	12.80	12.80
≥ 70	1,021,000	45	6.43	1.27	0.12	0.21	0.22	0.36	0.55	1.21	1.69	2.35	2.88	3.92	3.92
Season															
Fall	2,267,000	86	4.76	1.63	0.22	0.16	0.22	0.27	0.46	1.13	1.79	3.43	4.14	12.80	12.80
Spring	527,000	58	1.14	1.23	0.13	0.07	0.11	0.20	0.41	0.86	1.91	2.86	3.08	4.28	4.28
Summer	2,403,000	81	5.28	1.63	0.18	0.00	0.19	0.32	0.62	1.32	2.09	3.08	5.29	9.43	9.43
Winter	698,000	56	1.43	2.17	0.20	0.14	0.40	0.50	0.86	2.02	2.95	4.26	5.40	6.00	6.00
Urbanization															
Central City	679,000	25	1.20	0.96	0.15	0.16	0.16	0.18	0.38	0.56	1.52	2.07	2.25	2.54	2.54
Non-metropolitan	3,046,000	159	6.77	1.96	0.16	0.18	0.27	0.37	0.77	1.50	2.38	3.55	5.64	12.80	12.80
Suburban	2,110,000	95	2.44	1.49	0.17	0.11	0.19	0.32	0.54	0.93	1.68	3.11	4.76	9.43	9.43
Race															
Black	140,000	5	0.64	*	*	*	*	*	*	*	*	*	*	*	*
White	5,550,000	269	3.52	1.67	0.11	0.14	0.21	0.31	0.55	1.28	2.09	3.11	4.76	9.52	12.80
Region															
Midwest	2,587,000	133	5.58	1.77	0.15	0.18	0.24	0.34	0.64	1.35	2.15	3.77	5.29	9.43	9.43
Northeast	656,000	31	1.59	1.28	0.20	0.07	0.13	0.17	0.35	0.86	1.97	2.95	3.80	5.09	5.09
South	1,796,000	84	2.79	2.08	0.24	0.16	0.35	0.46	0.92	1.56	2.40	3.44	5.64	12.80	12.80
West	796,000	31	2.21	0.76	0.11	0.16	0.22	0.26	0.41	0.54	0.96	1.40	1.95	3.11	3.11
Response to Questionnaire															
Households who garden	5,291,000	250	7.76	1.65	0.11	0.00	0.21	0.31	0.56	1.28	2.09	3.10	4.28	9.52	12.80
Households who farm	1,082,000	62	14.76	1.83	0.18	0.07	0.21	0.58	0.92	1.46	2.31	3.80	5.09	6.52	6.52

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-58. Consumer-Only Intake of Home-Produced Exposed Fruit (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	11,770,000	679	6.26	1.49	0.08	0.04	0.14	0.26	0.45	0.83	1.70	3.16	4.78	12.00	32.50
Age															
1 to 2	306,000	19	5.37	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	470,000	30	5.80	2.60	0.78	0.00	0.00	0.37	1.00	1.82	2.64	5.41	6.07	32.50	32.50
6 to 11	915,000	68	5.48	2.52	0.42	0.00	0.17	0.37	0.62	1.11	2.91	6.98	11.70	15.70	15.90
12 to 19	896,000	50	4.37	1.33	0.21	0.08	0.12	0.26	0.40	0.61	2.27	3.41	4.78	5.90	5.90
20 to 39	2,521,000	139	4.09	1.09	0.14	0.08	0.13	0.17	0.30	0.62	1.07	2.00	3.58	12.90	12.90
40 to 69	4,272,000	247	7.53	1.25	0.11	0.06	0.16	0.25	0.44	0.72	1.40	2.61	3.25	13.00	13.00
≥ 70	2,285,000	118	14.39	1.39	0.12	0.04	0.21	0.28	0.57	0.96	1.66	3.73	4.42	5.39	7.13
Season															
Fall	2,877,000	100	6.04	1.37	0.12	0.26	0.29	0.34	0.54	1.03	1.88	2.88	4.25	5.41	5.41
Spring	2,466,000	265	5.34	1.49	0.15	0.09	0.20	0.25	0.43	0.86	1.65	2.91	4.67	8.27	32.50
Summer	3,588,000	122	7.89	1.75	0.25	0.00	0.09	0.13	0.39	0.64	1.76	4.29	6.12	13.00	15.70
Winter	2,839,000	192	5.83	1.27	0.11	0.04	0.10	0.23	0.46	0.83	1.55	2.61	4.66	8.16	11.30
Urbanization															
Central City	2,552,000	99	4.53	1.34	0.20	0.04	0.10	0.26	0.45	0.86	1.60	2.37	2.88	13.00	13.00
Non-metropolitan	3,891,000	269	8.64	1.78	0.17	0.06	0.10	0.17	0.42	0.94	1.94	4.07	5.98	15.70	32.50
Suburban	5,267,000	309	6.08	1.36	0.09	0.09	0.21	0.29	0.47	0.77	1.65	3.16	4.67	7.29	12.90
Race															
Black	250,000	12	1.15	*	*	*	*	*	*	*	*	*	*	*	*
White	11,411,000	663	7.24	1.51	0.08	0.06	0.16	0.26	0.45	0.86	1.72	3.31	4.78	12.00	32.50
Region															
Midwest	4,429,000	293	9.55	1.60	0.14	0.04	0.13	0.22	0.42	0.88	1.88	3.58	4.78	12.00	32.50
Northeast	1,219,000	69	2.96	0.76	0.12	0.08	0.09	0.17	0.30	0.47	0.78	1.39	2.86	5.21	7.13
South	2,532,000	141	3.94	1.51	0.18	0.08	0.23	0.30	0.51	0.92	1.63	2.63	5.98	15.70	15.70
West	3,530,000	174	9.79	1.60	0.14	0.10	0.24	0.32	0.57	0.96	1.97	3.72	5.00	13.00	13.00
Response to Questionnaire															
Households who garden	10,197,000	596	14.96	1.55	0.09	0.04	0.16	0.26	0.45	0.88	1.73	3.41	5.00	12.90	32.50
Households who farm	1,917,000	112	26.16	2.32	0.25	0.07	0.28	0.37	0.68	1.30	3.14	5.00	6.12	15.70	15.70

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-59. Consumer-Only Intake of Home-Produced Protected Fruits (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	3,855,000	173	2.05	5.74	0.63	0.15	0.27	0.34	0.93	2.34	7.45	16.00	19.70	47.30	53.60
Age															
1 to 2	79,000	5	1.39	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	80,000	4	0.99	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	181,000	9	1.08	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	377,000	20	1.84	2.96	0.99	0.12	0.16	0.28	0.39	1.23	2.84	7.44	11.40	19.10	19.10
20 to 39	755,000	29	1.23	4.51	1.08	0.18	0.36	0.49	1.22	1.88	4.47	14.60	16.10	24.10	24.10
40 to 69	1,702,000	77	3.00	5.65	0.87	0.11	0.24	0.29	0.67	2.22	9.36	15.50	21.20	41.30	41.30
≥ 70	601,000	26	3.78	4.44	0.69	0.26	0.26	0.29	1.95	3.29	7.06	8.97	9.97	15.20	15.20
Season															
Fall	394,000	12	0.83	*	*	*	*	*	*	*	*	*	*	*	*
Spring	497,000	36	1.08	2.08	0.35	0.16	0.18	0.26	0.38	1.22	4.08	5.10	6.57	6.79	6.79
Summer	1,425,000	47	3.13	7.39	1.45	0.11	0.27	0.39	1.25	3.06	10.30	16.60	24.10	53.60	53.60
Winter	1,539,000	78	3.16	6.24	0.91	0.15	0.30	0.38	1.39	2.65	8.23	17.80	21.20	47.30	47.30
Urbanization															
Central City	1,312,000	50	2.33	3.94	0.58	0.15	0.26	0.33	0.83	3.01	5.01	9.23	9.97	18.80	18.80
Non-metropolitan	506,000	19	1.12	*	*	*	*	*	*	*	*	*	*	*	*
Suburban	2,037,000	104	2.35	6.83	0.94	0.11	0.25	0.29	0.59	2.01	10.30	17.90	23.80	53.60	53.60
Race															
Black	200,000	8	0.92	*	*	*	*	*	*	*	*	*	*	*	*
White	3,655,000	165	2.32	5.91	0.65	0.12	0.26	0.33	1.06	2.44	7.46	16.00	21.20	47.30	53.60
Region															
Midwest	657,000	24	1.42	10.70	2.60	0.25	0.26	0.29	1.18	7.44	14.60	24.10	41.30	53.60	53.60
Northeast	105,000	5	0.26	*	*	*	*	*	*	*	*	*	*	*	*
South	1,805,000	74	2.81	4.77	0.65	0.16	0.36	0.45	1.23	2.54	5.10	15.20	16.60	23.80	24.00
West	1,288,000	70	3.57	4.85	0.93	0.11	0.18	0.27	0.49	1.84	5.34	12.30	18.80	47.30	47.30
Response to Questionnaire															
Households who garden	3,360,000	146	4.93	5.90	0.70	0.12	0.27	0.34	1.16	2.42	7.46	16.00	19.10	47.30	53.60
Households who farm	357,000	14	4.87	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-60. Consumer-Only Intake of Home-Produced Exposed Vegetables (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	28,762,000	1,511	15.30	1.52	0.05	0.00	0.09	0.17	0.40	0.86	1.83	3.55	5.12	10.30	20.60
Age															
1 to 2	815,000	43	14.30	3.48	0.51	0.02	0.24	0.83	1.20	1.89	4.23	10.70	11.90	12.10	12.10
3 to 5	1,069,000	62	13.19	1.74	0.22	0.00	0.01	0.05	0.58	1.16	2.53	3.47	6.29	7.36	8.86
6 to 11	2,454,000	134	14.68	1.39	0.18	0.00	0.04	0.09	0.31	0.64	1.60	3.22	5.47	13.30	13.30
12 to 19	2,611,000	143	12.74	1.07	0.09	0.00	0.03	0.14	0.30	0.66	1.46	2.35	3.78	5.67	5.67
20 to 39	6,969,000	348	11.31	1.05	0.08	0.01	0.07	0.12	0.26	0.56	1.26	2.33	3.32	7.57	20.60
40 to 69	10,993,000	579	19.38	1.60	0.08	0.00	0.14	0.24	0.48	0.98	1.92	3.59	5.22	8.99	19.00
≥ 70	3,517,000	185	22.15	1.68	0.12	0.01	0.15	0.24	0.52	1.13	2.38	4.08	4.96	6.96	10.20
Season															
Fall	8,865,000	314	18.60	1.31	0.10	0.05	0.11	0.18	0.33	0.65	1.56	3.13	4.45	8.92	12.20
Spring	4,863,000	487	10.54	1.14	0.06	0.00	0.05	0.15	0.34	0.66	1.39	2.76	4.02	7.51	10.70
Summer	10,151,000	348	22.32	2.03	0.13	0.00	0.11	0.20	0.61	1.30	2.52	4.32	6.35	12.70	19.00
Winter	4,883,000	362	10.02	1.21	0.10	0.00	0.02	0.14	0.37	0.67	1.42	2.76	3.69	8.86	20.60
Urbanization															
Central City	4,859,000	173	8.62	1.11	0.10	0.01	0.06	0.08	0.28	0.70	1.43	2.49	3.29	8.34	12.10
Non-metropolitan	11,577,000	711	25.71	1.87	0.09	0.02	0.17	0.25	0.50	1.16	2.20	4.12	6.10	12.20	19.00
Suburban	12,266,000	625	14.17	1.35	0.07	0.00	0.10	0.16	0.36	0.74	1.58	3.22	5.22	8.61	20.60
Race															
Black	1,713,000	100	7.88	1.23	0.13	0.00	0.08	0.14	0.35	0.89	1.51	3.32	3.92	5.55	7.19
White	26,551,000	1,386	16.85	1.53	0.05	0.00	0.10	0.18	0.40	0.86	1.82	3.48	5.12	10.30	20.60
Region															
Midwest	10,402,000	570	22.42	1.48	0.09	0.01	0.07	0.16	0.39	0.81	1.69	3.55	4.67	11.90	20.60
Northeast	4,050,000	191	9.84	1.65	0.18	0.00	0.08	0.14	0.26	0.67	1.75	5.58	6.80	12.70	14.90
South	9,238,000	503	14.36	1.55	0.08	0.05	0.16	0.26	0.52	1.00	1.92	3.19	4.52	9.92	13.30
West	5,012,000	245	13.90	1.43	0.10	0.00	0.03	0.15	0.39	0.76	2.13	3.45	4.84	7.51	8.34
Response to Questionnaire															
Households who garden	25,737,000	1,361	37.76	1.57	0.06	0.00	0.09	0.17	0.41	0.89	1.97	3.63	5.45	10.30	20.60
Households who farm	3,596,000	207	49.07	2.17	0.16	0.00	0.18	0.37	0.65	1.38	2.81	6.01	6.83	10.30	13.30

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Table 13-61. Consumer-Only Intake of Home-Produced Protected Vegetables (g/kg-day)															
Total	11,428,000	656	6.08	1.01	0.05	0.10	0.15	0.19	0.32	0.63	1.20	2.24	3.05	6.49	9.42
Age															
1 to 2	348,000	21	6.11	2.46	0.49	0.32	0.32	0.54	1.36	1.94	2.96	3.88	9.42	9.42	9.42
3 to 5	440,000	32	5.43	1.30	0.21	0.23	0.23	0.32	0.48	1.04	1.48	2.51	5.10	5.31	5.31
6 to 11	1,052,000	63	6.30	1.10	0.13	0.19	0.21	0.32	0.39	0.79	1.31	2.14	3.12	5.40	5.40
12 to 19	910,000	51	4.44	0.78	0.09	0.06	0.16	0.24	0.35	0.58	0.82	1.85	2.20	2.69	2.69
20 to 39	3,227,000	164	5.24	0.76	0.06	0.11	0.15	0.17	0.24	0.51	0.97	1.73	2.51	3.63	4.76
40 to 69	3,818,000	226	6.73	0.93	0.07	0.07	0.14	0.17	0.32	0.60	1.11	1.87	3.04	6.84	7.44
≥ 70	1,442,000	89	9.08	1.05	0.16	0.12	0.21	0.24	0.36	0.57	1.21	1.86	3.05	9.23	9.23
Season															
Fall	3,907,000	143	8.20	0.85	0.07	0.12	0.16	0.20	0.32	0.57	1.10	1.73	2.51	4.78	5.31
Spring	2,086,000	236	4.52	0.70	0.04	0.06	0.14	0.17	0.27	0.49	0.91	1.44	1.86	3.74	5.73
Summer	3,559,000	118	7.82	1.40	0.16	0.10	0.18	0.23	0.38	0.78	1.69	3.05	5.40	9.23	9.42
Winter	1,876,000	159	3.85	0.93	0.08	0.12	0.14	0.18	0.31	0.60	1.20	2.32	3.06	4.76	6.39
Urbanization															
Central City	1,342,000	49	2.38	1.00	0.15	0.12	0.15	0.17	0.32	0.72	1.18	2.36	2.83	4.78	4.78
Non-metropolitan	5,934,000	391	13.18	1.07	0.06	0.11	0.17	0.21	0.35	0.65	1.30	2.51	3.55	6.84	9.42
Suburban	4,152,000	216	4.80	0.93	0.08	0.07	0.15	0.19	0.29	0.56	1.15	1.85	2.67	6.49	9.23
Race															
Black	479,000	27	2.20	1.50	0.23	0.16	0.26	0.33	0.87	0.94	2.20	3.05	3.23	4.95	4.95
White	10,836,000	625	6.88	0.99	0.05	0.10	0.15	0.19	0.32	0.61	1.20	2.17	3.04	6.49	9.42
Region															
Midwest	4,359,000	273	9.40	1.01	0.07	0.11	0.17	0.23	0.33	0.57	1.08	2.45	3.68	6.84	7.44
Northeast	807,000	48	1.96	0.70	0.09	0.06	0.15	0.17	0.27	0.51	0.99	1.71	2.33	2.77	2.77
South	4,449,000	253	6.92	1.08	0.07	0.13	0.17	0.21	0.38	0.71	1.38	2.32	3.05	5.40	9.42
West	1,813,000	82	5.03	0.96	0.16	0.07	0.12	0.15	0.21	0.48	1.01	1.86	3.12	9.23	9.23
Response to Questionnaire															
Households who garden	10,286,000	602	15.09	1.01	0.05	0.10	0.15	0.19	0.34	0.64	1.21	2.32	3.05	6.49	9.23
Households who farm	2,325,000	142	31.72	1.30	0.15	0.09	0.17	0.21	0.34	0.60	1.40	3.55	5.40	9.23	9.23

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-62. Consumer-Only Intake of Home-Produced Root Vegetables (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	13,750,000	743	7.31	1.16	0.06	0.00	0.04	0.11	0.25	0.67	1.47	2.81	3.71	9.52	12.80
Age															
1 to 2	371,000	22	6.51	2.52	0.61	0.17	0.17	0.22	0.36	0.92	3.67	7.25	10.40	10.40	10.40
3 to 5	390,000	23	4.81	1.28	0.32	0.00	0.00	0.12	0.23	0.46	1.68	4.26	4.73	4.73	4.73
6 to 11	1,106,000	67	6.62	1.32	0.21	0.00	0.01	0.04	0.23	0.52	1.63	3.83	5.59	7.47	7.47
12 to 19	1,465,000	76	7.15	0.94	0.12	0.01	0.01	0.07	0.27	0.57	1.37	2.26	3.32	5.13	5.13
20 to 39	3,252,000	164	5.28	0.87	0.07	0.01	0.05	0.10	0.20	0.56	1.24	2.11	3.08	4.64	6.03
40 to 69	4,903,000	276	8.64	1.13	0.10	0.00	0.03	0.12	0.25	0.68	1.27	2.74	3.56	9.52	12.80
≥ 70	2,096,000	107	13.20	1.22	0.10	0.02	0.03	0.17	0.38	0.85	1.71	2.86	3.21	4.01	4.77
Season															
Fall	4,026,000	153	8.45	1.42	0.15	0.05	0.14	0.17	0.31	0.92	1.67	3.26	3.85	12.30	12.80
Spring	2,552,000	260	5.53	0.69	0.06	0.00	0.02	0.03	0.14	0.37	0.77	1.69	2.80	4.24	7.69
Summer	5,011,000	169	11.02	1.19	0.12	0.00	0.05	0.13	0.28	0.73	1.51	2.74	3.64	10.40	11.90
Winter	2,161,000	161	4.44	1.17	0.12	0.00	0.01	0.04	0.24	0.56	1.56	3.08	4.14	6.21	11.30
Urbanization															
Central City	2,385,000	96	4.23	0.75	0.08	0.03	0.04	0.14	0.22	0.43	0.92	1.91	2.70	3.56	3.93
Non-metropolitan	6,094,000	366	13.54	1.43	0.10	0.01	0.07	0.13	0.28	0.76	1.85	3.32	4.24	11.30	12.80
Suburban	5,211,000	279	6.02	1.06	0.09	0.00	0.01	0.07	0.23	0.73	1.19	2.34	3.26	6.29	11.90
Race															
Black	521,000	31	2.40	0.88	0.39	0.00	0.01	0.04	0.09	0.54	0.77	1.06	1.25	12.30	12.30
White	12,861,000	697	8.16	1.18	0.06	0.01	0.05	0.13	0.26	0.68	1.50	2.82	3.72	9.52	12.80
Region															
Midwest	5,572,000	314	12.01	1.31	0.10	0.03	0.07	0.17	0.27	0.74	1.67	3.23	4.26	10.40	11.90
Northeast	1,721,000	92	4.18	0.84	0.10	0.00	0.01	0.01	0.14	0.48	1.18	2.05	2.77	4.78	6.03
South	3,842,000	205	5.97	1.38	0.14	0.01	0.05	0.13	0.28	0.69	1.70	3.32	3.83	12.30	12.80
West	2,555,000	130	7.08	0.77	0.06	0.00	0.02	0.11	0.24	0.57	0.98	1.69	2.45	3.72	3.72
Response to Questionnaire															
Households who garden	12,578,000	682	18.46	1.15	0.06	0.00	0.04	0.12	0.26	0.67	1.50	2.81	3.64	7.47	12.80
Households who farm	2,367,000	136	32.30	1.39	0.13	0.11	0.16	0.18	0.37	0.88	1.85	3.11	4.58	7.47	7.69

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-63. Consumer-Only Intake of Home-Produced Dark Green Vegetables (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	8,855,000	428	4.71	0.39	0.03	0.00	0.00	0.01	0.09	0.21	0.44	0.92	1.25	3.53	5.82
Age															
1 to 2	180,000	8	3.16	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	226,000	12	2.79	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	826,000	39	4.94	0.31	0.05	0.00	0.01	0.02	0.09	0.18	0.39	0.95	1.04	1.28	1.28
12 to 19	628,000	32	3.07	0.42	0.15	0.00	0.01	0.01	0.06	0.20	0.37	0.92	1.64	4.86	4.86
20 to 39	1,976,000	87	3.21	0.34	0.06	0.00	0.00	0.01	0.09	0.18	0.38	0.67	0.92	2.94	4.29
40 to 69	3,710,000	184	6.54	0.40	0.04	0.00	0.00	0.03	0.08	0.23	0.48	0.98	1.25	3.29	5.82
≥ 70	1,253,000	63	7.89	0.41	0.07	0.00	0.00	0.01	0.11	0.23	0.47	0.93	1.08	3.45	3.45
Season															
Fall	2,683,000	88	5.63	0.44	0.07	0.01	0.04	0.09	0.15	0.24	0.46	0.79	1.08	3.86	4.29
Spring	1,251,000	127	2.71	0.56	0.08	0.00	0.00	0.01	0.10	0.31	0.54	1.28	2.81	4.86	5.82
Summer	3,580,000	124	7.87	0.34	0.04	0.00	0.00	0.01	0.06	0.15	0.41	0.98	1.15	2.48	2.48
Winter	1,341,000	89	2.75	0.27	0.04	0.00	0.00	0.01	0.02	0.15	0.37	0.66	1.17	2.04	2.18
Urbanization															
Central City	1,298,000	48	2.30	0.27	0.04	0.00	0.00	0.01	0.11	0.21	0.32	0.63	0.92	1.07	1.07
Non-metropolitan	3,218,000	167	7.15	0.33	0.04	0.00	0.00	0.02	0.07	0.17	0.45	0.75	1.00	2.48	5.82
Suburban	4,279,000	211	4.94	0.48	0.05	0.00	0.01	0.02	0.09	0.23	0.46	1.15	2.18	3.86	4.86
Race															
Black	724,000	49	3.33	1.04	0.18	0.00	0.10	0.11	0.22	0.55	1.17	3.29	3.86	4.86	4.86
White	7,963,000	373	5.05	0.32	0.02	0.00	0.00	0.01	0.08	0.20	0.38	0.78	1.07	2.37	5.82
Region															
Midwest	2,668,000	121	5.75	0.28	0.04	0.00	0.00	0.01	0.06	0.21	0.36	0.50	0.98	2.48	3.02
Northeast	1,554,000	76	3.77	0.51	0.09	0.00	0.00	0.00	0.06	0.20	0.49	1.25	1.93	3.53	5.82
South	2,945,000	148	4.58	0.48	0.05	0.04	0.07	0.09	0.15	0.29	0.64	0.92	1.28	3.86	4.29
West	1,628,000	81	4.51	0.32	0.07	0.00	0.00	0.01	0.04	0.11	0.31	0.66	0.93	4.86	4.86
Response to Questionnaire															
Households who garden	8,521,000	412	12.50	0.40	0.03	0.00	0.00	0.01	0.09	0.21	0.45	0.92	1.25	3.53	5.82
Households who farm	1,450,000	66	19.78	0.38	0.06	0.00	0.00	0.01	0.07	0.23	0.48	0.95	1.25	2.48	3.02

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-64. Consumer-Only Intake of Home-Produced Deep Yellow Vegetables (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	5,467,000	245	2.91	0.64	0.04	0.04	0.07	0.13	0.22	0.42	0.77	1.44	2.03	2.67	6.63
Age															
1 to 2	124,000	8	2.18	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	61,000	4	0.75	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	382,000	17	2.29	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	493,000	21	2.41	0.47	0.09	0.06	0.06	0.06	0.09	0.36	0.78	1.13	1.44	1.58	1.58
20 to 39	1,475,000	63	2.39	0.53	0.08	0.05	0.06	0.12	0.17	0.31	0.51	1.22	2.03	2.67	2.67
40 to 69	2,074,000	96	3.66	0.54	0.05	0.04	0.09	0.14	0.22	0.40	0.65	1.09	1.33	3.02	3.02
≥ 70	761,000	32	4.79	0.78	0.09	0.08	0.20	0.28	0.37	0.57	1.24	1.61	1.99	1.99	1.99
Season															
Fall	2,664,000	97	5.59	0.74	0.08	0.09	0.12	0.14	0.26	0.45	0.97	1.73	2.23	3.02	6.63
Spring	315,000	34	0.68	0.56	0.08	0.14	0.15	0.20	0.25	0.45	0.64	1.01	1.42	2.41	2.41
Summer	1,619,000	52	3.56	0.51	0.06	0.04	0.05	0.06	0.23	0.41	0.64	0.96	1.67	2.31	2.31
Winter	869,000	62	1.78	0.63	0.09	0.04	0.04	0.06	0.17	0.35	0.80	1.54	2.23	4.37	4.37
Urbanization															
Central City	1,308,000	43	2.32	0.51	0.07	0.04	0.06	0.14	0.21	0.39	0.59	0.96	1.41	2.24	2.24
Non-metropolitan	2,100,000	118	4.66	0.67	0.08	0.04	0.06	0.09	0.22	0.37	0.87	1.39	2.12	4.37	6.63
Suburban	2,059,000	84	2.38	0.71	0.07	0.06	0.09	0.13	0.26	0.43	0.97	1.67	2.03	2.67	2.67
Race															
Black	129,000	8	0.59	*	*	*	*	*	*	*	*	*	*	*	*
White	5,093,000	229	3.23	0.65	0.04	0.05	0.09	0.14	0.24	0.43	0.80	1.50	2.03	2.67	4.37
Region															
Midwest	2,792,000	128	6.02	0.75	0.06	0.04	0.13	0.19	0.28	0.51	0.96	1.73	2.23	3.02	4.37
Northeast	735,000	29	1.79	0.40	0.08	0.04	0.06	0.06	0.09	0.15	0.64	1.09	1.37	2.21	2.21
South	557,000	30	0.87	0.54	0.21	0.05	0.05	0.08	0.22	0.31	0.44	0.77	1.22	6.63	6.63
West	1,383,000	58	3.83	0.60	0.07	0.06	0.13	0.14	0.22	0.41	0.64	1.44	1.89	2.31	2.31
Response to Questionnaire															
Households who garden	5,177,000	233	7.60	0.62	0.04	0.04	0.09	0.13	0.23	0.42	0.75	1.42	1.99	2.67	4.37
Households who farm	1,088,000	51	14.85	0.61	0.09	0.09	0.09	0.12	0.19	0.34	0.94	1.28	1.73	3.02	3.02

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-65. Consumer-Only Intake of Home-Produced Other Vegetables (g/kg-day)

Population Group	Nc Wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	25,221,000	1,437	13.41	1.38	0.05	0.01	0.11	0.18	0.36	0.78	1.65	3.09	4.52	9.95	18.40
Age															
1 to 2	613,000	38	10.76	3.80	0.63	0.19	0.27	0.40	1.04	2.61	4.55	7.74	11.20	18.00	18.00
3 to 5	887,000	59	10.95	2.15	0.27	0.00	0.23	0.37	0.72	1.37	3.16	4.47	5.96	8.41	14.00
6 to 11	2,149,000	134	12.86	1.30	0.14	0.00	0.12	0.19	0.35	0.80	1.61	3.04	4.57	9.95	9.95
12 to 19	2,379,000	141	11.61	0.98	0.09	0.00	0.06	0.12	0.32	0.64	1.33	2.05	3.17	5.41	5.41
20 to 39	6,020,000	328	9.77	0.93	0.06	0.03	0.09	0.15	0.24	0.56	1.12	2.19	3.04	5.10	7.00
40 to 69	9,649,000	547	17.01	1.40	0.09	0.01	0.11	0.19	0.40	0.84	1.58	2.92	4.65	14.10	18.40
≥ 70	3,226,000	174	20.31	1.58	0.14	0.02	0.15	0.24	0.46	0.95	1.91	3.46	5.79	9.96	11.40
Season															
Fall	6,934,000	253	14.55	1.19	0.09	0.05	0.15	0.19	0.33	0.72	1.44	2.74	4.00	6.74	9.96
Spring	5,407,000	567	11.71	1.16	0.06	0.00	0.04	0.10	0.31	0.71	1.39	2.67	4.21	7.35	14.00
Summer	8,454,000	283	18.59	1.79	0.15	0.00	0.12	0.18	0.39	0.97	1.97	4.13	6.14	14.60	18.40
Winter	4,426,000	334	9.09	1.19	0.07	0.00	0.14	0.23	0.41	0.73	1.49	2.41	3.37	7.00	11.00
Urbanization															
Central City	4,148,000	161	7.36	0.97	0.09	0.04	0.09	0.16	0.32	0.61	1.23	1.97	3.22	7.00	8.85
Non-metropolitan	10,721,000	710	23.81	1.78	0.09	0.03	0.16	0.23	0.47	1.01	2.01	4.05	5.74	14.10	18.40
Suburban	10,292,000	564	11.89	1.14	0.06	0.00	0.09	0.15	0.31	0.65	1.44	2.69	3.77	6.81	11.40
Race															
Black	1,347,000	84	6.19	1.30	0.17	0.04	0.17	0.21	0.35	0.71	1.49	3.88	5.47	6.21	7.72
White	23,367,000	1,327	14.83	1.39	0.05	0.01	0.11	0.18	0.38	0.79	1.65	3.04	4.49	9.96	18.40
Region															
Midwest	8,296,000	522	17.88	1.43	0.09	0.03	0.12	0.19	0.37	0.73	1.65	3.05	4.65	11.20	18.40
Northeast	2,914,000	162	7.08	1.33	0.17	0.00	0.06	0.11	0.24	0.60	1.64	3.07	5.41	12.00	14.10
South	9,218,000	518	14.33	1.53	0.08	0.01	0.17	0.25	0.49	1.03	1.76	3.37	4.70	8.33	18.00
West	4,733,000	233	13.12	1.08	0.10	0.01	0.07	0.12	0.26	0.57	1.21	2.41	3.73	8.02	11.40
Response to Questionnaire															
Households who garden	22,417,000	1,291	32.89	1.44	0.05	0.01	0.11	0.18	0.38	0.82	1.70	3.22	4.65	9.95	18.40
Households who farm	3,965,000	239	54.10	1.95	0.16	0.01	0.14	0.23	0.52	1.21	2.04	5.32	7.02	14.60	15.90

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-66. Consumer-Only Intake of Home-Produced Citrus (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	2,530,000	125	1.35	4.76	0.61	0.08	0.16	0.29	0.76	1.99	5.10	14.10	19.70	32.20	47.90
Age															
1 to 2	54,000	4	0.95	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	51,000	3	0.63	*	*	*	*	*	*	*	*	*	*	*	*
6 to 11	181,000	9	1.08	*	*	*	*	*	*	*	*	*	*	*	*
12 to 19	194,000	14	0.95	*	*	*	*	*	*	*	*	*	*	*	*
20 to 39	402,000	18	0.65	*	*	*	*	*	*	*	*	*	*	*	*
40 to 69	1,183,000	55	2.09	4.54	0.81	0.08	0.15	0.25	0.52	1.74	5.24	15.20	19.70	23.80	23.80
≥ 70	457,000	21	2.88	4.43	0.76	0.08	0.08	0.49	1.95	3.53	6.94	8.97	8.97	15.70	15.70
Season															
Fall	280,000	8	0.59	*	*	*	*	*	*	*	*	*	*	*	*
Spring	437,000	33	0.95	2.31	0.38	0.16	0.18	0.24	0.37	1.36	4.15	5.10	6.50	7.52	7.52
Summer	334,000	11	0.73	*	*	*	*	*	*	*	*	*	*	*	*
Winter	1,479,000	73	3.04	6.47	0.95	0.15	0.33	0.49	1.64	2.93	8.59	19.10	23.80	47.90	47.90
Urbanization															
Central City	1,053,000	43	1.87	3.57	0.52	0.15	0.33	0.45	1.13	3.01	4.97	7.46	8.97	20.00	20.00
Non-metropolitan	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
Suburban	1,477,000	82	1.71	5.61	0.91	0.08	0.11	0.25	0.52	1.81	8.12	17.90	23.80	47.90	47.90
Race															
Black	200,000	8	0.92	*	*	*	*	*	*	*	*	*	*	*	*
White	2,330,000	117	1.48	4.93	0.63	0.08	0.15	0.28	0.78	2.34	5.34	14.10	19.70	32.20	47.90
Region															
Midwest	64,000	4	0.14	*	*	*	*	*	*	*	*	*	*	*	*
Northeast	0	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-
South	1,240,000	55	1.93	5.18	0.74	0.16	0.38	0.64	1.60	3.42	6.50	14.10	19.70	23.80	23.80
West	1,226,000	66	3.40	4.56	0.98	0.08	0.11	0.24	0.37	1.42	4.53	12.40	20.00	47.90	47.90
Response to Questionnaire															
Households who garden	2,151,000	102	3.16	4.55	0.66	0.08	0.15	0.28	0.76	1.99	4.99	12.40	17.90	32.20	47.90
Households who farm	130,000	5	1.77	*	*	*	*	*	*	*	*	*	*	*	*

* Intake data not provided for subpopulations for which there were less than 20 observations.
\- Indicates data are not available.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-67. Consumer-Only Intake of Home-Produced Other Fruit (g/kg-day)

Population Group	Nc wgtd	Nc unwgtd	% Consuming	Mean	SE	*p*1	*p*5	*p*10	*p*25	*p*50	*p*75	*p*90	*p*95	*p*99	MAX
Total	12,615,000	706	6.71	2.20	0.19	0.05	0.15	0.26	0.46	0.91	1.91	4.59	8.12	18.40	62.60
Age															
1 to 2	306,000	19	5.37	*	*	*	*	*	*	*	*	*	*	*	*
3 to 5	499,000	31	6.16	2.66	0.76	0.00	0.00	0.38	1.02	1.87	2.71	5.54	6.30	33.20	33.20
6 to 11	915,000	68	5.48	2.60	0.44	0.00	0.18	0.39	0.64	1.14	2.99	7.13	12.10	16.20	16.50
12 to 19	1,021,000	54	4.98	1.62	0.28	0.08	0.12	0.26	0.39	0.61	2.36	3.92	6.81	8.12	8.12
20 to 39	2,761,000	146	4.48	1.85	0.37	0.08	0.13	0.18	0.31	0.62	1.39	3.70	6.64	37.00	37.00
40 to 69	4,610,000	259	8.13	2.09	0.31	0.07	0.15	0.25	0.44	0.77	1.77	3.17	9.77	18.40	53.30
≥ 70	2,326,000	119	14.65	1.66	0.18	0.04	0.21	0.36	0.57	1.07	1.65	4.06	5.21	11.70	11.70
Season															
Fall	2,923,000	102	6.13	1.39	0.11	0.26	0.30	0.38	0.57	1.07	1.88	2.89	4.06	5.39	5.54
Spring	2,526,000	268	5.47	1.47	0.15	0.09	0.20	0.25	0.43	0.83	1.65	2.89	4.59	8.26	33.20
Summer	4,327,000	144	9.51												
Winter	2,839,000	192	5.83	1.29	0.11	0.04	0.10	0.23	0.45	0.83	1.55	2.70	4.79	8.06	11.30
Urbanization															
Central City	2,681,000	102	4.76	1.79	0.29	0.04	0.17	0.29	0.52	0.89	1.60	2.61	10.40	15.40	15.40
Non-metropolitan	4,118,000	278	9.15	2.43	0.31	0.07	0.12	0.24	0.45	1.13	2.43	4.60	8.12	24.00	53.30
Suburban	5,756,000	324	6.65	2.25	0.31	0.13	0.20	0.28	0.45	0.76	1.81	4.72	7.61	18.40	62.60
Race															
Black	250,000	12	1.15	*	*	*	*	*	*	*	*	*	*	*	*
White	12,256,000	690	7.78	2.24	0.19	0.07	0.15	0.26	0.47	0.92	1.94	4.65	8.26	18.40	62.60
Region															
Midwest	4,619,000	298	9.96	3.07	0.43	0.04	0.13	0.24	0.45	1.04	2.35	6.73	14.20	53.30	62.60
Northeast	1,279,000	72	3.11	0.93	0.22	0.08	0.09	0.16	0.31	0.48	0.81	1.29	2.16	11.70	11.70
South	3,004,000	157	4.67	1.99	0.26	0.08	0.24	0.30	0.55	1.10	1.82	4.06	6.30	16.20	24.00
West	3,653,000	177	10.13	1.76	0.16	0.10	0.22	0.29	0.54	0.97	2.04	4.35	5.75	13.00	13.00
Response to Questionnaire															
Households who garden	10,926,000	619	16.03	2.38	0.21	0.04	0.16	0.26	0.47	0.99	1.96	4.94	10.40	18.40	62.60
Households who farm	1,917,000	112	26.16	2.57	0.27	0.07	0.28	0.36	0.73	1.55	3.62	5.80	8.06	16.20	16.20

* Intake data not provided for subpopulations for which there were less than 20 observations.

SE = Standard error.
p = Percentile of the distribution.
Nc wgtd = Weighted number of consumers.
Nc unwgtd = Unweighted number of consumers in survey.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-68. Fraction of Food Intake That Is Home-Produced

	Total Fruits	Total Vegetables	Total Meats	Total Dairy	Total Fish	Exposed Vegetables	Protected Vegetables	Root Vegetables	Exposed Fruits	Protected Fruits
Total	0.040	0.068	0.024	0.012	0.094	0.095	0.069	0.043	0.050	0.037
Season										
Fall	0.021	0.081	0.020	0.008	0.076	0.106	0.073	0.060	0.039	0.008
Spring	0.021	0.037	0.020	0.011	0.160	0.050	0.039	0.020	0.047	0.008
Summer	0.058	0.116	0.034	0.022	0.079	0.164	0.101	0.066	0.068	0.054
Winter	0.059	0.041	0.022	0.008	0.063	0.052	0.048	0.026	0.044	0.068
Urbanization										
Central City	0.027	0.027	0.003	0.000	0.053	0.037	0.027	0.016	0.030	0.026
Non-metropolitan	0.052	0.144	0.064	0.043	0.219	0.207	0.134	0.088	0.100	0.025
Suburban	0.047	0.058	0.018	0.004	0.075	0.079	0.054	0.035	0.043	0.050
Race										
Black	0.007	0.027	0.001	0.000	0.063	0.037	0.029	0.012	0.008	0.007
White	0.049	0.081	0.031	0.014	0.110	0.109	0.081	0.050	0.059	0.045
Region										
Northeast	0.005	0.038	0.009	0.010	0.008	0.062	0.016	0.018	0.010	0.002
Midwest	0.059	0.112	0.046	0.024	0.133	0.148	0.109	0.077	0.078	0.048
South	0.042	0.069	0.017	0.006	0.126	0.091	0.077	0.042	0.040	0.044
West	0.062	0.057	0.023	0.007	0.108	0.079	0.060	0.029	0.075	0.054
Response to Questionnaire										
Households who garden	0.101	0.173	-	-	-	0.233	0.178	0.106	0.116	0.094
Households who raise animals	-	-	0.306	0.207	-	-	-	-	-	-
Households who farm	0.161	0.308	0.319	0.254	-	0.420	0.394	0.173	0.328	0.030
Households who fish	-	-	-	-	0.325	-	-	-	-	-

Table 13-68. Fraction of Food Intake That Is Home-Produced (continued)										
	Dark Green Vegetables	Deep Yellow Vegetables	Other Vegetables	Citrus Fruits	Other Fruits	Apples	Peaches	Pears	Strawberries	Other Berries
Total	0.044	0.065	0.069	0.038	0.042	0.030	0.147	0.067	0.111	0.217
Season										
Fall	0.059	0.099	0.069	0.114	0.027	0.032	0.090	0.038	0.408	0.163
Spring	0.037	0.017	0.051	0.014	0.025	0.013	0.206	0.075	0.064	0.155
Summer	0.063	0.080	0.114	0.010	0.070	0.053	0.133	0.066	0.088	0.232
Winter	0.018	0.041	0.044	0.091	0.030	0.024	0.183	0.111	0.217	0.308
Urbanization										
Central City	0.012	0.038	0.026	0.035	0.022	0.017	0.087	0.038	0.107	0.228
Non-metropolitan	0.090	0.122	0.154	0.000	0.077	0.066	0.272	0.155	0.133	0.282
Suburban	0.054	0.058	0.053	0.056	0.042	0.024	0.121	0.068	0.101	0.175
Race										
Black	0.053	0.056	0.026	0.012	0.004	0.007	0.018	0.004	0.000	0.470
White	0.043	0.071	0.082	0.045	0.051	0.035	0.164	0.089	0.125	0.214
Region										
Northeast	0.039	0.019	0.034	0.000	0.008	0.004	0.027	0.002	0.085	0.205
Midwest	0.054	0.174	0.102	0.001	0.083	0.052	0.164	0.112	0.209	0.231
South	0.049	0.022	0.077	0.060	0.031	0.024	0.143	0.080	0.072	0.177
West	0.034	0.063	0.055	0.103	0.046	0.043	0.238	0.093	0.044	0.233
Response to Questionnaire										
Households who garden	0.120	0.140	0.180	0.087	0.107	0.070	0.316	0.169	0.232	0.306
Households who farm	0.220	0.328	0.368	0.005	0.227	0.292	0.461	0.606	0.057	0.548

Table 13-68. Fraction of Food Intake That Is Home-Produced (continued)

	Asparagus	Beets	Broccoli	Cabbage	Carrots	Corn	Cucumbers	Lettuce	Lima Beans	Okra	Onions
Total	0.063	0.203	0.015	0.038	0.043	0.078	0.148	0.010	0.121	0.270	0.056
Season											
Fall	0.024	0.199	0.013	0.054	0.066	0.076	0.055	0.013	0.070	0.299	0.066
Spring	0.103	0.191	0.011	0.011	0.015	0.048	0.040	0.010	0.082	0.211	0.033
Summer	0	0.209	0.034	0.080	0.063	0.118	0.320	0.017	0.176	0.304	0.091
Winter	0.019	0.215	0.006	0.008	0.025	0.043	0	0.002	0.129	0.123	0.029
Urbanization											
Central City	0.058	0.212	0.004	0.004	0.018	0.025	0.029	0.009	0.037	0.068	0.017
Non-metropolitan	0.145	0.377	0.040	0.082	0.091	0.173	0.377	0.017	0.132	0.411	0.127
Suburban	0.040	0.127	0.016	0.045	0.039	0.047	0.088	0.009	0.165	0.299	0.050
Race											
Black	0.000	0.000	0.000	0.001	0.068	0.019	0.060	0.007	0.103	0.069	0.009
White	0.071	0.224	0.018	0.056	0.042	0.093	0.155	0.011	0.135	0.373	0.068
Region											
Northeast	0.091	0.074	0.020	0.047	0.025	0.020	0.147	0.009	0.026	0.000	0.022
Midwest	0.194	0.432	0.025	0.053	0.101	0.124	0.193	0.020	0.149	0.224	0.098
South	0.015	0.145	0.013	0.029	0.020	0.088	0.140	0.006	0.140	0.291	0.047
West	0.015	0.202	0.006	0.029	0.039	0.069	0.119	0.009	0.000	0.333	0.083
Response to Questionnaire											
Households who garden	0.125	0.420	0.043	0.099	0.103	0.220	0.349	0.031	0.258	0.618	0.148
Households who farm	0.432	0.316	0.159	0.219	0.185	0.524	0.524	0.063	0.103	0.821	0.361

Table 13-68. Fraction of Food Intake That Is Home-Produced (continued)

	Peas	Peppers	Pumpkin	Snap Beans	Tomatoes	White Potatoes	Beef	Game	Pork	Poultry	Eggs
Total	0.069	0.107	0.155	0.155	0.184	0.038	0.038	0.276	0.013	0.011	0.014
Season											
Fall	0.046	0.138	0.161	0.199	0.215	0.058	0.028	0.336	0.012	0.011	0.009
Spring	0.048	0.031	0.046	0.152	0.045	0.010	0.027	0.265	0.015	0.012	0.022
Summer	0.126	0.194	0.19	0.123	0.318	0.060	0.072	0.100	0.010	0.007	0.013
Winter	0.065	0.03	0.154	0.147	0.103	0.022	0.022	0.330	0.014	0.014	0.011
Urbanization											
Central City	0.033	0.067	0.130	0.066	0.100	0.009	0.001	0.146	0.001	0.002	0.002
Non-metropolitan	0.123	0.228	0.250	0.307	0.313	0.080	0.107	0.323	0.040	0.026	0.029
Suburban	0.064	0.086	0.127	0.118	0.156	0.029	0.026	0.316	0.006	0.011	0.014
Race											
Black	0.047	0.039	0.022	0.046	0.060	0.007	0.000	0.000	0.000	0.001	0.002
White	0.076	0.121	0.187	0.186	0.202	0.044	0.048	0.359	0.017	0.014	0.017
Region											
Northeast	0.021	0.067	0.002	0.052	0.117	0.016	0.014	0.202	0.006	0.002	0.004
Midwest	0.058	0.188	0.357	0.243	0.291	0.065	0.076	0.513	0.021	0.021	0.019
South	0.106	0.113	0.044	0.161	0.149	0.042	0.022	0.199	0.012	0.012	0.012
West	0.051	0.082	0.181	0.108	0.182	0.013	0.041	0.207	0.011	0.008	0.021
Response to Questionnaire											
Households who garden	0.193	0.246	0.230	0.384	0.398	0.090	-	-	-	-	-
Households who farm	0.308	0.564	0.824	0.623	0.616	0.134	0.485	-	0.242	0.156	0.146
Households who raise animals	-	-	-	-	-	-	0.478	-	0.239	0.151	0.214
Households who hunt	-	-	-	-	-	-	-	0.729	-	-	-

\- Indicates data are not available.

Source: Based on EPA's analyses of the 1987–1988 NFCS.

Table 13-69. Percent Weight Losses from Food Preparation

Food Group	Mean Net Preparation/Cooking Loss (%)	Mean Net Post Cooking (%)
Meats[a]	29.7[b]	29.7[c]
Fish and shellfish[d]	31.5[b]	10.5[c]
Fruits	25.4[e]	30.5[f]
Vegetables[g]	12.4[h]	22[i]

[a] Averaged over various cuts and preparation methods for various meats including beef, pork, chicken, turkey, lamb, and veal.
[b] Includes dripping and volatile losses during cooking.
[c] Includes losses from cutting, shrinkage, excess fat, bones, scraps, and juices.
[d] Averaged over a variety of fish and shellfish to include bass, bluefish, butterfish, cod, flounder, haddock, halibut, lake trout, mackerel, perch, porgy, red snapper, rockfish, salmon, sea trout, shad, smelt, sole, spot, squid, swordfish steak, trout, whitefish, clams, crab, crayfish, lobster, oysters, and shrimp and shrimp dishes.
[e] Based on preparation losses. Averaged over apples, pears, peaches, strawberries, and oranges. Includes losses from removal of skin or peel, core or pit, stems or caps, seeds, and defects. Also includes losses from removal of drained liquids from canned or frozen forms.
[f] Averaged over apples and peaches. Include losses from draining cooked forms.
[g] Averaged over various vegetables to include asparagus, beets, broccoli, cabbage, carrots, corn, cucumbers, lettuce, lima beans, okra, onions, green peas, peppers, pumpkins, snap beans, tomatoes, and potatoes.
[h] Includes losses due to paring, trimming, flowering the stalk, thawing, draining, scraping, shelling, slicing, husking, chopping, and dicing and gains from the addition of water, fat, or other ingredients. Averaged over various preparation methods.
[i] Includes losses from draining or removal of skin. Based on potatoes only.

Source: U.S. EPA, 1997. (Derived from USDA, 1975.)

Table 13-70. Estimated Age-Specific Per Capita Home-Produced Intake (adjusted; g/kg-day)[a]

	Home-Produced Fruits				Home-Produced Vegetables				Home-Produced Meats				Home-Produced Dairy			
	Gardening Population		Farming Population		Gardening Population		Farming Population		Population that Raises Animals		Farming Population		Population that Raises Animals		Farming Population	
	Mean	95th	Mean	95th	Mean	95th	Mean	95th	Mean	95th	Mean	95th	Mean	95th	Mean	95th
Unadjusted (g/kg-day)[b]																
Total population	0.52	2.4	0.67	4.5	0.96	5.1	1.9	9.8	1.5	6.1	1.5	6.3	1.9	14	2.4	17
Adjusted (g/kg-day)[c]																
Total population	0.27	1.2	0.35	2.4	0.66	3.5	1.3	6.7	0.71	3.0	0.73	3.1	1.9	14	2.4	17
Birth to 1 year[d]	1.0	4.4	1.2	8.4	0.87	4.7	1.8	8.9	0.41	1.7	0.42	1.8	3.6	26	4.5	32
1 to <2 years	1.0	4.8	1.4	9.1	1.3	7.1	2.7	14	1.4	5.8	1.4	6.0	11	76	13	92
2 to <3 years	1.0	4.8	1.4	9.1	1.3	7.1	2.7	14	1.4	5.8	1.4	6.0	11	76	13	92
3 to <6 years	0.78	3.6	1.0	6.8	1.1	6.1	2.3	12	1.4	5.8	1.4	6.0	6.7	48	8.3	58
6 to <11 years	0.40	1.9	0.52	3.5	0.80	4.2	1.6	8.1	1.0	4.1	1.0	4.2	3.9	28	4.8	34
11 to <16 years	0.13	0.62	0.17	1.2	0.56	3.0	1.1	5.7	0.71	3.0	0.73	3.1	1.6	12	2.0	14
16 to <21 years	0.13	0.62	0.17	1.2	0.56	3.0	1.1	5.7	0.71	3.0	0.73	3.1	1.6	12	2.0	14
21 to <50 years	0.15	0.70	0.20	1.3	0.56	3.0	1.1	5.7	0.65	2.7	0.66	2.8	0.95	6.9	1.2	8.3
50+ years	0.24	1.1	0.31	2.1	0.60	3.2	1.2	6.1	0.51	2.1	0.52	2.2	0.92	6.7	1.1	8.0

[a] Calculated as: per capita home-produced intake for total population of households that garden, farm, or raise animals (See Section 13.3.1), times age-specific ratio of mean per capita total intake to mean per capita total intake for total population, based on analysis of 1994–96 and 1998 CSFII data (See Chapters 9 and 11).

[b] Not adjusted for food preparation or post-cooking losses.

[c] Adjusted to account for food preparation and post-cooking losses; no adjustments made to dairy.

[d] Estimates are uncertain for this age group because of the wide range of intake patterns for children under 1 year of age.

Source: Phillips and Moya, 2011.

Table 13-71. 2008 Food Gardening by Demographic Factors

Demographic Factor	Percentage of total households that have gardens (%)
Total (~36 million)	31
Sex	
Female	54
Male	46
Age	
18–34	21
35–44	11
45–54	24
55 and over	44
Education	
College graduate	43
Some college	36
High school	21
Household income	
$75,000 and over	22
$50–$74,999	16
$35–$49,999	24
Under $35,000	21
Undesignated	17
Household size	
One person	20
Two person	40
Three to four person	32
Five or more persons	9

Source: National Gardening Association, 2009.

Table 13-72. Percentage of Gardening Households Growing Different Vegetables in 2008

Vegetable	Percent (%)
Tomatoes	86
Cucumbers	47
Sweet peppers	46
Beans	39
Carrots	34
Summer squash	32
Onions	32
Hot peppers	31
Lettuce	28
Peas	24
Sweet Corn	23
Radish	20
Potatoes	18
Salad greens	17
Pumpkins	17
Watermelon	16
Spinach	15
Broccoli	15
Melon	15
Cabbage	14
Beets	11
Winter squash	10
Asparagus	9
Collards	9
Cauliflower	7
Celery	5
Brussels sprouts	5
Leeks	3
Kale	3
Parsnips	2
Chinese cabbage	2
Rutabaga	1

Source: National Gardening Association, 2009.

APPENDIX 13A

FOOD CODES AND DEFINITIONS OF MAJOR FOOD GROUPS USED IN THE ANALYSIS OF THE 1987–1988 USDA NFCS DATA TO ESTIMATE HOME-PRODUCED INTAKE RATES

Table 13A-1. Food Codes and Definitions of Major Food Groups Used in Analysis of the 1987–1988 USDA NFCS Data to Estimate Intake of Home-Produced Foods

Food Product	Household Code/Definition[a]	Individual Code
MAJOR FOOD GROUPS		
Total Fruits	50- Fresh Fruits citrus other vitamin-C rich other fruits 512- Commercially Canned Fruits 522- Commercially Frozen Fruits 533- Canned Fruit Juice 534- Frozen Fruit Juice 535- Aseptically Packed Fruit Juice 536- Fresh Fruit Juice 542- Dried Fruits (includes baby foods)	6- Fruits citrus fruits and juices dried fruits other fruits fruits/juices & nectar fruit/juices baby food (includes baby foods)
Total Vegetables	48- Potatoes, Sweet Potatoes 49- Fresh Vegetables dark green deep yellow tomatoes light green other 511- Commercially Canned Vegetables 521- Commercially Frozen Vegetables 531- Canned Vegetable Juice 532- Frozen Vegetable Juice 537- Fresh Vegetable Juice 538- Aseptically Packed Vegetable Juice 541- Dried Vegetables (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners)	7- Vegetables (all forms) white potatoes & Puerto Rican starchy dark green vegetables deep yellow vegetables tomatoes and tom. mixtures other vegetables veg. and mixtures/baby food veg. with meat mixtures (includes baby foods; mixtures, mostly vegetables)
Total Meats	44- Meat beef pork veal lamb mutton goat game lunch meat mixtures 451- Poultry (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	20- Meat, type not specified 21- Beef 22- Pork 23- Lamb, veal, game, carcass meat 24- Poultry 25- Organ meats, sausages, lunchmeats, meat spreads (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks; includes baby foods)
Total Dairy	40- Milk Equivalent fresh fluid milk processed milk cream and cream substitutes frozen desserts with milk cheese dairy-based dips (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	1- Milk and Milk Products milk and milk drinks cream and cream substitutes milk desserts, sauces, and gravies cheeses (includes regular fluid milk, human milk, imitation milk products, yogurt, milk-based meal replacements, and infant formulas)
Total Fish	452- Fish, Shellfish various species fresh, frozen, commercial, dried (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	26- Fish, Shellfish various species and forms (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks)

[a] Food items within these categories that were identified by the household as being home-produced or home-caught (i.e., source code pertaining to home-produced foods) were included in the analysis.

APPENDIX 13B

1987−1988 NFCS FOOD CODES AND DEFINITIONS OF INDIVIDUAL FOOD ITEMS USED IN ESTIMATING THE FRACTION OF HOUSEHOLD FOOD INTAKE THAT IS HOME-PRODUCED

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced

Food Product	Household Code/Definition	Individual Code
INDIVIDUAL FOODS		
White Potatoes	4811- White Potatoes, fresh 4821- White Potatoes, commercially canned 4831- White Potatoes, commercially frozen 4841- White Potatoes, dehydrated 4851- White Potatoes, chips, sticks, salad (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	71- White Potatoes and Puerto Rican Starchy Veg. baked, boiled, chips, sticks, creamed, scalloped, au gratin, fried, mashed, stuffed, puffs, salad, recipes, soups, Puerto Rican starchy vegetables (does not include vegetables soups; vegetable mixtures; or vegetable with meat mixtures)
Peppers	4913- Green/Red Peppers, fresh 5111201 Sweet Green Peppers, commercially canned 5111202 Hot Chili Peppers, commercially canned 5211301 Sweet Green Peppers, commercially frozen 5211302 Green Chili Peppers, commercially frozen 5211303 Red Chili Peppers, commercially frozen 5413112 Sweet Green Peppers, dry 5413113 Red Chili Peppers, dry (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	7512100 Pepper, hot chili, raw 7512200 Pepper, raw 7512210 Pepper, sweet green, raw 7512220 Pepper, sweet red, raw 7522600 Pepper, green, cooked, NS as to fat added 7522601 Pepper, green, cooked, fat not added 7522602 Pepper, green, cooked, fat added 7522604 Pepper, red, cooked, NS as to fat added 7522605 Pepper, red, cooked, fat not added 7522606 Pepper, red, cooked, fat added 7522609 Pepper, hot, cooked, NS as to fat added 7522610 Pepper, hot, cooked, fat not added 7522611 Pepper, hot, cooked, fat added 7551101 Peppers, hot, sauce 7551102 Peppers, pickled (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Onions	4953- Onions, Garlic, fresh onions chives garlic leeks 5114908 Garlic Pulp, raw 5114915 Onions, commercially canned 5213722 Onions, commercially frozen 5213723 Onions with Sauce, commercially frozen 5413103 Chives, dried 5413105 Garlic Flakes, dried 5413110 Onion Flakes, dried (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners)	7510950 Chives, raw 7511150 Garlic, raw 7511250 Leek, raw 7511701 Onions, young green, raw 7511702 Onions, mature 7521550 Chives, dried 7521740 Garlic, cooked 7522100 Onions, mature cooked, NS as to fat added 7522101 Onions, mature cooked, fat not added 7522102 Onions, mature cooked, fat added 7522103 Onions, pearl cooked 7522104 Onions, young green cooked, NS as to fat 7522105 Onions, young green cooked, fat not added 7522106 Onions, young green cooked, fat added 7522110 Onion, dehydrated 7541501 Onions, creamed 7541502 Onion rings (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Corn	4956- Corn, fresh 5114601 Yellow Corn, commercially canned 5114602 White Corn, commercially canned 5114603 Yellow Creamed Corn, commercially canned 5114604 White Creamed Corn, commercially canned 5114605 Corn on Cob, commercially canned 5114607 Hominy, canned 5115306 Low Sodium Corn, commercially canned 5115307 Low Sodium Cr. Corn, commercially canned 5213501 Yellow Corn on Cob, commercially frozen 5213502 Yellow Corn off Cob, commercially frozen 5213503 Yell. Corn with Sauce, commercially frozen 5213504 Corn with other Veg., commercially frozen 5213505 White Corn on Cob, commercially frozen 5213506 White Corn off Cob, commercially frozen 5213507 Wh. Corn with Sauce, commercially frozen 5413104 Corn, dried 5413106 Hominy, dry 5413603 Corn, instant baby food (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby food)	7510960 Corn, raw 7521600 Corn, cooked, NS as to color/fat added 7521601 Corn, cooked, NS as to color/fat not added 7521602 Corn, cooked, NS as to color/fat added 7521605 Corn, cooked, NS as to color/cream style 7521607 Corn, cooked, dried 7521610 Corn, cooked, yellow/NS as to fat added 7521611 Corn, cooked, yellow/fat not added 7521612 Corn, cooked, yellow/fat added 7521615 Corn, yellow, cream style 7521616 Corn, cooked, yell. & wh./NS as to fat 7521617 Corn, cooked, yell. & wh./fat not added 7521618 Corn, cooked, yell. & wh./fat added 7521619 Corn, yellow, cream style, fat added 7521620 Corn, cooked, white/NS as to fat added 7521621 Corn, cooked, white/fat not added 7521622 Corn, cooked, white/fat added 7521625 Corn, white, cream style 7521630 Corn, yellow, canned, low sodium, NS fat 7521631 Corn, yell., canned, low sod., fat not add 7521632 Corn, yell., canned, low sod., fat added 7521749 Hominy, cooked 752175- Hominy, cooked 7541101 Corn scalloped or pudding 7541102 Corn fritter 7541103 Corn with cream sauce 7550101 Corn relish 76405- Corn, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby food)
Apples	5031- Apples, fresh 5122101 Applesauce with sugar, commercially canned 5122102 Applesauce without sugar, comm. canned 5122103 Apple Pie Filling, commercially canned 5122104 Apples, Applesauce, baby/jr., comm. canned 5122106 Apple Pie Filling, Low Cal., comm. canned 5223101 Apple Slices, commercially frozen 5332101 Apple Juice, canned 5332102 Apple Juice, baby, Comm. canned 5342201 Apple Juice, comm. frozen 5342202 Apple Juice, home frozen 5352101 Apple Juice, aseptically packed 5362101 Apple Juice, fresh 5423101 Apples, dried (includes baby food; except mixtures)	6210110 Apples, dried, uncooked 6210115 Apples, dried, uncooked, low sodium 6210120 Apples, dried, cooked, NS as to sweetener 6210122 Apples, dried, cooked, unsweetened 6210123 Apples, dried, cooked, with sugar 6310100 Apples, raw 6310111 Applesauce, NS as to sweetener 6310112 Applesauce, unsweetened 6310113 Applesauce with sugar 6310114 Applesauce with low calorie sweetener 6310121 Apples, cooked or canned with syrup 6310131 Apple, baked NS as to sweetener 6310132 Apple, baked, unsweetened 6310133 Apple, baked with sugar 6310141 Apple rings, fried 6310142 Apple, pickled 6310150 Apple, fried 6340101 Apple, salad 6340106 Apple, candied 6410101 Apple cider 6410401 Apple juice 6410405 Apple juice with vitamin C 6710200 Applesauce baby fd., NS as to str. or jr. 6710201 Applesauce baby food, strained 6710202 Applesauce baby food, junior 6720200 Apple juice, baby food (includes baby food; except mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Tomatoes	4931- Tomatoes, fresh 5113- Tomatoes, commercially canned 5115201 Tomatoes, low sodium, commercially canned 5115202 Tomato Sauce, low sodium, comm. canned 5115203 Tomato Paste, low sodium, comm. canned 5115204 Tomato Puree, low sodium, comm. canned 5311- Canned Tomato Juice and Tomato Mixtures 5321- Frozen Tomato Juice 5371- Fresh Tomato Juice 5381102 Tomato Juice, aseptically packed 5413115 Tomatoes, dry 5614- Tomato Soup 5624- Condensed Tomato Soup 5654- Dry Tomato Soup (does not include mixtures, and ready-to-eat dinners)	74- Tomatoes and Tomato Mixtures raw, cooked, juices, sauces, mixtures, soups, sandwiches
Snap Beans	4943- Snap or Wax Beans, fresh 5114401 Green or Snap Beans, commercially canned 5114402 Wax or Yellow Beans, commercially canned 5114403 Beans, baby/jr., commercially canned 5115302 Green Beans, low sodium, comm. canned 5115303 Yell. or Wax Beans, low sod., comm. canned 5213301 Snap or Green Beans, comm. frozen 5213302 Snap or Green w/sauce, comm. frozen 5213303 Snap or Green Beans w/other veg., comm. fr. 5213304 Sp. or Gr. Beans w/other veg./sc., comm. fr. 5213305 Wax or Yell. Beans, comm. frozen (does not include soups, mixtures, and ready-to-eat dinners; includes baby foods)	7510180 Beans, string, green, raw 7520498 Beans, string, cooked, NS color/fat added 7520499 Beans, string, cooked, NS color/no fat 7520500 Beans, string, cooked, NS color & fat 7520501 Beans, string, cooked, green/NS fat 7520502 Beans, string, cooked, green/no fat 7520503 Beans, string, cooked, green/fat 7520511 Beans, str., canned, low sod., green/NS fat 7520512 Beans, str., canned, low sod., green/no fat 7520513 Beans, str., canned, low sod., green/fat 7520600 Beans, string, cooked, yellow/NS fat 7520601 Beans, string, cooked, yellow/no fat 7520602 Beans, string, cooked, yellow/fat 7540301 Beans, string, green, creamed 7540302 Beans, string, green, w/mushroom sauce 7540401 Beans, string, yellow, creamed 7550011 Beans, string, green, pickled 7640100 Beans, green, string, baby 7640101 Beans, green, string, baby, str. 7640102 Beans, green, string, baby, junior 7640103 Beans, green, string, baby, creamed (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods)
Beef	441- Beef (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	21- Beef beef, nfs beef steak beef oxtails, neck bones, ribs roasts, stew meat, corned, brisket, sandwich steaks ground beef, patties, meatballs other beef items beef baby food (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry, and fish base; and gelatin-based drinks; includes baby food)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Pork	442- Pork (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	22- Pork pork, nfs; ground dehydrated chops steaks, cutlets ham roasts Canadian bacon bacon, salt pork other pork items pork baby food (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry and fish base; and gelatin-based drinks; includes baby food)
Game	445- Variety Meat, Game (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	233- Game (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry, and fish base; and gelatin-based drinks)
Poultry	451- Poultry (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	24- Poultry chicken turkey duck other poultry poultry baby food (excludes meat, poultry, and fish with non-meat items; frozen plate meals; soups and gravies with meat, poultry, and fish base; and gelatin-based drinks; includes baby food)
Eggs	46- Eggs (fresh equivalent) fresh processed eggs, substitutes (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	3- Eggs eggs egg mixtures egg substitutes eggs baby food froz. meals with egg as main ingred. (includes baby foods)
Broccoli	4912- Fresh Broccoli (and home canned/froz.) 5111203 Broccoli, comm. canned 52112- Comm. Frozen Broccoli (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	722- Broccoli (all forms) (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Carrots	4921- Fresh Carrots (and home canned/froz.) 51121- Comm. Canned Carrots 5115101 Carrots, Low Sodium, Comm. Canned 52121- Comm. Frozen Carrots 5312103 Comm. Canned Carrot Juice 5372102 Carrot Juice Fresh 5413502 Carrots, Dried Baby Food (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7310- Carrots (all forms) 7311140 Carrots in Sauce 7311200 Carrot Chips 76201- Carrots, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods except mixtures)
Pumpkin	4922- Fresh Pumpkin, Winter Squash (and home canned/froz.) 51122- Pumpkin/Squash, Baby or Junior, Comm. Canned 52122- Winter Squash, Comm. Frozen 5413504 Squash, Dried Baby Food (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	732- Pumpkin (all forms) 733- Winter squash (all forms) 76205- Squash, baby (does not include vegetable soups; vegetables mixtures; or vegetable with meat mixtures; includes baby foods)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Asparagus	4941- Fresh Asparagus (and home canned/froz.) 5114101 Comm. Canned Asparagus 5115301 Asparagus, Low Sodium, Comm. Canned 52131- Comm. Frozen Asparagus (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7510080 Asparagus, raw 75202- Asparagus, cooked 7540101 Asparagus, creamed or with cheese (does not include vegetable soups; vegetables mixtures, or vegetable with meat mixtures)
Lima Beans	4942- Fresh Lima and Fava Beans (and home canned/froz.) 5114204 Comm. Canned Mature Lima Beans 5114301 Comm. Canned Green Lima Beans 5115304 Comm. Canned Low Sodium Lima Beans 52132- Comm. Frozen Lima Beans 54111- Dried Lima Beans 5411306 Dried Fava Beans (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures; does not include succotash)	7510200 Lima Beans, raw 752040- Lima Beans, cooked 752041- Lima Beans, canned 75402- Lima Beans with sauce (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; does not include succotash)
Cabbage	4944- Fresh Cabbage (and home canned/froz.) 4958601 Sauerkraut, home canned or pkgd 5114801 Sauerkraut, comm. canned 5114904 Comm. Canned Cabbage 5114905 Comm. Canned Cabbage (no sauce; incl. baby) 5115501 Sauerkraut, low sodium., comm. canned 5312102 Sauerkraut Juice, comm. canned (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7510300 Cabbage, raw 7510400 Cabbage, Chinese, raw 7510500 Cabbage, red, raw 7514100 Cabbage salad or coleslaw 7514130 Cabbage, Chinese, salad 75210- Chinese Cabbage, cooked 75211- Green Cabbage, cooked 75212- Red Cabbage, cooked 752130- Savoy Cabbage, cooked 75230- Sauerkraut, cooked 7540701 Cabbage, creamed 755025- Cabbage, pickled or in relish (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Lettuce	4945- Fresh Lettuce, French Endive (and home canned/froz.) (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	75113- Lettuce, raw 75143- Lettuce salad with other veg. 7514410 Lettuce, wilted, with bacon dressing 7522005 Lettuce, cooked (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Okra	4946- Fresh Okra (and home canned/froz.) 5114914 Comm. Canned Okra 5213720 Comm. Frozen Okra 5213721 Comm. Frozen Okra with Oth. Veg. & Sauce (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7522000 Okra, cooked, NS as to fat 7522001 Okra, cooked, fat not added 7522002 Okra, cooked, fat added 7522010 Lufta, cooked (Chinese Okra) 7541450 Okra, fried 7550700 Okra, pickled (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Peas	4947- Fresh Peas (and home canned/froz.) 51147- Comm Canned Peas (incl. baby) 5115310 Low Sodium Green or English Peas (canned) 5115314 Low Sod. Blackeyed, Gr. or Imm. Peas (canned) 5114205 Blackeyed Peas, comm. canned 52134- Comm. Frozen Peas 5412- Dried Peas and Lentils (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7512000 Peas, green, raw 7512775 Snowpeas, raw 75223- Peas, cowpeas, field or blackeyed, cooked 75224- Peas, green, cooked 75225- Peas, pigeon, cooked 75231- Snowpeas, cooked 7541650 Pea salad 7541660 Pea salad with cheese 75417- Peas, with sauce or creamed 76409- Peas, baby 76411- Peas, creamed, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods except mixtures)
Cucumbers	4952- Fresh Cucumbers (and home canned/froz.) (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7511100 Cucumbers, raw 75142- Cucumber salads 752167- Cucumbers, cooked 7550301 Cucumber pickles, dill 7550302 Cucumber pickles, relish 7550303 Cucumber pickles, sour 7550304 Cucumber pickles, sweet 7550305 Cucumber pickles, fresh 7550307 Cucumber, Kim Chee 7550311 Cucumber pickles, dill, reduced salt 7550314 Cucumber pickles, sweet, reduced salt (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
Beets	4954- Fresh Beets (and home canned/froz.) 51145- Comm. Canned Beets (incl. baby) 5115305 Low Sodium Beets (canned) 5213714 Comm. Frozen Beets 5312104 Beet Juice (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7510250 Beets, raw 752080- Beets, cooked 752081- Beets, canned 7540501 Beets, harvard 7550021 Beets, pickled 76403- Beets, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures; includes baby foods except mixtures)
Strawberries	5022- Fresh Strawberries 5122801 Comm. Canned Strawberries with sugar 5122802 Comm. Canned Strawberries without sugar 5122803 Canned Strawberry Pie Filling 5222- Comm. Frozen Strawberries (does not include ready-to-eat dinners; includes baby foods except mixtures)	6322- Strawberries 6413250 Strawberry Juice (includes baby food; except mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Other Berries	5033- Fresh Berries Other than Strawberries 5122804 Comm. Canned Blackberries with sugar 5122805 Comm. Canned Blackberries without sugar 5122806 Comm. Canned Blueberries with sugar 5122807 Comm. Canned Blueberries without sugar 5122808 Canned Blueberry Pie Filling 5122809 Comm. Canned Gooseberries with sugar 5122810 Comm. Canned Gooseberries without sugar 5122811 Comm. Canned Raspberries with sugar 5122812 Comm. Canned Raspberries without sugar 5122813 Comm. Canned Cranberry Sauce 5122815 Comm. Canned Cranberry-Orange Relish 52233- Comm. Frozen Berries (not strawberries) 5332404 Blackberry Juice (home and comm. canned) 5423114 Dried Berries (not strawberries) (does not include ready-to-eat dinners; includes baby foods except mixtures)	6320- Other Berries 6321- Other Berries 6341101 Cranberry salad 6410460 Blackberry Juice 64105- Cranberry Juice (includes baby food; except mixtures)
Peaches	5036- Fresh Peaches 51224- Comm. Canned Peaches (incl. baby) 5223601 Comm. Frozen Peaches 5332405 Home Canned Peach Juice 5423105 Dried Peaches (baby) 5423106 Dried Peaches (does not include ready-to-eat dinners; includes baby foods except mixtures)	62116- Dried Peaches 63135- Peaches 6412203 Peach Juice 6420501 Peach Nectar 67108- Peaches, baby 6711450 Peaches, dry, baby (includes baby food; except mixtures)
Pears	5037- Fresh Pears 51225- Comm. Canned Pears (incl. baby) 5332403 Comm. Canned Pear Juice, baby 5362204 Fresh Pear Juice 5423107 Dried Pears (does not include ready-to-eat dinners; includes baby foods except mixtures)	62119- Dried Pears 63137- Pears 6341201 Pear salad 6421501 Pear Nectar 67109- Pears, baby 6711455 Pears, dry, baby (includes baby food; except mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code	Household Definition	Individual Code	Individual Definition
EXPOSED/PROTECTED FRUITS/VEGETABLES, ROOT VEGETABLES				
Exposed Fruits	5022-	Strawberries, fresh	62101-	Apple, dried
	5023101	Acerola, fresh	62104-	Apricot, dried
	5023401	Currants, fresh	62108-	Currants, dried
	5031-	Apples/Applesauce, fresh	62110-	Date, dried
	5033-	Berries other than Strawberries, fresh	62116-	Peaches, dried
	5034-	Cherries, fresh	62119-	Pears, dried
	5036-	Peaches, fresh	62121-	Plum, dried
	5037-	Pears, fresh	62122-	Prune, dried
	50381-	Apricots, Nectarines, Loquats, fresh	62125-	Raisins
	5038305	Dates, fresh	63101-	Apples/applesauce
	50384-	Grapes, fresh	63102-	Wi-apple
	50386-	Plums, fresh	63103-	Apricots
	50387-	Rhubarb, fresh	63111-	Cherries, maraschino
	5038805	Persimmons, fresh	63112-	Acerola
	5038901	Sapote, fresh	63113-	Cherries, sour
	51221-	Apples/Applesauce, canned	63115-	Cherries, sweet
	51222-	Apricots, canned	63117-	Currants, raw
	51223-	Cherries, canned	63123-	Grapes
	51224-	Peaches, canned	6312601	Juneberry
	51225-	Pears, canned	63131-	Nectarine
	51228-	Berries, canned	63135-	Peach
	5122903	Grapes with sugar, canned	63137-	Pear
	5122904	Grapes without sugar, canned	63139-	Persimmons
	5122905	Plums with sugar, canned	63143-	Plum
	5122906	Plums without sugar, canned	63146-	Quince
	5122907	Plums, canned, baby	63147-	Rhubarb/Sapodillo
	5122911	Prunes, canned, baby	632-	Berries
	5122912	Prunes, with sugar, canned	64101-	Apple Cider
	5122913	Prunes, without sugar, canned	64104-	Apple Juice
	5122914	Raisin Pie Filling	64105-	Cranberry Juice
	5222-	Frozen Strawberries	64116-	Grape Juice
	52231-	Apples Slices, frozen	64122-	Peach Juice
	52233-	Berries, frozen	64132-	Prune/Strawberry Juice
	52234-	Cherries, frozen	6420101	Apricot Nectar
	52236-	Peaches, frozen	64205-	Peach Nectar
	52239-	Rhubarb, frozen	64215-	Pear Nectar
	53321-	Canned Apple Juice	67102-	Applesauce, baby
	53322-	Canned Grape Juice	67108-	Peaches, baby

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Exposed Fruits (continued)	5332402 Canned Prune Juice 5332403 Canned Pear Juice 5332404 Canned Blackberry Juice 5332405 Canned Peach Juice 53421- Frozen Grape Juice 5342201 Frozen Apple Juice, comm. fr. 5342202 Frozen Apple Juice, home fr. 5352101 Apple Juice, asep. packed 5352201 Grape Juice, asep. packed 5362101 Apple Juice, fresh 5362202 Apricot Juice, fresh 5362203 Grape Juice, fresh 5362204 Pear Juice, fresh 5362205 Prune Juice, fresh 5421- Dried Prunes 5422- Raisins, Currants, dried 5423101 Dry Apples 5423102 Dry Apricots 5423103 Dates without pits 5423104 Dates with pits 5423105 Peaches, dry, baby 5423106 Peaches, dry 5423107 Pears, dry 5423114 Berries, dry 5423115 Cherries, dry (includes baby foods)	67109- Pears, baby 6711450 Peaches, baby, dry 6711455 Pears, baby, dry 67202- Apple Juice, baby 6720380 White Grape Juice, baby 67212- Pear Juice, baby (includes baby foods/juices except mixtures; excludes fruit mixtures)
Protected Fruits	501- Citrus Fruits, fresh 5021- Cantaloupe, fresh 5023201 Mangoes, fresh 5023301 Guava, fresh 5023601 Kiwi, fresh 5023701 Papayas, fresh 5023801 Passion Fruit, fresh 5032- Bananas, Plantains, fresh 5035- Melons other than Cantaloupe, fresh 50382- Avocados, fresh 5038301 Figs, fresh 5038302 Figs, cooked 5038303 Figs, home canned 5038304 Figs, home frozen 50385- Pineapple, fresh 5038801 Pomegranates, fresh 5038902 Cherimoya, fresh 5038903 Jackfruit, fresh 5038904 Breadfruit, fresh 5038905 Tamarind, fresh 5038906 Carambola, fresh 5038907 Longan, fresh 5121- Citrus, canned 51226- Pineapple, canned 5122901 Figs with sugar, canned 5122902 Figs without sugar, canned 5122909 Bananas, canned, baby 5122910 Bananas and Pineapple, canned, baby 5122915 Litchis, canned	61- Citrus Fr., Juices (incl. cit. juice mixtures) 62107- Bananas, dried 62113- Figs, dried 62114- Lychees/Papayas, dried 62120- Pineapple, dried 62126- Tamarind, dried 63105- Avocado, raw 63107- Bananas 63109- Cantaloupe, Carambola 63110- Cassaba Melon 63119- Figs 63121- Genip 63125- Guava/Jackfruit, raw 6312650 Kiwi 6312651 Lychee, raw 6312660 Lychee, cooked 63127- Honeydew 63129- Mango 63133- Papaya 63134- Passion Fruit 63141- Pineapple 63145- Pomegranate 63148- Sweetsop, Soursop, Tamarind 63149- Watermelon 64120- Papaya Juice 64121- Passion Fruit Juice 64124- Pineapple Juice 64133- Watermelon Juice 6420150 Banana Nectar

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Protected Fruits (continued)	5122916 Mangos with sugar, canned 5122917 Mangos without sugar, canned 5122918 Mangos, canned, baby 5122920 Guava with sugar, canned 5122921 Guava without sugar, canned 5122923 Papaya with sugar, canned 5122924 Papaya without sugar, canned 52232- Bananas, frozen 52235- Melon, frozen 52237- Pineapple, frozen 5331- Canned Citrus Juices 53323- Canned Pineapple Juice 5332408 Canned Papaya Juice 5332410 Canned Mango Juice 5332501 Canned Papaya Concentrate 5341- Frozen Citrus Juice 5342203 Frozen Pineapple Juice 5351- Citrus and Citrus Blend Juices, asep. packed 5352302 Pineapple Juice, asep. packed 5361- Fresh Citrus and Citrus Blend Juices 5362206 Papaya Juice, fresh 5362207 Pineapple-Coconut Juice, fresh 5362208 Mango Juice, fresh 5362209 Pineapple Juice, fresh 5423108 Pineapple, dry 5423109 Papaya, dry 5423110 Bananas, dry 5423111 Mangos, dry 5423117 Litchis, dry 5423118 Tamarind, dry 5423119 Plantain, dry (includes baby foods)	64202- Cantaloupe Nectar 64203- Guava Nectar 64204- Mango Nectar 64210- Papaya Nectar 64213- Passion Fruit Nectar 64221- Soursop Nectar 6710503 Bananas, baby 6711500 Bananas, baby, dry 6720500 Orange Juice, baby 6721300 Pineapple Juice, baby (includes baby foods/juices except mixtures; excludes fruit mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code	Household Definition	Individual Code	Individual Definition
Exposed Veg.	491-	Fresh Dark Green Vegetables	721-	Dark Green Leafy Veg.
	493-	Fresh Tomatoes	722-	Dark Green Non-Leafy Veg.
	4941-	Fresh Asparagus	74-	Tomatoes and Tomato Mixtures
	4943-	Fresh Beans, Snap or Wax	7510050	Alfalfa Sprouts
	4944-	Fresh Cabbage	7510075	Artichoke, Jerusalem, raw
	4945-	Fresh Lettuce	7510080	Asparagus, raw
	4946-	Fresh Okra	75101-	Beans, sprouts and green, raw
	49481-	Fresh Artichokes	7510275	Brussel Sprouts, raw
	49483-	Fresh Brussel Sprouts	7510280	Buckwheat Sprouts, raw
	4951-	Fresh Celery	7510300	Cabbage, raw
	4952-	Fresh Cucumbers	7510400	Cabbage, Chinese, raw
	4955-	Fresh Cauliflower	7510500	Cabbage, Red, raw
	4958103	Fresh Kohlrabi	7510700	Cauliflower, raw
	4958111	Fresh Jerusalem Artichokes	7510900	Celery, raw
	4958112	Fresh Mushrooms	7510950	Chives, raw
	4958113	Mushrooms, home canned	7511100	Cucumber, raw
	4958114	Mushrooms, home frozen	7511120	Eggplant, raw
	4958118	Fresh Eggplant	7511200	Kohlrabi, raw
	4958119	Eggplant, cooked	75113-	Lettuce, raw
	4958120	Eggplant, home frozen	7511500	Mushrooms, raw
	4958200	Fresh Summer Squash	7511900	Parsley
	4958201	Summer Squash, cooked	7512100	Pepper, hot chili
	4958202	Summer Squash, home canned	75122-	Peppers, raw
	4958203	Summer Squash, home frozen	7512750	Seaweed, raw
	4958402	Fresh Bean Sprouts	7512775	Snowpeas, raw
	4958403	Fresh Alfalfa Sprouts	75128-	Summer Squash, raw
	4958504	Bamboo Shoots	7513210	Celery Juice
	4958506	Seaweed	7514100	Cabbage or Cole Slaw
	4958508	Tree Fern, fresh	7514130	Chinese Cabbage Salad
	4958601	Sauerkraut	7514150	Celery with cheese
	5111-	Dark Green Vegetables (all are exposed)	75142-	Cucumber salads
	5113-	Tomatoes	75143-	Lettuce salads
	5114101	Asparagus, comm. canned	7514410	Lettuce, wilted with bacon dressing
	51144-	Beans, green, snap, yellow, comm. canned	7514600	Greek salad
	5114704	Snow Peas, comm. canned	7514700	Spinach salad
	5114801	Sauerkraut, comm. canned	7520600	Algae, dried
	5114901	Artichokes, comm. canned	75201-	Artichoke, cooked
	5114902	Bamboo Shoots, comm. canned	75202-	Asparagus, cooked
	5114903	Bean Sprouts, comm. canned	75203-	Bamboo Shoots, cooked
	5114904	Cabbage, comm. canned	752049-	Beans, string, cooked
	5114905	Cabbage, comm. canned, no sauce	75205-	Beans, green, cooked/canned
	5114906	Cauliflower, comm. canned, no sauce	75206-	Beans, yellow, cooked/canned
	5114907	Eggplant, comm. canned, no sauce	75207-	Bean Sprouts, cooked
	5114913	Mushrooms, comm. canned	752085-	Breadfruit
	5114914	Okra, comm. canned	752090-	Brussel Sprouts, cooked
	5114918	Seaweeds, comm. canned	75210-	Cabbage, Chinese, cooked
	5114920	Summer Squash, comm. canned	75211-	Cabbage, green, cooked

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Exposed Veg. (cont.)	5114923 Chinese or Celery Cabbage, comm. canned	75212- Cabbage, red, cooked
	51152- Tomatoes, canned, low sod.	752130- Cabbage, savoy, cooked
	5115301 Asparagus, canned, low sod.	75214- Cauliflower
	5115302 Beans, Green, canned, low sod.	75215- Celery, Chives, Christophine (chayote)
	5115303 Beans, Yellow, canned, low sod.	752167- Cucumber, cooked
	5115309 Mushrooms, canned, low sod.	752170- Eggplant, cooked
	51154- Greens, canned, low sod.	752171- Fern shoots
	5115501 Sauerkraut, low sodium	752172- Fern shoots
	5211- Dark Gr. Veg., comm. frozen (all exp.)	752173- Flowers of sesbania, squash or lily
	52131- Asparagus, comm. froz.	7521801 Kohlrabi, cooked
	52133- Beans, snap, green, yellow, comm. froz.	75219- Mushrooms, cooked
	5213407 Peapods, comm. froz.	75220- Okra/lettuce, cooked
	5213408 Peapods, with sauce, comm. froz.	7522116 Palm Hearts, cooked
	5213409 Peapods, with other veg., comm. froz.	7522121 Parsley, cooked
	5213701 Brussel Sprouts, comm. froz.	75226- Peppers, pimento, cooked
	5213702 Brussel Sprouts, comm. froz. with cheese	75230- Sauerkraut, cooked/canned
	5213703 Brussel Sprouts, comm. froz. with other veg.	75231- Snowpeas, cooked
	5213705 Cauliflower, comm. froz.	75232- Seaweed
	5213706 Cauliflower, comm. froz. with sauce	75233- Summer Squash
	5213707 Cauliflower, comm. froz. with other veg.	7540050 Artichokes, stuffed
	5213708 Caul., comm. froz. with other veg. & sauce	7540101 Asparagus, creamed or with cheese
	5213709 Summer Squash, comm. froz.	75403- Beans, green with sauce
	5213710 Summer Squash, comm. froz. with other veg.	75404- Beans, yellow with sauce
	5213716 Eggplant, comm. froz.	7540601 Brussel Sprouts, creamed
	5213718 Mushrooms with sauce, comm. froz.	7540701 Cabbage, creamed
	5213719 Mushrooms, comm. froz.	75409- Cauliflower, creamed
	5213720 Okra, comm. froz.	75410- Celery/Chiles, creamed
	5213721 Okra, comm. froz., with sauce	75412- Eggplant, fried, with sauce, etc.
	5311- Canned Tomato Juice and Tomato Mixtures	75413- Kohlrabi, creamed
	5312102 Canned Sauerkraut Juice	75414- Mushrooms, Okra, fried, stuffed, creamed
	5321- Frozen Tomato Juice	754180- Squash, baked, fried, creamed, etc.
	5371- Fresh Tomato Juice	7541822 Christophine, creamed
	5381102 Aseptically Packed Tomato Juice	7550011 Beans, pickled
	5413101 Dry Algae	7550051 Celery, pickled
	5413102 Dry Celery	7550201 Cauliflower, pickled
	5413103 Dry Chives	755025- Cabbage, pickled
	5413109 Dry Mushrooms	7550301 Cucumber pickles, dill
	5413111 Dry Parsley	7550302 Cucumber pickles, relish
	5413112 Dry Green Peppers	7550303 Cucumber pickles, sour
	5413113 Dry Red Peppers	7550304 Cucumber pickles, sweet
	5413114 Dry Seaweed	7550305 Cucumber pickles, fresh
	5413115 Dry Tomatoes	7550307 Cucumber, Kim Chee
	(does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	7550308 Eggplant, pickled
		7550311 Cucumber pickles, dill, reduced salt
		7550314 Cucumber pickles, sweet, reduced salt
		7550500 Mushrooms, pickled
		7550700 Okra, pickled
		75510- Olives
		7551101 Peppers, hot
		7551102 Peppers, pickled
		7551301 Seaweed, pickled
		7553500 Zucchini, pickled
		76102- Dark Green Veg., baby
		76401- Beans, baby (excl. most soups & mixtures)

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Protected Veg.	4922- Fresh Pumpkin, Winter Squash	732- Pumpkin
	4942- Fresh Lima Beans	733- Winter Squash
	4947- Fresh Peas	7510200 Lima Beans, raw
	49482- Fresh Soy Beans	7510550 Cactus, raw
	4956- Fresh Corn	7510960 Corn, raw
	4958303 Succotash, home canned	7512000 Peas, raw
	4958304 Succotash, home frozen	7520070 Aloe vera juice
	4958401 Fresh Cactus (prickly pear)	752040- Lima Beans, cooked
	4958503 Burdock	752041- Lima Beans, canned
	4958505 Bitter Melon	7520829 Bitter Melon
	4958507 Horseradish Tree Pods	752083- Bitter Melon, cooked
	51122- Comm. Canned Pumpkin and Squash (baby)	7520950 Burdock
	51142- Beans, comm. canned	752131- Cactus
	51143- Beans, lima and soy, comm. canned	752160- Corn, cooked
	51146- Corn, comm. canned	752161- Corn, yellow, cooked
	5114701 Peas, green, comm. canned	752162- Corn, white, cooked
	5114702 Peas, baby, comm. canned	752163- Corn, canned
	5114703 Peas, blackeyed, comm. canned	7521749 Hominy
	5114705 Pigeon Peas, comm. canned	752175- Hominy
	5114919 Succotash, comm. canned	75223- Peas, cowpeas, field or blackeyed, cooked
	5115304 Lima Beans, canned, low sod.	75224- Peas, green, cooked
	5115306 Corn, canned, low sod.	75225- Peas, pigeon, cooked
	5115307 Creamed Corn, canned, low sod.	75301- Succotash
	511531- Peas and Beans, canned, low sod.	75402- Lima Beans with sauce
	52122- Winter Squash, comm. froz.	75411- Corn, scalloped, fritter, with cream
	52132- Lima Beans, comm. froz.	7541650 Pea salad
	5213401 Peas, gr., comm. froz.	7541660 Pea salad with cheese
	5213402 Peas, gr., with sauce, comm. froz.	75417- Peas, with sauce or creamed
	5213403 Peas, gr., with other veg., comm. froz.	7550101 Corn relish
	5213404 Peas, gr., with other veg., comm. froz.	76205- Squash, yellow, baby
	5213405 Peas, blackeyed, comm. froz.	76405- Corn, baby
	5213406 Peas, blackeyed, with sauce, comm. froz.	76409- Peas, baby
	52135- Corn, comm. froz.	76411- Peas, creamed, baby
	5213712 Artichoke Hearts, comm. froz.	(does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
	5213713 Baked Beans, comm. froz.	
	5213717 Kidney Beans, comm. froz.	
	5213724 Succotash, comm. froz.	
	5411- Dried Beans	
	5412- Dried Peas and Lentils	
	5413104 Dry Corn	
	5413106 Dry Hominy	
	5413504 Dry Squash, baby	
	5413603 Dry Creamed Corn, baby	
	(does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Root Vegetables	48- Potatoes, Sweetpotatoes 4921- Fresh Carrots 4953- Fresh Onions, Garlic 4954- Fresh Beets 4957- Fresh Turnips 4958101 Fresh Celeriac 4958102 Fresh Horseradish 4958104 Fresh Radishes, no greens 4958105 Radishes, home canned 4958106 Radishes, home frozen 4958107 Fresh Radishes, with greens 4958108 Fresh Salsify 4958109 Fresh Rutabagas 4958110 Rutabagas, home frozen 4958115 Fresh Parsnips 4958116 Parsnips, home canned 4958117 Parsnips, home frozen 4958502 Fresh Lotus Root 4958509 Ginger Root 4958510 Jicama, including yambean 51121- Carrots, comm. canned 51145- Beets, comm. canned 5114908 Garlic Pulp, comm. canned 5114910 Horseradish, comm. prep. 5114915 Onions, comm. canned 5114916 Rutabagas, comm. canned 5114917 Salsify, comm. canned 5114921 Turnips, comm. canned 5114922 Water Chestnuts, comm. canned 51151- Carrots, canned, low sod. 5115305 Beets, canned, low sod. 5115502 Turnips, low sod. 52121- Carrots, comm. froz. 5213714 Beets, comm. froz. 5213722 Onions, comm. froz. 5213723 Onions, comm. froz., with sauce 5213725 Turnips, comm. froz. 5312103 Canned Carrot Juice 5312104 Canned Beet Juice 5372102 Fresh Carrot Juice 5413105 Dry Garlic 5413110 Dry Onion 5413502 Dry Carrots, baby 5413503 Dry Sweet Potatoes, baby (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures)	71- White Potatoes and Puerto Rican St. Veg. 7310- Carrots 7311140 Carrots in sauce 7311200 Carrot chips 734- Sweetpotatoes 7510250 Beets, raw 7511150 Garlic, raw 7511180 Jicama (yambean), raw 7511250 Leeks, raw 75117- Onions, raw 7512500 Radish, raw 7512700 Rutabaga, raw 7512900 Turnip, raw 752080- Beets, cooked 752081- Beets, canned 7521362 Cassava 7521740 Garlic, cooked 7521771 Horseradish 7521850 Lotus root 752210- Onions, cooked 7522110 Onions, dehydrated 752220- Parsnips, cooked 75227- Radishes, cooked 75228- Rutabaga, cooked 75229- Salsify, cooked 75234- Turnip, cooked 75235- Water Chestnut 7540501 Beets, harvard 75415- Onions, creamed, fried 7541601 Parsnips, creamed 7541810 Turnips, creamed 7550021 Beets, pickled 7550309 Horseradish 7551201 Radishes, pickled 7553403 Turnip, pickled 76201- Carrots, baby 76209- Sweetpotatoes, baby 76403- Beets, baby (does not include vegetable soups; vegetable mixtures; or vegetable with meat mixtures)
USDA SUBCATEGORIES		
Dark Green Vegetables	491- Fresh Dark Green Vegetables 5111- Comm. Canned Dark Green Veg. 51154- Low Sodium Dark Green Veg. 5211- Comm. Frozen Dark Green Veg. 5413111 Dry Parsley 5413112 Dry Green Peppers 5413113 Dry Red Peppers (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners; excludes vegetable juices and dried vegetables)	72- Dark Green Vegetables all forms leafy, nonleafy, dk. gr. veg. soups

Table 13B-1. Food Codes and Definitions for Individual Food Items Used in Analysis of the 1987–1988 USDA NFCS Household Data to Estimate Fraction of Food Intake That Is Home-Produced (continued)

Food Product	Household Code/Definition	Individual Code
Deep Yellow Vegetables	492- Fresh Deep Yellow Vegetables 5112- Comm. Canned Deep Yellow Veg. 51151- Low Sodium Carrots 5212- Comm. Frozen Deep Yellow Veg. 5312103 Carrot Juice 54135- Dry Carrots, Squash, Sw. Potatoes (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners; excludes vegetable juices and dried vegetables)	73- Deep Yellow Vegetables all forms carrots, pumpkin, squash, sweet potatoes, dp. yell. veg. soups
Other Vegetables	494- Fresh Light Green Vegetables 495- Fresh Other Vegetables 5114- Comm. Canned Other Veg. 51153- Low Sodium Other Veg. 51155- Low Sodium Other Veg. 5213- Comm. Frozen Other Veg. 5312102 Sauerkraut Juice 5312104 Beet Juice 5411- Dried Beans 5412- Dried Peas, Lentils 541310- Dried Other Veg. 5413114 Dry Seaweed 5413603 Dry Cr. Corn, baby (does not include soups, sauces, gravies, mixtures, and ready-to-eat dinners; includes baby foods except mixtures/dinners; excludes vegetable juices and dried vegetables)	75- Other Vegetables all forms
Citrus Fruits	501- Fresh Citrus Fruits 5121- Comm. Canned Citrus Fruits 5331- Canned Citrus and Citrus Blend Juice 5341- Frozen Citrus and Citrus Blend Juice 5351- Aseptically Packed Citrus and Citr. Blend Juice 5361- Fresh Citrus and Citrus Blend Juice (includes baby foods; excludes dried fruits)	61- Citrus Fruits and Juices 6720500 Orange Juice, baby food 6720600 Orange-Apricot Juice, baby food 6720700 Orange-Pineapple Juice, baby food 6721100 Orange-Apple-Banana Juice, baby food (excludes dried fruits)
Other Fruits	502- Fresh Other Vitamin C-Rich Fruits 503- Fresh Other Fruits 5122- Comm. Canned Fruits Other than Citrus 5222- Frozen Strawberries 5223- Frozen Other than Citr. or Vitamin C-Rich Fr. 5332- Canned Fruit Juice Other than Citrus 5342- Frozen Juices Other than Citrus 5352- Aseptically Packed Fruit Juice Other than Citr. 5362- Fresh Fruit Juice Other than Citrus 542- Dry Fruits (includes baby foods; excludes dried fruits)	62- Dried Fruits 63- Other Fruits 64- Fruit Juices and Nectars Excluding Citrus 671- Fruits, baby 67202- Apple Juice, baby 67203- Baby Juices 67204- Baby Juices 67212- Baby Juices 67213- Baby Juices 673- Baby Fruits 674- Baby Fruits

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14. TOTAL FOOD INTAKE

14.1. INTRODUCTION

The U.S. food supply is generally considered to be one of the safest in the world. Nevertheless, contamination of foods may occur as a result of environmental pollution of the air, water, or soil, or the intentional use of chemicals such as pesticides or other agrochemicals. Ingestion of contaminated foods is a potential pathway of exposure to such contaminants. To assess chemical exposure through this pathway, information on food ingestion rates is needed. Chapters 9 through 13 of this handbook report per capita and consumer-only data on food consumption rates for various food items and food categories. These intake rates were estimated by the U.S. Environmental Protection Agency (EPA) using databases developed by the U.S. Department of Agriculture (USDA). U.S. EPA (2007) expanded the analysis of food intake in order to examine individuals' food consumption habits in greater detail. Using data from the USDA's Continuing Survey of Food Intake by Individuals (CSFII) conducted in 1994−1996 and 1998, U.S. EPA (2007) derived distributions to characterize (1) the total food intake among various groups in the U.S. population, subdivided by age, race, geographic region, and urbanization; (2) the contribution of various food categories (e.g., meats, grains, vegetables, etc.) to total food intake among these populations; and (3) the contribution of various food categories to total food intake among individuals exhibiting low- or high-end consumption patterns of a specific food category (e.g., individuals below the 10th percentile or above the 90th percentile for fish consumption). These data may be useful for assessing exposure among populations exhibiting lower or higher than usual intake of certain types of foods (e.g., people who eat little or no meat, or people who eat large quantities of fish). Recently, U.S. EPA's Office of Pesticide Programs (OPP) used data from the 2003 to 2006 National Health and Nutrition Examination Survey (NHANES) to estimate intake of various foods, including total foods.

The recommendations for total food intake rates are provided in the next section, along with a summary of the confidence ratings for these recommendations. Following the recommendations, the studies on total food intake are summarized.

14.2. RECOMMENDATIONS

Table 14-1 presents a summary of recommended values for total food intake. Table 14-2 presents the confidence ratings for these recommendations. The recommended total food intake rates are based on data from the U.S. EPA/OPP's recent analysis of NHANES data from 2003 to 2006. For information about the proportion of total intake represented by the major food groups, it is recommended that the data based on a re-analysis of the data from U.S. EPA (2007) be used. Section 14.3.1 describes this re-analysis, and Tables 14-3 to 14-11 provide the data. However, it should be noted that, because the U.S. EPA (2007) data are based on 1994−1996 and 1998 CSFII data, they may not reflect recent changes that may have occurred in consumption patterns.

Both of the studies of total dietary intake presented in this chapter are based on data collected over a 2-day period and may not necessarily reflect the long-term distribution of average daily intake rates. However, because the broad categories of foods used in this analysis (e.g., total foods, total fruits, total vegetables, etc.) are typically eaten on a daily basis throughout the year with minimal seasonality, the short-term distribution may be a reasonable approximation of the long-term distribution, although it will display somewhat increased variability. This implies that the upper percentiles shown here will tend to overestimate the corresponding percentiles of the true long-term distribution.

Table 14-1. Recommended Values for Per Capita Total Food Intake, Edible Portion, Uncooked Weight				
Age Group (years)	Mean	95th Percentile	Multiple Percentiles	Source
	g/kg-day			
Children				
Birth to <1	91	208[c]	See Table 14-12	U.S. EPA/OPP analysis of NHANES 2003−2006
1 to <3	113	185[c]		
3 to <6	79	137		
6 to <11[a]	47	92		
11 to <16[b]	28	56		
16 to <21[b]	28	56		
Adults				
21 to <50	29	63		
≥50	29	59		

a Based on data for ages 6 to <13 years.
b Based on data for ages 13 to <20 years.
c Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Note: Total food intake was defined as intake of the sum of all foods, beverages, and water ingested.

Table 14-2. Confidence in Recommendations for Total Food Intake

General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodologies were adequate and the analytical approaches were competently executed. The study sizes were very large; sample sizes varied with age. The response rates were good. The studies analyzed primary data on recall of ingestion.	
Minimal (or Defined) Bias	No direct measurements were taken. The studies relied on survey data.	
Applicability and Utility		Medium
Exposure Factor of Interest	The analyses were specifically designed to address food intake.	
Representativeness	The populations studied were representative of the U.S. population.	
Currency	The data used were the most current data publicly available at the time the analysis was conducted for the handbook. However, the data used in the re-analysis of the U.S. EPA study are now 11−15 years old. The national trends in bodyweight,(increasing obesity prevalence) may in part be due to changes in food intake patterns.	
Data Collection Period	Ingestion rates were estimated based on short-term data collected in the CSFII 1994−1996, 1998 and NHANES 2003−2006.	
Clarity and Completeness		Medium
Accessibility	The NHANES and CSFII data are publicly available. The U.S. EPA (2007) report is available online.	
Reproducibility	The methodology was clearly presented; enough information was included to reproduce results.	
Quality Assurance	NHANES and CSFII follow strict QA/QC procedures. U.S. EPA's analysis of NHANES data has only been reviewed internally, but the methodology has been used in an analysis of previous data.	
Variability and Uncertainty		Medium
Variability in Population	Short term distributions of total intake were provided. The survey was not designed to capture long-term day-to-day variability.	
Uncertainty	The survey data were based on recall over a 2-day period. The U.S. EPA/OPP analysis of NHANES data included all foods, beverages, and water ingested. Beverages, sugar, candy, and sweets, and nuts and nut products were not included in the re-analysis of the U.S. EPA (2007) data. There is also some uncertainty associated with the translation of mixed foods (i.e., recipes) to food commodity ingredients in both studies.	
Evaluation and Review		Medium
Peer Review	The USDA CSFII survey received a high level of peer review. The U.S. EPA (2007) analysis was also peer reviewed; however, the re-analysis of these data using the new age categories for children was not peer reviewed outside the Agency. The methodology used in the NHANES 2003−2006 analysis is the same as used in previous peer-reviewed analysis conducted by U.S. EPA/OPP.	
Number and Agreement of Studies	Two studies were available for this factor.	
Overall Rating		**Medium**

14.3. STUDIES OF TOTAL FOOD INTAKE

14.3.1. U.S. EPA Re−Analysis of 1994−1996, 1998 Continuing Survey of Food Intake by Individuals (CSFII), Based on U.S. EPA (2007)—Analysis of Total Food Intake and Composition of Individual's Diet Based on U.S. Department of Agriculture's (USDA's) 1994−1996, 1998 CSFII

U.S. EPA's National Center for Environmental Assessment (NCEA) conducted an analysis to evaluate the total food intake of individuals in the United States using data from the USDA's 1994−1996, 1998 CSFII (USDA, 2000) and U.S. EPA's *Food Commodity Intake Database* (FCID) (U.S. EPA, 2000). The 1994−1996 CSFII and its 1998 Supplemental Children's Survey were designed to obtain data from a statistically representative sample of non-institutionalized persons living in the United States. Survey participants were selected using a multistage process. The respondents were interviewed twice to collect information on food consumption during 2 non-consecutive days. For both survey days, data were collected by an in-home interviewer. The Day 2 interview was conducted 3 to10 days later and on a different day of the week. Of the more than 20,000 individuals surveyed, approximately 10,000 were under 21 years of age, and approximately 9,000 were under the age of 11. The 1994−1996 survey and 1998 supplement are referred to collectively as CSFII 1994−1996, 1998. Each individual in the survey was assigned a sample weight based on his or her demographic data; these weights were taken into account when calculating mean and percentile values of food consumption for the various demographic categories that were analyzed in the study. The sample weighting process used in the CSFII 1994−1996, 1998 is discussed in detail in USDA (2000).

For the analysis of total food intake, food commodity codes provided in U.S. EPA's FCID (U.S. EPA, 2000) were used to translate as-eaten foods (e.g., beef stew) identified by USDA food codes in the CSFII data set into food commodities (e.g., beef, potatoes, carrots, etc.). The method used to translate USDA food codes into U.S. EPA commodity codes is discussed in detail in USDA (2000). The U.S. EPA commodity codes were assigned to broad food categories (e.g., total meats, total vegetables, etc.) for use in the analysis. Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts (and nut products) were not included because they could not be categorized into the major food groups. Also, human milk intake was not included. Percent consuming, mean, standard error, and a range of percentile values were calculated on the basis of grams of food per kilogram of body weight per day (g/kg-day) and on the basis of grams per day (g/day). In addition to total food intake, intake of the various major food groups for the various age groups in units of g/day and g/kg-day were also estimated for comparison to total intake.

To evaluate variability in the contributions of the major food groups to total food intake, individuals were ranked from lowest to highest, based on total food intake. Three subsets of individuals were defined, as follows: a group at the low end of the distribution of total intake (below the 10th percentile of total intake), a mid-range or central group (the 45th to 55th percentile of total intake), and a group at the high end of the distribution of total intake (above the 90th percentile of total intake). Mean total food intake (in g/day and g/kg-day), mean intake of each of the major food groups (in g/day and g/kg-day), and the percent of total food intake that each of these food groups represents were calculated for each of the three populations (i.e., individuals with low-end, central, and high-end total food intake). A similar analysis was conducted to estimate the contribution of the major food groups to total food intake for individuals at the low-end, central, and high-end of the distribution of total meat intake, total dairy intake, total meat and dairy intake, total fish intake, and total fruit and vegetable intake. For example, to evaluate the variability in the diets of individuals at the low-end, mid-range, and high-end of the distribution of total meat intake, survey individuals were ranked according to their reported total meat intake. Three subsets of individuals were formed as described above. Mean total food intake, intake of the major food groups, and the percent of total food intake represented by each of the major food groups were tabulated. U.S. EPA (2007) presented the results of the analysis for the following age groups: <1 year, 1 to 2 years, 3 to 5 years, 6 to 11 years, 12 to 19 years, 20 to 39 years, 40 to 69 years, and 70 years and older. The data were tabulated in units of g/kg-day and g/day.

The analysis presented in U.S. EPA (2007) was conducted before U.S. EPA published the guidance entitled *Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). As a result, the age groups used for children in U.S. EPA (2007) were not entirely consistent with the age groups recommended in the 2005 guidance. In order to conform to the standard age categories for children recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005), each of the tables from U.S. EPA (2007) was modified by re-analyzing the source data and applying the new childhood age categories (i.e., <1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, 1 to <2 years, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, and 16 to <21 years). Table 14-3 presents distributions of total food intake in units of g/day and g/kg-day. Tables 14-4 and 14-5 compare total food intake to intake of the various major food groups for the various age groups in units of g/day and g/kg-day, respectively. It should be noted that some U.S. EPA commodity codes are listed under more than one food category. For this reason, in the tables, the intake rates for the individual food categories do not necessarily add up to the figure given for total food intake (U.S. EPA, 2007). Also, data are not reported for food groups for which there were less than 20 consumers in a particular age group. Tables 14-6 through 14-11 present the contributions of the major food groups to total food intake for individuals (in the various age groups) at the low-end, central, and high-end of the distribution of total food intake (see Table 14-6), total meat intake (see Table 14-7), total meat and dairy intake (see Table 14-8), total fish intake (see Table 14-9), total fruit and vegetable intake (see Table 14-10), and total dairy intake (see Table 14-11) in units of g/day and g/kg-day. For each of the three classes of consumers, consumption of nine different food categories is presented (i.e., total foods, dairy, meats, fish, eggs, grains, vegetables, fruits, and fats). For example, in Table 14-9 one will find the mean consumption of meats, eggs, vegetables, etc. for individuals with an unusually high (or low or average) consumption of fish.

As discussed in previous chapters, the 1994−1996, 1998 CSFII data have both advantages and limitations with regard to estimating food intake rates. The large sample size (more than 20,000 persons) is sufficient to allow categorization within narrowly defined age categories. In addition, the survey was designed to obtain a statistically valid sample of the entire U.S. population that included children and low income groups. However, the survey design is of limited utility for assessing small and potentially at-risk populations based on ethnicity, medical status, geography, or other factors (such as activity level). Another limitation is that data are based on a 2-day survey period and, as such, may not accurately reflect long-term eating patterns. This is particularly true for the extremes of the distribution of food intake.

14.3.2. U.S. EPA Analysis of National Health and Nutrition Examination Survey (NHANES) 2003−2006 Data

U.S. EPA/OPP used data from the 2003 to 2006 NHANES to estimate intake of various individual foods, major food groups, and total foods. This chapter presents the data for total foods (Chapter 9 provides data on the intake of fruits and vegetables; Chapter 11 provides data on intake of meat, dairy products, and fats, and Chapter 12 provides data on intake of grain and grain products). The total intake rates presented here represent intake of all forms of foods eaten (e.g., both home produced and commercially produced). Individuals who provided data for 2 days of the survey were included in the intake estimates. Individuals who did not provide information on body weight or for whom identifying information was unavailable were excluded from the analysis. The U.S. EPA/OPP analysis of 2003−2006 NHANES data included all foods, beverages, and water ingested. Two-day average intake rates were calculated for all individuals in the database for each of the food items/groups. These average daily intake rates were divided by each individual's reported body weight to generate intake rates in units of grams per kilogram of body weight per day (g/kg-day). The data were weighted according to the 4-year, 2-day sample weights provided in the 2003−2006 NHANES to adjust the data for the sample population to reflect the national population.

Intake data from the NHANES were based on uncooked forms of the edible portion of the food items/groups. Summary statistics, including: number of individuals represented in the estimates, mean intake rate, and standard error of the mean intake rate were calculated for total foods. Percentiles of the intake rate distribution (i.e., 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th, 99th, and the maximum value) were also provided. The data represent per capita data. However, the intake rates are the same as those for consumers only because all survey respondents ate some type of food during the survey period. Data were provided for the following age groups: <1 year, 1 to <3 years, 3 to <6 years, 6 to <13 years, 13 to <20 years, 20 to <50 years, ≥50 years, females only—13 to 49 years, and all ages combined. Data were also generated for various racial/ethnic groups (i.e., Mexican American, non-Hispanic Black, non-Hispanic White, other Hispanic, and other race). Table 14-12 presents intake data for total foods in g/kg-day from the 2003−2006 NHANES analysis for these age groups and racial/ethnic groups.

The strength of U.S. EPA's analysis is that it provides distributions of total food intake for various age groups of children and adults, normalized by body weight. The analysis uses the 2003−2006 NHANES data set, which was designed to be representative of the U.S. population. The data set includes 4 years of intake data combined, and is based on a 2-day survey period. Because these data were developed for use in U.S. EPA's pesticide registration program, the childhood age groups used are slightly different than those recommended in U.S. EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). However, given the similarities in the age groups used, the data should provide suitable intake estimates for the age groups of interest. The data for infants <12 months could not be separated out into the recommended age groups due to sample size limitations. This analysis generated data for total foods only. Analyses to estimate the proportion of total food intake represented by the various food groups were not conducted for this data set.

14.4. REFERENCES FOR CHAPTER 14

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Table 14-3. Per Capita Total Food Intake, Edible Portion, Uncooked[a]

Age Group	*N* cons.[b]	*N* Total[c]	PC (%)	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Total Food Intake (g/day)															
Birth to <1 month	59	88	67.0	67	59	0	0	0	0	67	108	142	221	222	222
1 to <3 months	183	245	74.7	80	70	0	0	0	0	94	120	168	188	273	404
3 to <6 months	385	411	93.7	197	150	0	0	12	100	167	286	385	476	705	1,151
6 to <12 months	676	678	99.7	507	344	34	141	191	283	413	600	925	1,220	1,823	2,465
1 to <2 years	1,002	1,002	100	1,039	407	216	414	570	770	998	1,244	1,556	1,756	2,215	3,605
2 to <3 years	994	994	100	1,024	377	312	491	575	752	994	1,257	1,517	1,649	2,071	2,737
3 to <6 years	4,112	4,112	100	1,066	380	416	548	629	805	1,020	1,276	1,548	1,746	2,168	4,886
6 to <11 years	1,553	1,553	100	1,118	372	438	586	680	846	1,052	1,344	1,642	1,825	2,218	3,602
11 to <16 years	975	975	100	1,209	499	343	536	657	851	1,124	1,491	1,860	2,179	2,668	4,548
16 to <21 years	743	743	100	1,184	634	308	467	556	750	1,061	1,447	1,883	2,283	3,281	8,840
21 to <40 years	2,950	2,950	100	1,100	518	-	493	579	778	1,040	1,390	1,780	2,110	3,120	5,640
40 to <70 years	4,818	4,818	100	1,100	468	-	472	567	766	1,030	1,350	1,710	1,930	2,480	4,320
70 years and older	1,393	1,393	100	1,000	430	-	449	549	741	982	1,280	1,560	1,820	2,260	3,090
Total Food Intake (g/kg-day)															
Birth to <1 month	59	88	67.0	20	18	0	0	0	0	19	33	43	61	69	69
1 to <3 months	183	245	74.7	16	14	0	0	0	0	18	25	36	40	55	76
3 to <6 months	385	411	93.7	28	21	0	0	2	15	24	38	53	65	107	169
6 to <12 months	676	678	99.7	56	36	3	17	22	33	47	66	99	134	211	233
1 to <2 years	1,002	1,002	100	90	37	17	38	48	65	85	109	137	161	207	265
2 to <3 years	994	994	100	74	29	23	34	39	52	72	92	113	126	146	194
3 to <6 years	4,112	4,112	100	61	24	21	30	34	44	57	73	91	102	132	239
6 to <11 years	1,553	1,553	100	40	17	10	17	21	28	38	49	61	70	88	122
11 to <16 years	975	975	100	24	11	5	9	11	16	22	30	38	45	55	82
16 to <21 years	743	743	100	18	9	5	6	8	12	16	22	30	35	47	115
20 to <40 years	2,950	2,950	100	16	7	-	6	8	11	15	20	25	30	38	70
40 to <70 years	4,818	4,818	100	14	6	-	6	7	10	14	18	23	26	34	75
70 years and older	1,393	1,393	100	15	6	-	6	8	10	14	19	24	27	35	47

[a] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts (and nut products) were not included because they could not be categorized into the major food groups.
[b] Number of consumers. The number of consumers of total food may be less than the number of individuals in the study sample for the youngest age groups because human milk was not included in the total food intake estimates presented here.
[c] Sample size.
PC = Percent consuming.
SE = Standard error.
\- = Value not available.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, edible portion, uncooked)

Food Group	*N* cons[a]	*N* total[b]	PC (%)	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Age Group: Birth to <1 month															
Total Food Intake[c]	59	88	67.0	67	59	0	0	0	0	67	108	142	221	222	222
Total Dairy Intake	51	88	58.0	41	38	0	0	0	0	40	72	81	156	156	156
Total Meat Intake	0	88	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	88	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	88	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	5	88	5.7	-	-	-	-	-	-	-	-	-	-	-	-
Total Vegetable Intake	27	88	30.7	5	23	0	0	0	0	0	0.29	16	32	108	125
Total Fruit Intake	2	88	2.3	-	-	-	-	-	-	-	-	-	-	-	-
Total Fat Intake	58	88	65.9	19	16	0	0	0	0	20	32	38	64	64	64
Age Group: 1 to <3 months															
Total Food Intake[c]	183	245	74.7	80	70	0	0	0	0	94	120	168	188	273	404
Total Dairy Intake	147	245	60.0	37	40	0	0	0	0	19	72	89	103	129	155
Total Meat Intake	1	245	0.4	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	245	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	245	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	44	245	18.0	1	5	0	0	0	0	0	0	3	9	20	45
Total Vegetable Intake	88	245	35.9	15	33	0	0	0	0	0	0.92	74	94	119	211
Total Fruit Intake	23	245	9.4	4	21	0	0	0	0	0	0	0	31	114	171
Total Fat Intake	176	245	71.8	21	17	0	0	0	0	27	34	42	49	65	72
Age Group: 3 to <6 months															
Total Food Intake[c]	385	411	93.7	197	150	0	0	12	100	167	286	385	476	705	1,151
Total Dairy Intake	308	411	74.9	56	56	0	0	0	0	60	85	109	124	260	496
Total Meat Intake	44	411	10.7	2	7	0	0	0	0	0	0	1	13	29	92
Total Egg Intake	28	411	6.8	0.23	3	0	0	0	0	0	0	0	0.49	4	50
Total Fish Intake	1	411	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	284	411	69.1	8	11	0	0	0	0	4	11	21	27	44	68
Total Vegetable Intake	263	411	64.0	34	46	0	0	0	0	13	58	102	120	184	226
Total Fruit Intake	218	411	53.0	68	102	0	0	0	0	15	99	196	282	522	750
Total Fat Intake	357	411	86.9	28	17	0	0	0	20	30	38	45	53	81	106

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, edible portion, uncooked) (continued)

Food Group	*N* cons.[a]	*N* total[b]	PC (%)	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Age Group: 6 to <12 months															
Total Food Intake[c]	676	678	99.7	507	344	34	141	191	283	413	600	925	1,220	1,823	2,465
Total Dairy Intake	628	678	92.6	151	246	0	0	1.0	26	71	124	401	722	1,297	1,873
Total Meat Intake	500	678	73.7	22	27	0	0	0	0	14	32	59	78	117	269
Total Egg Intake	352	678	51.9	6	13	0	0	0	0	0	2	22	42	73	103
Total Fish Intake	34	678	5.0	0.62	3	0	0	0	0	0	0	0	0	21	42
Total Grain Intake	653	678	96.3	33	28	0	0.83	6	14	28	45	66	84	125	260
Total Vegetable Intake	662	678	97.6	91	67	0	2	14	41	81	127	180	231	285	452
Total Fruit Intake	639	678	94.2	169	142	0	0	17	70	147	232	335	425	670	1,254
Total Fat Intake	661	678	97.5	31	16	0	2	7	23	31	40	51	58	81	90
Age Group: 1 to <2 years															
Total Food Intake[c]	1,002	1,002	100	1,039	407	216	414	570	770	998	1,244	1,556	1,756	2,215	3,605
Total Dairy Intake	999	1,002	99.7	489	332	1	38	94	241	451	681	917	1,090	1,474	2,935
Total Meat Intake	965	1,002	96.3	47	37	0	0	6	20	39	66	100	120	181	221
Total Egg Intake	906	1,002	90.4	14	21	0	0	0	1	4	23	45	57	86	212
Total Fish Intake	188	1,002	18.8	3	10	0	0	0	0	0	0	11	21	45	135
Total Grain Intake	997	1,002	99.5	66	34	8	19	27	42	60	83	111	126	172	209
Total Vegetable Intake	1,000	1,002	99.8	120	75	9	25	37	68	107	155	220	255	402	739
Total Fruit Intake	986	1,002	98.4	254	204	0	4	30	99	209	349	532	664	828	1,762
Total Fat Intake	1,002	1,002	100	39	17	8	15	20	28	37	48	62	69	87	146
Age Group: 2 to <3 years															
Total Food Intake[c]	994	994	100	1,024	377	312	491	575	752	994	1,257	1,517	1,649	2,071	2,737
Total Dairy Intake	994	994	100	383	243	6	54	104	201	346	510	709	838	1,079	1,378
Total Meat Intake	981	994	98.7	60	41	0	8	14	31	51	80	115	139	199	280
Total Egg Intake	943	994	94.9	18	24	0	0	0	1	7	27	50	60	93	169
Total Fish Intake	190	994	19.1	4	12	0	0	0	0	0	0	13	26	53	127
Total Grain Intake	993	994	99.9	81	35	16	32	41	58	78	99	126	147	195	263
Total Vegetable Intake	994	994	100	145	89	18	45	57	86	128	178	249	302	431	846
Total Fruit Intake	970	994	97.6	279	230	0	2	25	117	231	382	594	750	992	2,042
Total Fat Intake	994	994	100	42	18	11	17	22	30	40	51	65	73	101	129

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, edible portion, uncooked) (continued)															
Food Group	*N* cons.[a]	*N* total[b]	PC (%)	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age Group: 3 to <6 years															
Total Food Intake[c]	4,112	4,112	100	1,066	380	416	548	629	805	1,020	1,276	1,548	1,746	2,168	4,886
Total Dairy Intake	4,112	4,112	100	392	249	14	68	121	224	356	522	706	805	1,151	3,978
Total Meat Intake	4,062	4,112	98.8	73	49	0	11	20	38	65	97	133	163	230	433
Total Egg Intake	3,910	4,112	95.1	16	23	0	0	0	1	6	24	47	59	99	290
Total Fish Intake	801	4,112	19.5	5	16	0	0	0	0	0	0	19	36	71	192
Total Grain Intake	4,111	4,112	100	101	41	29	44	54	72	95	122	155	175	230	410
Total Vegetable Intake	4,111	4,112	100	170	89	30	56	75	109	156	213	280	329	454	915
Total Fruit Intake	4,021	4,112	97.8	243	220	0	2	16	85	196	344	516	642	1,000	2,252
Total Fat Intake	4,112	4,112	100	50	19	14	23	27	36	47	60	74	85	113	167
Age Group: 6 to <11 years															
Total Food Intake[c]	1,553	1,553	100	1,118	372	438	586	680	846	1,052	1,344	1,642	1,825	2,218	3,602
Total Dairy Intake	1,553	1,553	100	408	243	10	63	126	229	371	557	741	837	1,130	2,680
Total Meat Intake	1,533	1,553	98.7	87	56	0	12	24	48	79	116	156	195	268	435
Total Egg Intake	1,490	1,553	95.9	16	22	0	0	0	2	6	22	46	58	107	163
Total Fish Intake	258	1,553	16.6	6	17	0	0	0	0	0	0	23	38	102	169
Total Grain Intake	1,553	1,553	100	119	48	31	54	67	87	114	143	179	201	262	513
Total Vegetable Intake	1,553	1,553	100	210	103	42	76	96	136	193	264	342	410	560	896
Total Fruit Intake	1,515	1,553	97.6	193	184	0	1	8	60	141	280	440	545	880	1,406
Total Fat Intake	1,553	1,553	100	58	22	16	27	33	42	56	70	86	95	121	168
Age Group: 11 to <16 years															
Total Food Intake[c]	975	975	100	1,209	499	343	536	657	851	1,124	1,491	1,860	2,179	2,668	4,548
Total Dairy Intake	975	975	100	368	291	1	25	43	152	307	507	740	948	1,401	1,972
Total Meat Intake	970	975	99.5	114	75	1	18	32	63	101	154	208	244	355	578
Total Egg Intake	930	975	95.4	19	27	0	0	0	2	7	25	53	72	123	244
Total Fish Intake	167	975	17.1	9	24	0	0	0	0	0	0	30	62	125	227
Total Grain Intake	975	975	100	136	63	33	56	70	93	127	168	212	249	333	645
Total Vegetable Intake	975	975	100	280	146	65	105	124	176	246	352	472	552	713	1,333
Total Fruit Intake	923	975	94.7	195	202	0	0	0.68	31	135	273	483	635	930	1,535
Total Fat Intake	975	975	100	69	33	18	28	34	47	64	83	110	131	176	321
Age Group: 16 to <21 years															
Total Food Intake[c]	743	743	100	1,184	634	308	467	556	750	1,061	1,447	1,883	2,283	3,281	8,840
Total Dairy Intake	742	743	99.9	283	279	0	8	19	63	196	410	649	934	1,235	1,866
Total Meat Intake	730	743	98.3	139	127	0	12	28	64	116	185	266	310	458	2,343
Total Egg Intake	703	743	94.6	21	30	0	0		1	7	29	59	89	126	223
Total Fish Intake	143	743	19.2	10	33	0	0	0	0	0	0	34	76	146	399
Total Grain Intake	743	743	100	150	93	13	48	58	88	132	190	256	307	543	730
Total Vegetable Intake	743	743	100	325	204	43	86	128	194	280	400	562	683	1,160	2,495
Total Fruit Intake	671	743	90.3	168	237	0	0	0	3	74	242	432	665	1,023	2,270
Total Fat Intake	743	743	100	74	42	13	22	30	46	67	94	129	148	213	391

Table 14-4. Per Capita Intake of Total Food and Intake of Major Food Groups (g/day, edible portion, uncooked) (continued)

Food Group	*N* cons.[a]	*N* total[b]	PC (%)	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Age Group: 20 years and older															
Total Food Intake[c]	9,161	9,161	100	1,110	481	-	477	570	769	1,030	1,360	1,730	2,010	2,650	5,640
Total Dairy Intake	9,161	9,143	99.8	221	228	-	9	20	60	153	312	509	643	1,020	3,720
Total Meat Intake	9,161	9,005	98.3	130	90	-	15	35	65	111	171	246	299	457	1,010
Total Egg Intake	9,161	8,621	94.1	24	32	-	0	0.13	2	10	36	63	87	129	445
Total Fish Intake	9,161	2,648	28.9	15	36	-	0	0	0	0	12	56	86	162	434
Total Grain Intake	9,161	9,152	99.9	136	84	-	42	53	79	116	167	238	297	462	1,110
Total Vegetable Intake	9,161	9,161	100	309	171	-	91	124	191	281	394	525	626	850	1,810
Total Fruit Intake	9,161	8,566	93.5	191	224	-	0	0	18	125	280	473	625	996	2,690
Total Fat Intake	9,161	9,161	100	64	34	-	20	26	39	57	81	109	127	178	359

[a] Number of consumers. The number of consumers of total food may be less than the number of individuals in the study sample for the youngest age groups because human milk was not included in the total food intake estimates presented here.

[b] Sample size.

[c] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.

PC = Percent consuming.

SE = Standard error.

\- = Value not available or data not reported where the number of consumers was less than 20.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, edible portion, uncooked)

Food Group	*N* cons[a]	*N* total[b]	PC (%)	Mean	SE	Percentile									
						1	5	10	25	50	75	90	95	99	Max
Age Group: Birth to <1 month															
Total Food Intake[c]	59	88	67.0	20	18	0	0	0	0	19	33	43	61	69	69
Total Dairy Intake	51	88	58.0	12	12	0	0	0	0	13	21	25	43	49	49
Total Meat Intake	0	88	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	88	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	88	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	5	88	5.7	-	-	-	-	-	-	-	-	-	-	-	-
Total Vegetable Intake	27	88	30.7	2	6	0	0	0	0	0	0	4	12	30	35
Total Fruit Intake	2	88	2.3	-	-	-	-	-	-	-	-	-	-	-	-
Total Fat Intake	58	88	65.9	6	5	0	0	0	0	6	9	11	18	20	20
Age Group: 1 to <3 months															
Total Food Intake[c]	183	245	74.7	16	14	0	0	0	0	18	25	36	40	55	76
Total Dairy Intake	147	245	60.0	8	9	0	0	0	0	4	15	20	26	34	43
Total Meat Intake	1	245	0.4	-	-	-	-	-	-	-	-	-	-	-	-
Total Egg Intake	0	245	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Fish Intake	0	245	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	44	245	18.0	0	1	0	0	0	0	0	0	1	2	3	9
Total Vegetable Intake	88	245	35.9	3	6	0	0	0	0	0	0	13	17	26	34
Total Fruit Intake	23	245	9.4	1	5	0	0	0	0	0	0	0	7	19	43
Total Fat Intake	176	245	71.8	4	4	0	0	0	0	5	7	9	11	14	18
Age Group: 3 to <6 months															
Total Food Intake[c]	385	411	93.7	28	21	0	0	2	15	24	38	53	65	107	169
Total Dairy Intake	308	411	74.9	8	8	0	0	0	0	8	12	16	20	38	73
Total Meat Intake	44	411	10.7	0	1	0	0	0	0	0	0	0	1	4	13
Total Egg Intake	28	411	6.8	0	0	0	0	0	0	0	0	0	0	1	4
Total Fish Intake	1	411	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Total Grain Intake	284	411	69.1	1	2	0	0	0	0	1	1	3	4	6	10
Total Vegetable Intake	263	411	64.0	5	7	0	0	0	0	2	8	14	18	25	52
Total Fruit Intake	218	411	53.0	9	15	0	0	0	0	2	13	29	37	72	110
Total Fat Intake	357	411	86.9	4	3	0	0	0	2	4	6	7	8	12	17

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, edible portion, uncooked) (continued)

Food Group	*N* cons[a]	*N* total[b]	PC (%)	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Age Group: 6 to <12 months															
Total Food Intake[c]	676	678	99.7	56	36	3	17	22	33	47	66	99	134	211	233
Total Dairy Intake	628	678	92.6	16	26	0	0	0	3	8	14	38	72	165	180
Total Meat Intake	500	678	73.7	2	3	0	0	0	0	1	4	6	8	12	30
Total Egg Intake	352	678	51.9	1	1	0	0	0	0	0	0	2	4	7	11
Total Fish Intake	34	678	5.0	0	0	0	0	0	0	0	0	0	0	2	4
Total Grain Intake	653	678	96.3	4	3	0	0	1	2	3	5	7	9	14	26
Total Vegetable Intake	662	678	97.6	10	8	0	0	2	5	9	14	20	25	34	67
Total Fruit Intake	639	678	94.2	19	16	0	0	2	8	16	26	36	46	84	138
Total Fat Intake	661	678	97.5	3	2	0	0	1	2	3	4	6	7	8	10
Age Group: 1 to <2 years															
Total Food Intake[c]	1,002	1,002	100	90	37	17	38	48	65	85	109	137	161	207	265
Total Dairy Intake	999	1,002	99.7	43	30	0	3	8	20	38	59	83	100	137	216
Total Meat Intake	965	1,002	96.3	4	3	0	0	1	2	3	6	8	10	14	21
Total Egg Intake	906	1,002	90.4	1	2	0	0	0	0	0	2	4	5	7	15
Total Fish Intake	188	1,002	18.8	0	1	0	0	0	0	0	0	1	2	3	12
Total Grain Intake	997	1,002	99.5	6	3	1	2	2	4	5	7	9	11	15	19
Total Vegetable Intake	1,000	1,002	99.8	10	7	1	2	3	6	9	14	19	22	33	61
Total Fruit Intake	986	1,002	98.4	22	18	0	0	3	9	18	31	44	58	81	144
Total Fat Intake	1,002	1,002	100	3	2	0.73	1	2	2	3	4	5	6	8	11
Age Group: 2 to <3 years															
Total Food Intake[c]	994	994	100	74	29	23	34	39	52	72	92	113	126	146	194
Total Dairy Intake	994	994	100	28	18	0	4	7	14	24	37	52	63	84	108
Total Meat Intake	981	994	98.7	4	3	0	1	1	2	4	6	8	9	14	20
Total Egg Intake	943	994	94.9	1	2	0	0	0	0	0	2	4	4	6	13
Total Fish Intake	190	994	19.1	0	1	0	0	0	0	0	0	1	2	4	11
Total Grain Intake	993	994	99.9	6	3	1	2	3	4	5	7	9	10	14	28
Total Vegetable Intake	994	994	100	10	6	1	3	4	6	9	13	18	22	34	64
Total Fruit Intake	970	994	97.6	20	17	0	0	2	8	16	27	44	56	71	114
Total Fat Intake	994	994	100	3	1	1	1	1	2	3	4	5	5	7	9

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, edible portion, uncooked) (continued)

Food Group	*N* cons[a]	*N* total[b]	PC (%)	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Age Group: 3 to <6 years															
Total Food Intake[c]	4,112	4,112	100	61	24	21	30	34	44	57	73	91	102	132	239
Total Dairy Intake	4,112	4,112	100	22	15	1	4	7	12	20	30	41	48	66	195
Total Meat Intake	4,062	4,112	98.8	4	3	0	1	1	2	4	5	8	9	13	23
Total Egg Intake	3,910	4,112	95.1	1	1	0	0	0	0	0	1	3	3	5	13
Total Fish Intake	801	4,112	19.5	0	1	0	0	0	0	0	0	1	2	4	12
Total Grain Intake	4,111	4,112	100	6	3	2	2	3	4	5	7	9	10	14	27
Total Vegetable Intake	4,111	4,112	100	10	5	2	3	4	6	9	12	16	19	26	60
Total Fruit Intake	4,021	4,112	97.8	14	13	0	0	1	5	11	20	30	39	57	124
Total Fat Intake	4,112	4,112	100	3	1	1	1	2	2	3	3	4	5	6	10
Age Group: 6 to <11 years															
Total Food Intake[c]	1,553	1,553	100	40	17	10	17	21	28	38	49	61	70	88	122
Total Dairy Intake	1,553	1,553	100	15	10	0	2	4	7	13	20	27	33	42	79
Total Meat Intake	1,533	1,553	98.7	3	2	0	0	1	2	3	4	6	7	10	18
Total Egg Intake	1,490	1,553	95.9	1	1	0	0	0	0	0	1	2	2	4	8
Total Fish Intake	258	1,553	16.6	0	1	0	0	0	0	0	0	1	1	3	7
Total Grain Intake	1,553	1,553	100	4	2	1	2	2	3	4	5	7	8	11	16
Total Vegetable Intake	1,553	1,553	100	7	4	1	2	3	5	7	9	12	15	20	50
Total Fruit Intake	1,515	1,553	97.6	7	7	0	0	0	2	5	10	16	21	32	55
Total Fat Intake	1,553	1,553	100	2	1	1	1	1	1	2	3	3	4	5	9
Age Group: 11 to <16 years															
Total Food Intake[c]	975	975	100	24	11	5	9	11	16	22	30	38	45	55	82
Total Dairy Intake	975	975	100	7	6	0	0	1	3	6	10	15	20	29	38
Total Meat Intake	970	975	99.5	2	1	0	0	1	1	2	3	4	5	7	10
Total Egg Intake	930	975	95.4	0	1	0	0	0	0	0	0	1	1	3	7
Total Fish Intake	167	975	17.1	0	0	0	0	0	0	0	0	1	1	2	7
Total Grain Intake	975	975	100	3	1	1	1	1	2	2	3	5	5	7	9
Total Vegetable Intake	975	975	100	5	3	1	2	2	3	5	7	9	11	14	31
Total Fruit Intake	923	975	94.7	4	4	0	0	0	1	3	6	10	14	18	32
Total Fat Intake	975	975	100	1	1	0	0	1	1	1	2	2	3	4	5

Table 14-5. Per Capita Intake of Total Food and Intake of Major Food Groups (g/kg-day, edible portion, uncooked) (continued)

Food Group	*N* cons[a]	*N* total[b]	PC (%)	Mean	SE	Percentile 1	5	10	25	50	75	90	95	99	Max
Age Group: 16 to <21 years															
Total Food Intake[c]	743	743	100	18	9	5	6	8	12	16	22	30	35	47	115
Total Dairy Intake	742	743	99.9	4	4	0	0	0	1	3	6	10	12	19	25
Total Meat Intake	730	743	98.3	2	2	0	0	0	1	2	3	4	5	7	30
Total Egg Intake	703	743	94.6	0	0	0	0	0	0	0	0	1	1	2	3
Total Fish Intake	143	743	19.2	0	1	0	0	0	0	0	0	1	1	2	7
Total Grain Intake	743	743	100	2	1	0	1	1	1	2	3	4	5	7	12
Total Vegetable Intake	743	743	100	5	3	1	1	2	3	4	6	8	10	15	32
Total Fruit Intake	671	743	90.3	3	4	0	0	0	0	1	4	7	10	16	29
Total Fat Intake	743	743	100	1	1	0	0	0	1	1	1	2	2	3	5
Age Group: 20 years and older															
Total Food Intake[c]	9,161	9,161	100	15	7	-	6	8	10	14	19	24	28	37	75
Total Dairy Intake	9,161	9,143	99.8	3	3	-	0	0	1	2	4	7	9	14	41
Total Meat Intake	9,161	9,005	98.3	2	1	-	0	0	1	2	2	3	4	6	13
Total Egg Intake	9,161	8,621	94.1	0	0	-	0	0	0	0	0	1	1	2	8
Total Fish Intake	9,161	2,648	28.9	0	0	-	0	0	0	0	0	1	1	2	8
Total Grain Intake	9,161	9,152	100	2	1	-	1	1	1	2	2	3	4	6	16
Total Vegetable Intake	9,161	9,161	100	4	2	-	1	2	3	4	5	7	9	12	28
Total Fruit Intake	9,161	8,566	93.5	3	3	-	0	0	0	2	4	7	9	15	52
Total Fat Intake	9,161	9,161	100	1	0	-	0	0	1	1	1	1	2	2	4

[a] Number of consumers. The number of consumers of total food may be less than the number of individuals in the study sample for the youngest age groups because human milk was not included in the total food intake estimates presented here.
[b] Sample size.
[c] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.
PC = Percent consuming.
SE = Standard error.
\- = Data not reported where the number of consumers was less than 20.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Food Intake

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/day)							Age Group: Birth to <1 month (g/kg-day)						
Total Foods[a]	0	0.0	64	100.0	196	100.0	Total Foods[a]	0	0.0	20	100.0	58	100.0
Total Dairy	0	0.0	39	61.2	109	55.4	Total Dairy	0	0.0	14	70.5	35	60.1
Total Meats	0	0.0	0	0.0	0	0.0	Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0	Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0	Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.0	0	0.0	4	2.1	Total Grains	0	0.0	0	0.0	1	2.1
Total Vegetables	0	0.0	5	7.4	24	12.1	Total Vegetables	0	0.0	0	0.1	6	10.0
Total Fruits	0	0.0	0	0.0	8	4.1	Total Fruits	0	0.0	0	0.0	0	0.0
Total Fats[b]	0	0.0	19	29.4	52	26.2	Total Fats[b]	0	0.0	6	29.4	16	27.8
Age Group: 1 to <3 months (g/day)							Age Group: 1 to <3 months (g/kg-day)						
Total Foods[a]	0	0.0	94	100.0	206	100.0	Total Foods[a]	0	0.0	18	100.0	44	100.0
Total Dairy	0	0.0	53	56.9	63	30.8	Total Dairy	0	0.0	9	51.9	20	45.4
Total Meats	0	0.0	0	0.0	0	0.0	Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0	Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0	Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.0	1	1.1	3	1.3	Total Grains	0	0.0	0	1.1	0	0.5
Total Vegetables	0	0.0	11	12.0	58	28.4	Total Vegetables	0	0.0	3	18.9	7	16.4
Total Fruits	0	0.0	0	0.0	27	13.0	Total Fruits	0	0.0	0	0.0	5	12.3
Total Fats[b]	0	0.0	27	28.4	49	23.6	Total Fats[b]	0	0.0	5	27.7	11	24.4
Age Group: 3 to <6 months (g/day)							Age Group: 3 to <6 months (g/kg-day)						
Total Foods[a]	1	100.0	166	100.0	507	100.0	Total Foods[a]	0	100.0	24	100.0	73	100.0
Total Dairy	0	3.0	69	41.9	90	17.8	Total Dairy	0	0.5	9	37.3	13	17.9
Total Meats	0	0.0	0	0.2	4	0.8	Total Meats	0	0.0	0	0.5	1	0.8
Total Fish	0	0.0	0	0.0	0	0.1	Total Fish	0	0.0	0	0.0	0	0.1
Total Eggs	0	0.0	1	0.3	1	0.1	Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	1	74.5	8	4.9	14	2.8	Total Grains	0	85.0	1	4.0	2	3.4
Total Vegetables	0	10.9	27	16.3	73	14.4	Total Vegetables	0	7.4	5	20.8	11	14.5
Total Fruits	0	9.9	24	14.6	284	56.0	Total Fruits	0	6.7	4	15.0	40	55.0
Total Fats[b]	0	1.3	34	20.4	36	7.2	Total Fats[b]	0	0.2	5	21.3	5	7.5

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Food Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/day)						
Total Foods[a]	124	100.0	414	100.0	1,358	100.0
Total Dairy	33	26.4	72	17.5	770	56.7
Total Meats	3	2.4	19	4.6	47	3.5
Total Fish	0	0.2	1	0.3	0	0.0
Total Eggs	1	0.5	7	1.6	8	0.6
Total Grains	11	9.1	37	8.9	50	3.7
Total Vegetables	30	24.2	90	21.9	121	8.9
Total Fruits	30	24.4	151	36.5	314	23.1
Total Fats[b]	14	11.6	35	8.4	44	3.2
Age Group: 1 to <2 years (g/day)						
Total Foods[a]	407	100.0	998	100.0	1,859	100.0
Total Dairy	113	27.8	487	48.8	1,008	54.2
Total Meats	28	6.9	46	4.6	66	3.5
Total Fish	1	0.3	3	0.3	4	0.2
Total Eggs	9	2.2	16	1.6	22	1.2
Total Grains	44	10.8	63	6.3	81	4.3
Total Vegetables	82	20.1	101	10.2	165	8.9
Total Fruits	100	24.6	238	23.8	446	24.0
Total Fats[b]	24	5.8	38	3.8	61	3.3
Age Group: 2 to <3 years (g/day)						
Total Foods[a]	448	100.0	989	100.0	1,760	100.0
Total Dairy	118	26.3	370	37.4	698	39.7
Total Meats	50	11.1	60	6.1	72	4.1
Total Fish	1	0.3	4	0.4	7	0.4
Total Eggs	12	2.7	14	1.4	24	1.4
Total Grains	62	13.7	86	8.7	98	5.6
Total Vegetables	98	21.9	145	14.6	185	10.5
Total Fruits	70	15.6	255	25.8	609	34.6
Total Fats[b]	31	6.8	44	4.4	56	3.2

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/kg-day)						
Total Foods[a]	15	100.0	47	100.0	144	100.0
Total Dairy	4	25.4	6	13.8	77	53.1
Total Meats	0	2.3	2	4.9	5	3.4
Total Fish	0	0.2	0	0.2	0	0.0
Total Eggs	0	0.9	1	1.5	1	0.8
Total Grains	2	10.7	4	9.1	5	3.6
Total Vegetables	3	21.9	10	22.4	14	9.8
Total Fruits	4	25.9	19	40.0	37	25.8
Total Fats[b]	2	11.4	4	7.5	5	3.2
Age Group: 1 to <2 years (g/kg-day)						
Total Foods[a]	35	100.0	85	100.0	167	100.0
Total Dairy	10	29.5	41	48.1	94	56.1
Total Meats	3	7.5	4	4.7	5	3.2
Total Fish	0	0.4	1	0.5	0	0.2
Total Eggs	1	2.1	1	1.4	2	0.9
Total Grains	4	10.9	5	6.0	7	4.3
Total Vegetables	7	18.6	10	11.9	13	7.8
Total Fruits	8	23.0	19	22.8	40	24.0
Total Fats[b]	2	6.4	3	3.8	5	3.2
Age Group: 2 to <3 years (g/kg-day)						
Total Foods[a]	32	100.0	72	100.0	129	100.0
Total Dairy	8	24.8	26	36.3	54	42.2
Total Meats	4	11.2	4	5.3	5	3.8
Total Fish	0	0.4	0	0.2	0	0.3
Total Eggs	1	3.6	1	1.7	2	1.3
Total Grains	4	13.8	6	8.0	7	5.6
Total Vegetables	7	22.0	10	13.3	13	10.0
Total Fruits	5	16.2	21	29.8	42	32.9
Total Fats[b]	2	7.1	3	3.9	4	3.2

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Food Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/day)							Age Group: 3 to <6 years (g/kg-day)						
Total Foods[a]	527	100.0	1,020	100.0	1,817	100.0	Total Foods[a]	28	100.0	57	100.0	108	100.0
Total Dairy	144	27.3	378	37.0	728	40.1	Total Dairy	8	27.3	21	36.3	43	40.3
Total Meats	53	10.0	72	7.0	94	5.2	Total Meats	3	10.4	4	7.1	5	4.8
Total Fish	3	0.6	5	0.5	9	0.5	Total Fish	0	0.5	0	0.5	0	0.4
Total Eggs	11	2.0	15	1.5	24	1.3	Total Eggs	1	2.1	1	1.6	1	1.1
Total Grains	76	14.4	103	10.1	132	7.3	Total Grains	4	14.0	6	9.9	8	7.1
Total Vegetables	117	22.3	163	16.0	233	12.8	Total Vegetables	6	22.0	9	16.0	14	12.5
Total Fruits	76	14.4	216	21.2	509	28.0	Total Fruits	4	15.2	13	22.1	31	29.0
Total Fats[b]	34	6.5	50	4.9	68	3.7	Total Fats[b]	2	6.4	3	4.8	4	3.7
Age Group: 6 to <11 years (g/day)							Age Group: 6 to <11 years (g/kg-day)						
Total Foods[a]	565	100.0	1,060	100.0	1,886	100.0	Total Foods[a]	16	100.0	38	100.0	73	100.0
Total Dairy	147	26.1	370	34.9	766	40.6	Total Dairy	4	26.2	15	38.6	30	40.8
Total Meats	65	11.4	95	9.0	104	5.5	Total Meats	2	11.9	3	8.1	4	5.9
Total Fish	2	0.3	6	0.6	10	0.5	Total Fish	0	0.5	0	0.5	0	0.4
Total Eggs	10	1.7	16	1.5	22	1.2	Total Eggs	0	1.8	1	1.6	1	1.3
Total Grains	89	15.8	116	10.9	157	8.3	Total Grains	2	14.7	4	10.8	7	9.0
Total Vegetables	136	24.1	203	19.2	294	15.6	Total Vegetables	4	24.7	7	18.0	11	15.5
Total Fruits	66	11.6	178	16.8	426	22.6	Total Fruits	2	11.2	6	14.9	15	21.2
Total Fats[b]	39	6.8	58	5.5	76	4.0	Total Fats[b]	1	7.3	2	5.3	3	4.3
Age Group: 11 to <16 years (g/day)							Age Group: 11 to <16 years (g/kg-day)						
Total Foods[a]	513	100.0	1,127	100.0	2,256	100.0	Total Foods[a]	8	100.0	22	100.0	46	100.0
Total Dairy	92	17.9	308	27.3	808	35.8	Total Dairy	1	17.3	6	26.9	18	38.4
Total Meats	71	13.9	116	10.3	172	7.6	Total Meats	1	14.7	2	10.3	3	7.0
Total Fish	4	0.8	7	0.6	16	0.7	Total Fish	0	0.9	0	0.8	0	0.8
Total Eggs	10	1.9	20	1.8	28	1.2	Total Eggs	0	1.8	0	2.2	1	1.3
Total Grains	84	16.3	133	11.8	207	9.2	Total Grains	1	16.6	3	11.7	4	9.3
Total Vegetables	162	31.6	258	22.9	459	20.3	Total Vegetables	3	31.7	5	23.4	9	18.4
Total Fruits	42	8.2	203	18.0	420	18.6	Total Fruits	1	7.2	4	17.4	8	18.2
Total Fats[b]	40	7.8	64	5.7	114	5.0	Total Fats[b]	1	8.3	1	5.9	2	4.8

Table 14-6. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Food Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 16 to <21 years (g/day)							Age Group: 16 to <21 years (g/kg-day)						
Total Foods[a]	438	100.0	1,060	100.0	2,590	100.0	Total Foods[a]	6	100.0	16	100.0	38	100.0
Total Dairy	56	12.8	219	20.7	759	29.3	Total Dairy	1	12.2	4	23.8	10	27.4
Total Meats	61	14.0	141	13.3	272	10.5	Total Meats	1	15.6	2	11.5	4	10.0
Total Fish	7	1.5	11	1.1	14	0.5	Total Fish	0	1.7	0	1.0	0	0.5
Total Eggs	8	1.9	17	1.6	29	1.1	Total Eggs	0	1.8	0	1.6	0	1.1
Total Grains	67	15.2	138	13.0	241	9.3	Total Grains	1	14.8	2	13.1	4	9.9
Total Vegetables	148	33.8	312	29.4	620	23.9	Total Vegetables	2	34.0	5	30.0	10	25.3
Total Fruits	48	11.0	138	13.1	487	18.8	Total Fruits	1	10.2	2	10.9	8	19.7
Total Fats[b]	33	7.6	72	6.8	136	5.3	Total Fats[b]	1	8.1	1	7.1	2	5.0
Age Group: 20 years and older (g/day)							Age Group: 20 years and older (g/kg-day)						
Total Foods[a]	451	100.0	1,030	100.0	2,140	100.0	Total Foods[a]	6	100.0	14	100.0	30	100.0
Total Dairy	55	12.1	188	18.3	520	24.3	Total Dairy	1	12.5	3	19.4	7	24.9
Total Meats	74	16.5	128	12.5	210	9.8	Total Meats	1	17.3	2	12.2	2	8.2
Total Fish	7	1.6	13	1.2	25	1.2	Total Fish	0	1.6	0	1.4	0	0.9
Total Eggs	15	3.2	23	2.3	34	1.6	Total Eggs	0	3.5	0	2.3	0	1.5
Total Grains	69	15.3	130	12.7	230	10.8	Total Grains	1	15.6	2	13.1	3	10.1
Total Vegetables	147	32.6	291	28.4	516	24.2	Total Vegetables	2	32.1	4	28.9	7	23.5
Total Fruits	40	8.9	174	17.0	466	21.8	Total Fruits	0	7.9	2	14.9	7	23.6
Total Fats[b]	34	7.6	60	5.9	105	4.9	Total Fats[b]	0	7.7	1	6.1	1	4.6

a Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.

b Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 14-7. Per Capita Intake of Total Foods[a] and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat Intake

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/day)[c]						
Total Foods[a]	67	100.0	-	-	-	-
Total Dairy	41	61.5	-	-	-	-
Total Meats	0	0.0	-	-	-	-
Total Fish	0	0.0	-	-	-	-
Total Eggs	0	0.0	-	-	-	-
Total Grains	0	0.7	-	-	-	-
Total Vegetables	5	7.7	-	-	-	-
Total Fruits	1	1.3	-	-	-	-
Total Fats[b]	19	28.3	-	-	-	-
Age Group: 1 to <3 months (g/day)[d]						
Total Foods[a]	79	100.0	-	-	149	100.0
Total Dairy	37	46.4	-	-	103	68.9
Total Meats	0	0.0	-	-	1	0.7
Total Fish	0	0.0	-	-	0	0.0
Total Eggs	0	0.0	-	-	0	0.0
Total Grains	1	1.5	-	-	0	0.1
Total Vegetables	15	18.6	-	-	3	2.1
Total Fruits	4	5.2	-	-	0	0.0
Total Fats[b]	21	26.4	-	-	42	28.2
Age Group: 3 to <6 months (g/day)[e]						
Total Foods[a]	181	100.0	-	-	316	100.0
Total Dairy	55	30.1	-	-	62	19.7
Total Meats	0	0.0	-	-	16	4.9
Total Fish	0	0.0	-	-	0	0.1
Total Eggs	0	0.1	-	-	1	0.5
Total Grains	7	3.7	-	-	16	5.0
Total Vegetables	31	17.0	-	-	56	17.9
Total Fruits	59	32.9	-	-	133	42.3
Total Fats[b]	28	15.3	-	-	28	8.9

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/kg-day)[c]						
Total Foods[a]	20	100.0	-	-	-	-
Total Dairy	12	61.6	-	-	-	-
Total Meats	0	0.0	-	-	-	-
Total Fish	0	0.0	-	-	-	-
Total Eggs	0	0.0	-	-	-	-
Total Grains	0	0.7	-	-	-	-
Total Vegetables	2	7.7	-	-	-	-
Total Fruits	0	1.1	-	-	-	-
Total Fats[b]	6	28.4	-	-	-	-
Age Group: 1 to <3 months (g/kg-day)[d]						
Total Foods[a]	16	100.0	-	-	47	100.0
Total Dairy	8	47.9	-	-	32	68.9
Total Meats	0	0.0	-	-	0	0.7
Total Fish	0	0.0	-	-	0	0.0
Total Eggs	0	0.0	-	-	0	0.0
Total Grains	0	1.4	-	-	0	0.1
Total Vegetables	3	16.8	-	-	1	2.1
Total Fruits	1	5.6	-	-	0	0.0
Total Fats[b]	4	26.5	-	-	13	28.2
Age Group: 3 to <6 months (g/kg-day)[e]						
Total Foods[a]	26	100.0	-	-	41	100.0
Total Dairy	8	30.6	-	-	8	20.5
Total Meats	0	0.0	-	-	2	4.9
Total Fish	0	0.0	-	-	0	0.1
Total Eggs	0	0.0	-	-	0	0.3
Total Grains	1	3.7	-	-	2	4.8
Total Vegetables	4	16.9	-	-	7	17.6
Total Fruits	8	32.2	-	-	17	41.7
Total Fats[b]	4	15.6	-	-	4	9.2

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/day)						
Total Foods[a]	347	100.0	466	100.0	922	100.0
Total Dairy	80	23.0	108	23.2	384	41.6
Total Meats	0	0.0	14	2.9	85	9.3
Total Fish	0	0.0	0	0.1	0	0.0
Total Eggs	2	0.5	3	0.6	11	1.2
Total Grains	24	6.8	29	6.2	51	5.6
Total Vegetables	69	19.8	116	24.8	135	14.7
Total Fruits	143	41.3	162	34.8	216	23.4
Total Fats[b]	27	7.7	31	6.7	43	4.6
Age Group: 1 to <2 years (g/day)						
Total Foods[a]	921	100.0	992	100.0	1,229	100.0
Total Dairy	464	50.4	483	48.7	460	37.4
Total Meats	2	0.2	39	4.0	128	10.4
Total Fish	3	0.3	2	0.2	6	0.5
Total Eggs	8	0.9	14	1.5	24	1.9
Total Grains	56	6.1	64	6.5	78	6.4
Total Vegetables	97	10.5	113	11.3	189	15.4
Total Fruits	250	27.2	228	23.0	290	23.6
Total Fats[b]	30	3.3	38	3.8	57	4.6
Age Group: 2 to <3 years (g/day)						
Total Foods[a]	950	100.0	947	100.0	1,131	100.0
Total Dairy	426	44.9	373	39.3	374	33.0
Total Meats	7	0.7	52	5.4	148	13.1
Total Fish	4	0.5	4	0.5	2	0.2
Total Eggs	12	1.3	18	1.9	21	1.9
Total Grains	73	7.7	76	8.1	90	8.0
Total Vegetables	104	10.9	146	15.4	202	17.9
Total Fruits	279	29.4	226	23.8	232	20.5
Total Fats[b]	29	3.0	40	4.2	62	5.5

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/kg-day)						
Total Foods[a]	40	100.0	48	100.0	99	100.0
Total Dairy	9	22.6	11	23.9	41	41.1
Total Meats	0	0.0	1	3.0	9	9.3
Total Fish	0	0.0	0	0.1	0	0.0
Total Eggs	0	0.5	0	1.0	1	0.9
Total Grains	3	6.6	3	6.0	6	5.8
Total Vegetables	8	19.7	10	21.9	15	15.4
Total Fruits	17	41.9	17	36.5	23	23.1
Total Fats[b]	2	7.8	3	7.1	5	4.6
Age Group: 1 to <2 years (g/kg-day)						
Total Foods[a]	82	100.0	90	100.0	108	100.0
Total Dairy	41	49.9	46	50.5	43	40.1
Total Meats	0	0.2	3	3.8	11	10.0
Total Fish	0	0.3	0	0.3	0	0.5
Total Eggs	1	0.8	1	1.4	2	1.9
Total Grains	5	6.1	6	6.1	7	6.9
Total Vegetables	9	11.1	10	10.8	16	15.1
Total Fruits	22	27.3	21	22.7	22	20.8
Total Fats[b]	3	3.3	3	3.8	5	4.7
Age Group: 2 to <3 years (g/kg-day)						
Total Foods[a]	71	100.0	68	100.0	83	100.0
Total Dairy	31	44.2	26	37.7	27	32.3
Total Meats	1	0.7	4	5.5	10	12.4
Total Fish	0	0.5	0	0.3	0	0.2
Total Eggs	1	1.3	1	1.3	2	1.8
Total Grains	6	7.8	6	8.3	7	8.1
Total Vegetables	8	11.1	10	15.1	14	16.8
Total Fruits	21	29.6	18	26.7	19	23.1
Total Fats[b]	2	3.1	3	4.0	4	5.2

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/day)						
Total Foods[a]	991	100.0	1,037	100.0	1,246	100.0
Total Dairy	419	42.3	376	36.3	389	31.2
Total Meats	10	1.0	65	6.3	176	14.1
Total Fish	7	0.7	6	0.5	4	0.3
Total Eggs	10	1.0	16	1.5	24	1.9
Total Grains	98	9.9	101	9.8	117	9.4
Total Vegetables	128	13.0	170	16.4	217	17.4
Total Fruits	257	25.9	238	22.9	243	19.5
Total Fats[b]	35	3.6	48	4.7	73	5.9
Age Group: 6 to <11 years (g/day)						
Total Foods[a]	1,028	100.0	1,087	100.0	1,300	100.0
Total Dairy	424	41.3	386	35.5	382	29.4
Total Meats	11	1.1	79	7.3	206	15.8
Total Fish	6	0.6	5	0.5	4	0.3
Total Eggs	13	1.3	15	1.4	17	1.3
Total Grains	121	11.8	117	10.7	136	10.4
Total Vegetables	164	16.0	212	19.5	270	20.7
Total Fruits	214	20.8	191	17.6	198	15.2
Total Fats[b]	40	3.9	59	5.4	81	6.2
Age Group: 11 to <16 years (g/day)						
Total Foods[a]	1,043	100.0	1,194	100.0	1,606	100.0
Total Dairy	342	32.8	377	31.6	435	27.1
Total Meats	17	1.6	101	8.5	268	16.7
Total Fish	13	1.3	7	0.6	7	0.4
Total Eggs	17	1.6	13	1.1	21	1.3
Total Grains	116	11.1	144	12.1	159	9.9
Total Vegetables	227	21.7	260	21.8	404	25.2
Total Fruits	238	22.8	202	16.9	204	12.7
Total Fats[b]	44	4.2	67	5.6	106	6.6

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/kg-day)						
Total Foods[a]	57	100.0	59	100.0	74	100.0
Total Dairy	24	42.1	23	38.2	23	31.3
Total Meats	1	1.0	4	6.0	10	13.4
Total Fish	0	0.6	0	0.5	0	0.3
Total Eggs	1	1.0	1	1.4	1	2.0
Total Grains	6	9.9	6	9.5	7	9.4
Total Vegetables	7	13.0	9	15.8	13	17.5
Total Fruits	15	26.1	13	22.0	15	20.1
Total Fats[b]	2	3.6	3	4.8	4	5.7
Age Group: 6 to <11 years (g/kg-day)						
Total Foods[a]	36	100.0	39	100.0	51	100.0
Total Dairy	15	41.5	15	38.7	15	29.7
Total Meats	0	1.0	3	7.0	8	14.8
Total Fish	0	0.9	0.32	0.8	0	0.3
Total Eggs	0	1.2	0.42	1.1	1	1.5
Total Grains	4	11.5	4	10.7	5	10.4
Total Vegetables	5	15.1	7	19.1	10	20.2
Total Fruits	8	21.7	6	15.6	8	16.5
Total Fats[b]	1	3.8	2	5.1	3	6.0
Age Group: 11 to <16 years (g/kg-day)						
Total Foods[a]	19	100.0	22	100.0	33	100.0
Total Dairy	6	31.5	6	27.0	10	29.7
Total Meats	0	1.6	2	8.8	5	16.3
Total Fish	0	1.5	0	0.5	0	0.5
Total Eggs	0	1.5	0	1.3	0	1.4
Total Grains	2	11.6	3	11.7	3	10.0
Total Vegetables	4	22.2	5	24.1	8	23.3
Total Fruits	4	23.1	4	18.9	4	11.7
Total Fats[b]	1	4.4	1	5.7	2	6.7

Table 14-7. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 16 to <21 years (g/day)							Age Group: 16 to <21 years (g/kg-day)						
Total Foods[a]	922	100.0	1,084	100.0	1,957	100.0	Total Foods[a]	15	100.0	18	100.0	28	100.0
Total Dairy	307	33.3	280	25.8	403	20.6	Total Dairy	4	30.3	4	24.0	5	18.1
Total Meats	12	1.3	115	10.6	385	19.7	Total Meats	0	1.3	2	9.6	5	19.8
Total Fish	20	2.1	9	0.9	12	0.6	Total Fish	0	2.2	0	1.0	0	0.4
Total Eggs	14	1.5	15	1.4	31	1.6	Total Eggs	0	1.4	0	1.9	0	1.6
Total Grains	131	14.2	147	13.6	231	11.8	Total Grains	2	14.5	2	12.8	3	12.3
Total Vegetables	215	23.3	287	26.5	532	27.2	Total Vegetables	4	24.6	5	27.5	8	28.9
Total Fruits	151	16.4	147	13.5	226	11.6	Total Fruits	3	17.8	3	15.7	3	12.4
Total Fats[b]	42	4.5	73	6.7	139	7.1	Total Fats[b]	1	4.6	1	6.2	2	6.5
Age Group: 20 years and older (g/day)							Age Group: 20 years and older (g/kg-day)						
Total Foods[a]	943	100.0	1,030	100.0	1,560	100.0	Total Foods[a]	14	100.0	15	100.0	21	100.0
Total Dairy	213	22.6	211	20.4	254	16.3	Total Dairy	3	22.6	3	20.7	3	15.9
Total Meats	15	1.6	111	10.8	338	21.7	Total Meats	0	1.6	2	10.3	4	21.3
Total Fish	25	2.6	12	1.2	13	0.8	Total Fish	0	2.6	0	1.3	0	0.9
Total Eggs	17	1.8	21	2.0	33	2.1	Total Eggs	0	1.8	0	2.1	0	2.0
Total Grains	113	12.0	124	12.0	196	12.5	Total Grains	2	11.9	2	12.2	3	12.2
Total Vegetables	259	27.4	282	27.2	446	28.5	Total Vegetables	4	27.3	4	27.6	6	28.2
Total Fruits	234	24.9	192	18.6	165	10.5	Total Fruits	3	25.3	3	18.2	3	12.3
Total Fats[b]	38	4.1	59	5.7	115	7.4	Total Fats[b]	1	4.0	1	5.5	1	7.0

[a] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.

[b] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.

[c] All individuals in this sample group consumed 0 g/day of meat. Therefore, results are reported in the low-end decile.

[d] Only one individual in this sample group consumed more than 0 g/day of meat. This result is reported in the high-end decile. All other samples are reported in the low-end decile.

[e] All individuals in this sample group below the 89th percentile consumed 0 g/day of meat. Therefore, only high-end and low-end consumer groups are reported.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat and Dairy Intake

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/day)						
Total Foods[a]	12	100.0	60	100.0	185	100.0
Total Dairy	0	0.0	40	67.3	127	69.0
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.3	0	0.0	4	2.2
Total Vegetables	8	66.1	2	3.4	1	0.4
Total Fruits	0	0.0	0	0.0	0	0.0
Total Fats[b]	3	27.1	18	29.2	52	28.4
Age Group: 1 to <3 months (g/day)						
Total Foods[a]	36	100.0	84	100.0	166	100.0
Total Dairy	0	0.0	19	22.4	109	65.6
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.9	1	1.2	1	0.8
Total Vegetables	21	58.8	42	50.7	4	2.7
Total Fruits	2	4.3	0	0.0	6	3.7
Total Fats[b]	10	26.7	21	25.4	45	27.2
Age Group: 3 to <6 months (g/day)						
Total Foods[a]	121	100.0	204	100.0	334	100.0
Total Dairy	0	0.0	60	29.7	159	47.7
Total Meats	0	0.0	0	0.3	5	1.4
Total Fish	0	0.0	0	0.0	0	0.1
Total Eggs	0	0.0	0	0.1	1	0.2
Total Grains	5	4.5	7	3.2	12	3.7
Total Vegetables	44	36.4	29	14.5	27	8.0
Total Fruits	52	42.9	80	39.0	74	22.3
Total Fats[b]	15	12.3	27	13.2	54	16.3

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/kg-day)						
Total Foods[a]	4	100.0	18	100.0	56	100.0
Total Dairy	0	0.0	12	67.1	39	69.0
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.2	0	0.0	1	2.1
Total Vegetables	2	64.4	1	3.7	0	0.5
Total Fruits	0	0.0	0	0.0	0	0.0
Total Fats[b]	1	27.5	5	29.2	16	28.4
Age Group: 1 to <3 months (g/kg-day)						
Total Foods[a]	7	100.0	14	100.0	41	100.0
Total Dairy	0	0.0	3	24.0	26	64.1
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.8	0	2.0	0	0.6
Total Vegetables	4	57.8	7	48.7	0	1.1
Total Fruits	0	5.4	0	0.0	3	7.7
Total Fats[b]	2	26.4	4	25.0	11	26.5
Age Group: 3 to <6 months (g/kg-day)						
Total Foods[a]	17	100.0	30	100.0	45	100.0
Total Dairy	0	0.0	8	26.5	24	53.4
Total Meats	0	0.0	0	0.6	1	1.3
Total Fish	0	0.0	0	0.0	0	0.1
Total Eggs	0	0.0	0	0.3	0	0.1
Total Grains	1	4.5	1	3.7	2	3.6
Total Vegetables	6	37.1	3	11.2	2	5.3
Total Fruits	7	41.7	14	46.0	8	17.3
Total Fats[b]	2	12.6	3	11.4	8	18.7

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat and Dairy Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/day)						
Total Foods[a]	253	100.0	403	100.0	1,284	100.0
Total Dairy	1	0.5	71	17.6	827	64.5
Total Meats	1	0.3	17	4.1	45	3.5
Total Fish	0	0.0	1	0.4	0	0.0
Total Eggs	3	1.0	3	0.7	7	0.5
Total Grains	22	8.5	32	8.0	45	3.5
Total Vegetables	95	37.7	82	20.3	108	8.4
Total Fruits	110	43.4	166	41.1	209	16.3
Total Fats[b]	17	6.7	32	8.0	41	3.2
Age Group: 1 to <2 years (g/day)						
Total Foods[a]	569	100.0	1,014	100.0	1,687	100.0
Total Dairy	46	8.0	456	45.0	1,165	69.0
Total Meats	30	5.2	43	4.2	52	3.1
Total Fish	2	0.4	2	0.2	3	0.2
Total Eggs	12	2.0	13	1.3	19	1.1
Total Grains	54	9.5	64	6.3	65	3.8
Total Vegetables	128	22.5	114	11.3	111	6.6
Total Fruits	264	46.4	278	27.4	209	12.4
Total Fats[b]	25	4.5	36	3.6	59	3.5
Age Group: 2 to <3 years (g/day)						
Total Foods[a]	641	100.0	981	100.0	1,546	100.0
Total Dairy	57	9.0	348	35.5	883	57.1
Total Meats	45	6.9	59	6.0	60	3.9
Total Fish	4	0.6	3	0.3	4	0.3
Total Eggs	21	3.2	18	1.9	20	1.3
Total Grains	75	11.8	86	8.7	86	5.6
Total Vegetables	155	24.1	148	15.1	143	9.2
Total Fruits	240	37.5	264	26.9	286	18.5
Total Fats[b]	32	5.0	42	4.3	55	3.6

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/kg-day)						
Total Foods[a]	29	100.0	43	100.0	135	100.0
Total Dairy	0	0.4	8	18.0	87	64.2
Total Meats	0	0.3	2	4.7	5	3.3
Total Fish	0	0.0	0	0.3	0	0.0
Total Eggs	0	1.1	0	0.9	1	0.5
Total Grains	2	8.0	3	7.1	5	3.5
Total Vegetables	11	38.2	9	20.0	12	8.6
Total Fruits	13	43.4	17	40.4	22	16.6
Total Fats[b]	2	6.7	4	8.3	4	3.2
Age Group: 1 to <2 years (g/kg-day)						
Total Foods[a]	51	100.0	82	100.0	155	100.0
Total Dairy	4	7.7	38	45.6	106	68.2
Total Meats	3	5.5	4	5.3	4	2.8
Total Fish	0	0.2	0	0.3	0	0.1
Total Eggs	1	2.1	1	1.6	1	0.9
Total Grains	5	9.5	6	7.2	6	3.7
Total Vegetables	11	22.2	11	13.0	11	6.9
Total Fruits	24	46.6	19	22.7	21	13.7
Total Fats[b]	2	4.5	3	3.8	5	3.4
Age Group: 2 to <3 years (g/kg-day)						
Total Foods[a]	46	100.0	73	100.0	114	100.0
Total Dairy	4	8.2	24	32.6	67	58.3
Total Meats	3	7.4	5	6.5	4	3.8
Total Fish	0	0.4	0	0.3	0	0.2
Total Eggs	1	3.2	1	1.6	2	1.3
Total Grains	5	11.6	6	8.7	7	5.7
Total Vegetables	11	23.6	11	14.9	11	9.5
Total Fruits	18	38.7	22	29.9	19	16.6
Total Fats[b]	2	5.2	3	4.3	4	3.7

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat and Dairy Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/day)						
Total Foods[a]	702	100.0	1,043	100.0	1,646	100.0
Total Dairy	75	10.7	352	33.8	878	53.3
Total Meats	52	7.5	79	7.6	88	5.4
Total Fish	5	0.7	5	0.5	5	0.3
Total Eggs	15	2.2	16	1.5	19	1.2
Total Grains	85	12.0	107	10.2	121	7.3
Total Vegetables	159	22.6	167	16.0	191	11.6
Total Fruits	258	36.7	251	24.1	259	15.8
Total Fats[b]	35	5.0	51	4.9	67	4.1
Age Group: 6 to <11 years (g/day)						
Total Foods[a]	725	100.0	1,061	100.0	1,727	100.0
Total Dairy	76	10.5	366	34.5	883	51.1
Total Meats	66	9.2	91	8.6	105	6.1
Total Fish	6	0.8	7	0.7	6	0.3
Total Eggs	16	2.3	17	1.6	18	1.1
Total Grains	101	13.9	116	10.9	151	8.7
Total Vegetables	202	27.9	205	19.4	245	14.2
Total Fruits	198	27.3	178	16.7	221	12.8
Total Fats[b]	43	6.0	56	5.3	73	4.2
Age Group: 11 to <16 years (g/day)						
Total Foods[a]	727	100.0	1,111	100.0	2,045	100.0
Total Dairy	38	5.2	299	26.9	1,004	49.1
Total Meats	58	8.0	118	10.6	161	7.9
Total Fish	10	1.4	11	1.0	12	0.6
Total Eggs	16	2.2	22	2.0	26	1.3
Total Grains	103	14.2	137	12.4	181	8.9
Total Vegetables	234	32.2	265	23.9	332	16.2
Total Fruits	213	29.3	176	15.8	204	10.0
Total Fats[b]	42	5.8	66	6.0	104	5.1

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/kg-day)						
Total Foods[a]	39	100.0	59	100.0	97	100.0
Total Dairy	4	10.8	20	33.6	52	53.1
Total Meats	3	7.6	4	7.1	5	5.2
Total Fish	0	0.8	0	0.4	0	0.3
Total Eggs	1	2.2	1	1.6	1	1.0
Total Grains	5	12.0	6	10.0	7	7.2
Total Vegetables	9	22.7	10	16.1	11	11.7
Total Fruits	14	36.1	15	25.0	16	16.2
Total Fats[b]	2	5.1	3	4.7	4	4.1
Age Group: 6 to <11 years (g/kg-day)						
Total Foods[a]	21	100.0	38	100.0	68	100.0
Total Dairy	2	11.6	13	34.8	35	51.0
Total Meats	2	9.9	3	8.2	4	5.9
Total Fish	0	0.8	0	0.6	0	0.4
Total Eggs	1	2.4	1	1.4	1	1.0
Total Grains	3	14.1	4	10.9	6	9.2
Total Vegetables	6	27.0	7	18.7	10	14.1
Total Fruits	6	25.9	7	17.8	8	12.4
Total Fats[b]	1	6.2	2	5.4	3	4.4
Age Group: 11 to <16 years (g/kg-day)						
Total Foods[a]	12	100.0	23	100.0	43	100.0
Total Dairy	1	4.9	6	26.0	21	47.9
Total Meats	1	9.3	2	10.9	3	7.5
Total Fish	0	1.3	0	0.6	0	0.8
Total Eggs	0	2.5	0	1.5	1	1.2
Total Grains	2	14.2	3	11.5	4	9.1
Total Vegetables	4	32.4	6	24.5	7	15.5
Total Fruits	3	27.0	4	17.1	5	11.8
Total Fats[b]	1	6.3	1	6.1	2	4.9

Table 14-8. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Meat and Dairy Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 16 to <21 years (g/day)							Age Group: 16 to <21 years (g/kg-day)						
Total Foods[a]	610	100.0	1,017	100.0	2,379	100.0	Total Foods[a]	9	100.0	15	100.0	34	100.0
Total Dairy	22	3.5	204	20.1	923	38.8	Total Dairy	0	3.8	3	19.1	13	39.1
Total Meats	42	6.8	128	12.6	256	10.8	Total Meats	1	6.8	2	13.4	4	10.8
Total Fish	12	1.9	12	1.2	8	0.3	Total Fish	0	1.8	0	0.9	0	0.3
Total Eggs	13	2.2	19	1.8	28	1.2	Total Eggs	0	2.0	0	1.8	0	1.1
Total Grains	87	14.3	140	13.8	233	9.8	Total Grains	1	14.6	2	14.3	3	10.1
Total Vegetables	202	33.1	305	29.9	492	20.7	Total Vegetables	3	34.0	5	30.4	7	20.8
Total Fruits	177	29.1	133	13.1	282	11.9	Total Fruits	3	28.1	2	12.2	4	11.2
Total Fats[b]	34	5.6	68	6.6	127	5.3	Total Fats[b]	1	5.5	1	6.8	2	5.4
Age Group: 20 years and older (g/day)							Age Group: 20 years and older (g/kg-day)						
Total Foods[a]	679	100.0	1,050	100.0	1,860	100.0	Total Foods[a]	9	100.0	14	100.0	26	100.0
Total Dairy	28	4.1	157	14.9	696	37.5	Total Dairy	0	3.9	2	15.2	10	37.6
Total Meats	45	6.6	136	12.9	208	11.2	Total Meats	1	6.8	2	12.7	3	10.4
Total Fish	21	3.1	14	1.3	17	0.9	Total Fish	0	3.1	0	1.4	0	1.0
Total Eggs	19	2.8	22	2.1	29	1.5	Total Eggs	0	2.8	0	2.1	0	1.5
Total Grains	99	14.6	131	12.5	185	10.0	Total Grains	1	14.5	2	12.9	3	9.8
Total Vegetables	236	34.7	319	30.3	385	20.7	Total Vegetables	3	35.0	4	29.9	5	20.3
Total Fruits	179	26.3	190	18.1	215	11.6	Total Fruits	2	26.1	3	18.1	3	13.1
Total Fats[b]	34	5.0	65	6.1	100	5.4	Total Fats[b]	0	5.1	1	6.0	1	5.1

[a] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.

[b] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fish Intake

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/day)[a]							Age Group: Birth to <1 month (g/kg-day)[a]						
Total Foods[b]	67	100.0	-	-	-	-	Total Foods[b]	20	100.0	-	-	-	-
Total Dairy	41	61.5	-	-	-	-	Total Dairy	12	61.6	-	-	-	-
Total Meats	0	0.0	-	-	-	-	Total Meats	0	0.0	-	-	-	-
Total Fish	0	0.0	-	-	-	-	Total Fish	0	0.0	-	-	-	-
Total Eggs	0	0.0	-	-	-	-	Total Eggs	0	0.0	-	-	-	-
Total Grains	0	0.7	-	-	-	-	Total Grains	0	0.7	-	-	-	-
Total Vegetables	5	7.7	-	-	-	-	Total Vegetables	2	7.7	-	-	-	-
Total Fruits	1	1.3	-	-	-	-	Total Fruits	0	1.1	-	-	-	-
Total Fats[c]	19	28.3	-	-	-	-	Total Fats[c]	6	28.4	-	-	-	-
Age Group: 1 to <3 months (g/day)[a]							Age Group: 1 to <3 months (g/kg-day)[a]						
Total Foods[b]	80	100.0	-	-	-	-	Total Foods[b]	16	100.0	-	-	-	-
Total Dairy	37	46.5	-	-	-	-	Total Dairy	8	48.2	-	-	-	-
Total Meats	0	0.0	-	-	-	-	Total Meats	0	0.0	-	-	-	-
Total Fish	0	0.0	-	-	-	-	Total Fish	0	0.0	-	-	-	-
Total Eggs	0	0.0	-	-	-	-	Total Eggs	0	0.0	-	-	-	-
Total Grains	1	1.5	-	-	-	-	Total Grains	0	1.4	-	-	-	-
Total Vegetables	15	18.5	-	-	-	-	Total Vegetables	3	16.6	-	-	-	-
Total Fruits	4	5.2	-	-	-	-	Total Fruits	1	5.5	-	-	-	-
Total Fats[c]	21	26.4	-	-	-	-	Total Fats[c]	4	26.5	-	-	-	-
Age Group: 3 to <6 months (g/day)[d]							Age Group: 3 to <6 months (g/kg-day)[d]						
Total Foods[b]	196	100.0	-	-	410	100.0	Total Foods[b]	28	100.0	-	-	53	100.0
Total Dairy	55	28.3	-	-	159	38.8	Total Dairy	8	28.9	-	-	21	38.8
Total Meats	2	0.8	-	-	28	6.8	Total Meats	0	0.7	-	-	4	6.8
Total Fish	0	0.0	-	-	17	4.1	Total Fish	0	0.0	-	-	2	4.1
Total Eggs	0	0.1	-	-	4	1.0	Total Eggs	0	0.1	-	-	1	1.0
Total Grains	8	3.9	-	-	47	11.5	Total Grains	1	3.8	-	-	6	11.5
Total Vegetables	34	17.2	-	-	34	8.3	Total Vegetables	5	17.1	-	-	4	8.3
Total Fruits	68	34.7	-	-	30	7.2	Total Fruits	9	33.9	-	-	4	7.2
Total Fats[c]	28	14.1	-	-	81	19.8	Total Fats[c]	4	14.5	-	-	11	19.8

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fish Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/day)[e]						
Total Foods[b]	799	100.0	-	-	770	100.0
Total Dairy	334	41.8	-	-	287	37.3
Total Meats	38	4.7	-	-	46	6.0
Total Fish	0	0.0	-	-	7	0.9
Total Eggs	11	1.4	-	-	14	1.9
Total Grains	47	5.9	-	-	66	8.6
Total Vegetables	101	12.6	-	-	117	15.3
Total Fruits	227	28.4	-	-	194	25.2
Total Fats[c]	37	4.7	-	-	36	4.7
Age Group: 1 to <2 years (g/day)[e]						
Total Foods[b]	1,032	100.0	-	-	1,139	100.0
Total Dairy	496	48.1	-	-	461	40.5
Total Meats	46	4.5	-	-	56	4.9
Total Fish	0	0.0	-	-	26	2.3
Total Eggs	14	1.4	-	-	19	1.7
Total Grains	65	6.3	-	-	76	6.7
Total Vegetables	118	11.4	-	-	151	13.2
Total Fruits	247	24.0	-	-	300	26.3
Total Fats[c]	39	3.8	-	-	43	3.8
Age Group: 2 to <3 years (g/day)[e]						
Total Foods[b]	1,015	100.0	-	-	1,107	100.0
Total Dairy	381	37.6	-	-	424	38.3
Total Meats	62	6.1	-	-	53	4.8
Total Fish	0	0.0	-	-	31	2.8
Total Eggs	18	1.8	-	-	17	1.6
Total Grains	81	7.9	-	-	84	7.6
Total Vegetables	144	14.2	-	-	142	12.8
Total Fruits	276	27.2	-	-	304	27.4
Total Fats[c]	42	4.2	-	-	43	3.9

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/kg-day)[e]						
Total Foods[b]	81	100.0	-	-	74	100.0
Total Dairy	34	41.8	-	-	27	37.1
Total Meats	4	4.7	-	-	4	6.0
Total Fish	0	0.0	-	-	1	0.9
Total Eggs	1	1.4	-	-	1	2.0
Total Grains	5	5.9	-	-	6	8.4
Total Vegetables	10	12.6	-	-	12	15.6
Total Fruits	23	28.4	-	-	19	25.2
Total Fats[c]	4	4.7	-	-	3	4.7
Age Group: 1 to <2 years (g/kg-day)[e]						
Total Foods[b]	90	100.0	-	-	98	100.0
Total Dairy	43	48.2	-	-	41	42.4
Total Meats	4	4.4	-	-	5	4.8
Total Fish	0	0.0	-	-	2	2.2
Total Eggs	1	1.3	-	-	2	1.6
Total Grains	6	6.2	-	-	7	6.7
Total Vegetables	10	11.4	-	-	12	12.3
Total Fruits	22	24.0	-	-	25	25.5
Total Fats[c]	3	3.8	-	-	4	3.8
Age Group: 2 to <3 years (g/kg-day)[e]						
Total Foods[b]	73	100.0	-	-	82	100.0
Total Dairy	28	37.9	-	-	31	37.6
Total Meats	4	6.0	-	-	4	4.6
Total Fish	0	0.0	-	-	2	2.9
Total Eggs	1	1.7	-	-	1	1.5
Total Grains	6	7.9	-	-	6	7.5
Total Vegetables	10	14.1	-	-	10	12.7
Total Fruits	20	27.0	-	-	23	28.5
Total Fats[c]	3	4.2	-	-	3	3.9

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fish Intake (continued)													
Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/day)[e]							Age Group: 3 to <6 years (g/kg-day)[e]						
Total Foods[b]	1,053	100.0	-	-	1,156	100.0	Total Foods[b]	60	100.0	-	-	66	100.0
Total Dairy	390	37.1	-	-	399	34.5	Total Dairy	22	37.1	-	-	22	33.9
Total Meats	76	7.2	-	-	62	5.3	Total Meats	4	7.1	-	-	3	5.3
Total Fish	0	0.0	-	-	43	3.7	Total Fish	0	0.0	-	-	2	3.7
Total Eggs	16	1.5	-	-	17	1.4	Total Eggs	1	1.5	-	-	1	1.6
Total Grains	101	9.6	-	-	103	8.9	Total Grains	6	9.5	-	-	6	9.0
Total Vegetables	168	15.9	-	-	193	16.7	Total Vegetables	9	15.8	-	-	11	16.9
Total Fruits	237	22.5	-	-	273	23.6	Total Fruits	14	22.7	-	-	16	23.8
Total Fats[c]	50	4.8	-	-	50	4.3	Total Fats[c]	3	4.7	-	-	3	4.3
Age Group: 6 to <11 years (g/day)[e]							Age Group: 6 to <11 years (g/kg-day)[e]						
Total Foods[b]	1,109	100.0	-	-	1,234	100.0	Total Foods[b]	40	100.0	-	-	44	100.0
Total Dairy	408	36.8	-	-	430	34.8	Total Dairy	15	37.0	-	-	16	35.6
Total Meats	89	8.0	-	-	76	6.2	Total Meats	3	7.9	-	-	3	6.1
Total Fish	0	0.0	-	-	51	4.1	Total Fish	0	0.0	-	-	2	4.1
Total Eggs	15	1.3	-	-	22	1.8	Total Eggs	1	1.3	-	-	1	1.6
Total Grains	119	10.7	-	-	126	10.2	Total Grains	4	10.7	-	-	4	10.1
Total Vegetables	208	18.8	-	-	233	18.9	Total Vegetables	7	18.5	-	-	8	18.4
Total Fruits	190	17.1	-	-	218	17.7	Total Fruits	7	17.3	-	-	8	17.5
Total Fats[c]	58	5.2	-	-	61	4.9	Total Fats[c]	2	5.2	-	-	2	4.9

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fish Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 11 to <16 years (g/day)[e]							Age Group: 11 to <16 years (g/kg-day)[e]						
Total Foods[b]	1,197	100.0	-	-	1,378	100.0	Total Foods[b]	24	100.0	-	-	28	100.0
Total Dairy	372	31.1	-	-	397	28.8	Total Dairy	7	31.1	-	-	9	30.9
Total Meats	117	9.8	-	-	104	7.5	Total Meats	2	9.7	-	-	2	6.9
Total Fish	0	0.0	-	-	72	5.2	Total Fish	0	0.0	-	-	1	4.9
Total Eggs	17	1.4	-	-	28	2.0	Total Eggs	0	1.4	-	-	1	1.9
Total Grains	135	11.3	-	-	146	10.6	Total Grains	3	11.3	-	-	3	10.5
Total Vegetables	277	23.1	-	-	310	22.5	Total Vegetables	5	22.9	-	-	6	21.1
Total Fruits	190	15.8	-	-	226	16.4	Total Fruits	4	16.2	-	-	5	17.1
Total Fats[c]	69	5.8	-	-	76	5.5	Total Fats[c]	1	5.7	-	-	1	5.2
Age Group: 16 to <21 years (g/day)[e]							Age Group: 16 to <21 years (g/kg-day)[e]						
Total Foods[b]	1,171	100.0	-	-	1,339	100.0	Total Foods[b]	18	100.0	-	-	19	100.0
Total Dairy	288	24.6	-	-	261	19.5	Total Dairy	4	24.5	-	-	4	20.3
Total Meats	143	12.2	-	-	139	10.4	Total Meats	2	11.9	-	-	2	9.4
Total Fish	0	0.0	-	-	86	6.5	Total Fish	0	0.0	-	-	1	6.7
Total Eggs	20	1.7	-	-	21	1.6	Total Eggs	0	1.7	-	-	0	1.6
Total Grains	146	12.5	-	-	162	12.1	Total Grains	2	12.5	-	-	2	12.0
Total Vegetables	325	27.8	-	-	357	26.6	Total Vegetables	5	27.9	-	-	5	26.0
Total Fruits	160	13.7	-	-	219	16.3	Total Fruits	2	13.9	-	-	3	16.9
Total Fats[c]	75	6.4	-	-	80	6.0	Total Fats[c]	1	6.4	-	-	1	5.9

Table 14-9. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fish Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 20 years and older (g/day)						
Total Foods[b]	1,040	100.0	1,060	100.0	1,340	100.0
Total Dairy	207	20.0	205	19.3	250	18.7
Total Meats	126	12.1	143	13.4	121	9.1
Total Fish	0	0.0	0	0.0	102	7.7
Total Eggs	22	2.1	24	2.2	27	2.0
Total Grains	134	12.9	133	12.5	152	11.4
Total Vegetables	303	29.2	300	28.3	348	26.0
Total Fruits	165	15.9	180	16.9	238	17.8
Total Fats[c]	62	6.0	64	6.0	74	5.5

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 20 years and older (g/kg-day)						
Total Foods[b]	14	100.0	15	100.0	19	100.0
Total Dairy	3	20.2	3	19.1	4	19.0
Total Meats	2	11.9	2	12.7	2	8.5
Total Fish	0	0.0	0	0.0	1	7.6
Total Eggs	0	2.0	0	2.0	0	1.9
Total Grains	2	13.0	2	12.3	2	11.2
Total Vegetables	4	29.1	4	28.3	5	26.0
Total Fruits	2	16.1	3	18.2	4	18.7
Total Fats[c]	1	5.9	1	5.8	1	5.2

[a] All individuals in this sample group consumed 0 g/day of fish. Therefore, only low-end consumers are reported.
[b] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.
[c] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.
[d] Only one individual in this sample group consumed more than 0 g/day of fish. Therefore, this sample is reported in the high-end consumer group and all other samples are placed in the low-end consumer group.
[e] All individuals in this sample group below the 80th percentile consumed 0 g/day of fish. Therefore, only high-end and low-end consumer groups are reported.

Source: U.S. EPA analysis of 1994−1996, 1998 CSFII.

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fruit and Vegetable Intake

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/day)[a]							Age Group: Birth to <1 month (g/kg-day)[a]						
Total Foods[b]	49	100.0	-	-	101	100.0	Total Foods[b]	14	100.0	-	-	29	100.0
Total Dairy	34	69.7	-	-	21	21.1	Total Dairy	10	69.6	-	-	6	19.4
Total Meats	0	0.0	-	-	0	0.0	Total Meats	0	0.0	-	-	0	0.0
Total Fish	0	0.0	-	-	0	0.0	Total Fish	0	0.0	-	-	0	0.0
Total Eggs	0	0.0	-	-	0	0.0	Total Eggs	0	0.0	-	-	0	0.0
Total Grains	1	1.2	-	-	0.21	0.2	Total Grains	0	1.3	-	-	0	0.2
Total Vegetables	0	0.0	-	-	44	43.3	Total Vegetables	0	0.0	-	-	13	44.8
Total Fruits	0	0.0	-	-	8	7.6	Total Fruits	0	0.0	-	-	2	6.4
Total Fats[c]	14	29.1	-	-	25	24.8	Total Fats[c]	4	29.1	-	-	7	25.4
Age Group: 1 to <3 months (g/day)[a]							Age Group: 1 to <3 months (g/kg-day)[a]						
Total Foods[b]	49	100.0	-	-	171	100.0	Total Foods[b]	11	100.0	-	-	35	100.0
Total Dairy	34	69.2	-	-	16	9.5	Total Dairy	7	69.4	-	-	4	11.5
Total Meats	0	0.0	-	-	0	0.0	Total Meats	0	0.0	-	-	0	0.0
Total Fish	0	0.0	-	-	0	0.0	Total Fish	0	0.0	-	-	0	0.0
Total Eggs	0	0.0	-	-	0	0.0	Total Eggs	0	0.0	-	-	0	0.0
Total Grains	1	1.9	-	-	2	1.0	Total Grains	0	1.7	-	-	0	1.1
Total Vegetables	0	0.0	-	-	89	52.0	Total Vegetables	0	0.0	-	-	16	46.8
Total Fruits	0	0.0	-	-	18	10.2	Total Fruits	0	0.0	-	-	5	13.9
Total Fats[c]	14	28.9	-	-	40	23.4	Total Fats[c]	3	29.0	-	-	8	22.7
Age Group: 3 to <6 months (g/day)							Age Group: 3 to <6 months (g/kg-day)						
Total Foods[b]	69	100.0	144	100.0	495	100.0	Total Foods[b]	11	100.0	21	100.0	70	100.0
Total Dairy	47	68.0	51	35.6	49	9.9	Total Dairy	7	68.1	8	37.2	7	10.1
Total Meats	0	0.0	2	1.3	4	0.8	Total Meats	0	0.0	0	1.5	1	0.7
Total Fish	0	0.0	0	0.3	0	0.0	Total Fish	0	0.0	0	0.3	0	0.0
Total Eggs	0	0.0	1	0.4	0	0.0	Total Eggs	0	0.0	0	0.5	0	0.0
Total Grains	2	3.3	10	6.7	12	2.4	Total Grains	0	3.2	1	6.6	2	2.6
Total Vegetables	0	0.0	24	16.6	88	17.7	Total Vegetables	0	0.0	3	15.1	12	17.7
Total Fruits	0	0.0	29	19.9	311	62.8	Total Fruits	0	0.0	4	20.8	44	62.4
Total Fats[c]	20	28.4	25	17.7	27	5.4	Total Fats[c]	3	28.5	4	16.9	4	5.5

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fruit and Vegetable Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/day)							Age Group: 6 to <12 months (g/kg-day)						
Total Foods[b]	189	100.0	461	100.0	951	100.0	Total Foods[b]	21	100.0	57	100.0	100	100.0
Total Dairy	91	48.3	129	28.0	207	21.8	Total Dairy	10	48.1	19	33.2	18	17.9
Total Meats	8	4.0	17	3.6	37	3.9	Total Meats	1	3.6	2	4.3	4	3.8
Total Fish	1	0.4	1	0.2	0	0.0	Total Fish	0	0.4	0	0.1	0	0.0
Total Eggs	4	1.9	9	1.9	8	0.8	Total Eggs	0	1.7	1	1.0	1	0.7
Total Grains	23	12.1	31	6.8	41	4.3	Total Grains	2	11.4	4	6.5	5	4.6
Total Vegetables	18	9.4	83	18.1	160	16.8	Total Vegetables	2	9.3	10	16.9	19	19.0
Total Fruits	15	7.7	158	34.3	459	48.2	Total Fruits	2	8.4	18	30.8	50	49.5
Total Fats[c]	31	16.3	31	6.8	35	3.6	Total Fats[c]	3	16.8	4	6.6	4	3.9
Age Group: 1 to <2 years (g/day)							Age Group: 1 to <2 years (g/kg-day)						
Total Foods[b]	796	100.0	1,048	100.0	1,499	100.0	Total Foods[b]	68	100.0	88	100.0	133	100.0
Total Dairy	578	72.7	535	51.0	425	28.4	Total Dairy	49	71.8	44	49.6	39	29.5
Total Meats	35	4.5	46	4.4	62	4.2	Total Meats	3	4.7	4	4.5	5	3.6
Total Fish	1	0.1	3	0.3	5	0.4	Total Fish	0	0.2	0	0.3	0	0.2
Total Eggs	8	1.0	16	1.5	17	1.1	Total Eggs	1	1.1	1	1.2	2	1.2
Total Grains	49	6.2	65	6.2	77	5.1	Total Grains	4	6.2	6	6.9	7	5.2
Total Vegetables	56	7.1	123	11.7	179	11.9	Total Vegetables	5	7.1	11	12.6	15	11.6
Total Fruits	26	3.2	210	20.1	687	45.8	Total Fruits	2	3.4	18	20.5	60	45.4
Total Fats[c]	36	4.6	41	3.9	39	2.6	Total Fats[c]	3	4.7	3	3.7	4	2.7
Age Group: 2 to <3 years (g/day)							Age Group: 2 to <3 years (g/kg-day)						
Total Foods[b]	601	100.0	942	100.0	1,589	100.0	Total Foods[b]	43	100.0	69	100.0	114	100.0
Total Dairy	308	51.2	352	37.4	384	24.1	Total Dairy	22	51.3	27	39.3	27	23.6
Total Meats	53	8.8	59	6.3	64	4.0	Total Meats	4	8.8	4	6.0	4	3.8
Total Fish	2	0.3	4	0.5	5	0.3	Total Fish	0	0.3	0	0.4	0	0.4
Total Eggs	14	2.3	18	2.0	20	1.3	Total Eggs	1	2.3	1	1.9	2	1.4
Total Grains	72	12.0	80	8.5	91	5.7	Total Grains	5	12.0	6	8.6	7	5.7
Total Vegetables	81	13.4	141	15.0	202	12.7	Total Vegetables	6	13.8	10	14.0	14	12.4
Total Fruits	24	4.0	237	25.1	765	48.1	Total Fruits	2	3.7	17	24.6	56	49.1
Total Fats[c]	38	6.3	40	4.2	46	2.9	Total Fats[c]	3	6.3	3	4.1	3	2.9

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fruit and Vegetable Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/day)						
Total Foods[b]	731	100.0	1,014	100.0	1,594	100.0
Total Dairy	388	53.1	385	38.0	401	25.1
Total Meats	60	8.2	74	7.3	81	5.1
Total Fish	4	0.5	7	0.7	9	0.6
Total Eggs	13	1.7	14	1.4	21	1.3
Total Grains	92	12.5	96	9.4	113	7.1
Total Vegetables	92	12.5	174	17.1	231	14.5
Total Fruits	27	3.6	199	19.6	668	41.9
Total Fats[c]	45	6.1	49	4.9	53	3.3
Age Group: 6 to <11 years (g/day)						
Total Foods[b]	784	100.0	1,068	100.0	1,664	100.0
Total Dairy	385	49.2	406	38.0	448	26.9
Total Meats	76	9.7	88	8.3	98	5.9
Total Fish	5	0.6	6	0.6	8	0.5
Total Eggs	16	2.1	16	1.5	17	10.
Total Grains	105	13.3	117	11.0	127	7.6
Total Vegetables	103	13.2	213	19.9	313	18.8
Total Fruits	26	3.4	144	13.5	559	33.6
Total Fats[c]	48	6.2	59	5.5	64	3.9
Age Group: 11 to <16 years (g/day)						
Total Foods[b]	709	100.0	1,149	100.0	1,911	100.0
Total Dairy	301	42.4	362	31.5	395	20.7
Total Meats	91	12.8	112	9.7	146	7.7
Total Fish	3	0.4	10	0.8	14	0.7
Total Eggs	13	1.8	20	1.7	24	1.3
Total Grains	106	15.0	136	11.8	165	8.6
Total Vegetables	125	17.7	286	24.9	458	24.0
Total Fruits	13	1.9	136	11.8	597	31.2
Total Fats[c]	49	6.9	66	5.8	87	4.5

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/kg-day)						
Total Foods[b]	40	100.0	58	100.0	95	100.0
Total Dairy	21	52.7	22	38.2	25	25.8
Total Meats	3	8.6	4	7.0	5	4.8
Total Fish	0	0.4	0	0.6	0	0.5
Total Eggs	1	1.6	1	1.4	1	1.1
Total Grains	5	12.4	6	10.3	7	6.8
Total Vegetables	5	13.0	10	16.5	13	13.9
Total Fruits	1	3.4	11	19.5	41	42.5
Total Fats[c]	2	6.1	3	4.9	3	3.3
Age Group: 6 to <11 years (g/kg-day)						
Total Foods[b]	23	100.0	38	100.0	64	100.0
Total Dairy	11	47.0	14	37.6	18	27.5
Total Meats	2	10.1	3	8.9	4	5.7
Total Fish	0	0.8	0	0.4	0	0.5
Total Eggs	1	2.3	1	1.5	1	1.2
Total Grains	3	13.8	5	11.8	5	8.1
Total Vegetables	3	13.8	7	19.1	11	17.7
Total Fruits	1	3.6	5	13.3	22	33.6
Total Fats[c]	1	6.4	2	5.4	3	3.9
Age Group: 11 to <16 years (g/kg-day)						
Total Foods[b]	12	100.0	23	100.0	39	100.0
Total Dairy	5	42.0	8	33.1	9	22.3
Total Meats	1	12.4	2	9.8	3	6.4
Total Fish	0	0.5	0	0.5	0	0.5
Total Eggs	0	1.9	0	1.7	1	1.5
Total Grains	2	14.8	3	12.1	3	8.8
Total Vegetables	2	18.2	5	23.0	9	22.4
Total Fruits	0	2.2	3	12.3	13	32.3
Total Fats[c]	1	7.0	1	5.9	2	4.2

Table 14-10. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Fruit and Vegetable Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer		Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%		Intake	%	Intake	%	Intake	%
Age Group: 16 to <21 years (g/day)							Age Group: 16 to <21 years (g/kg-day)						
Total Foods[b]	624	100.0	970	100.0	2,353	100.0	Total Foods[b]	9	100.0	16	100.0	34	100.0
Total Dairy	238	38.1	203	21.0	449	19.1	Total Dairy	4	39.0	3	21.0	6	17.8
Total Meats	76	12.2	112	11.5	245	10.4	Total Meats	1	11.7	2	12.7	3	9.6
Total Fish	8	1.2	15	1.6	17	0.7	Total Fish	0	1.4	0	0.8	0	0.6
Total Eggs	21	3.3	16	1.6	30	1.3	Total Eggs	0	3.4	0	2.5	0	1.0
Total Grains	100	16.1	138	14.2	211	9.0	Total Grains	1	16.2	2	14.6	3	10.0
Total Vegetables	109	17.5	283	29.2	615	26.1	Total Vegetables	2	17.9	5	30.7	9	25.8
Total Fruits	18	2.9	121	12.5	644	27.4	Total Fruits	0	1.8	1	9.1	10	30.0
Total Fats[c]	46	7.3	66	6.8	116	4.9	Total Fats[c]	1	7.2	1	7.5	2	4.4
Age Group: 20 years and older (g/day)							Age Group: 20 years and older (g/kg-day)						
Total Foods[b]	602	100.0	1,040	100.0	1,920	100.0	Total Foods[b]	8	100.0	14	100.0	27	100.0
Total Dairy	178	29.6	215	20.6	282	14.7	Total Dairy	2	28.6	3	20.3	4	14.7
Total Meats	99	16.4	129	12.4	168	8.7	Total Meats	1	16.9	2	13.0	2	7.5
Total Fish	11	1.8	15	1.4	23	1.2	Total Fish	0	1.8	0	1.2	0	1.3
Total Eggs	21	3.5	23	2.2	28	1.5	Total Eggs	0	3.4	0	2.1	0	1.3
Total Grains	105	17.5	131	12.6	177	9.2	Total Grains	1	17.8	2	13.2	2	9.0
Total Vegetables	115	19.1	306	29.4	527	27.4	Total Vegetables	2	19.6	4	29.7	7	27.2
Total Fruits	16	2.6	138	13.3	610	31.7	Total Fruits	0	2.5	2	12.5	9	33.9
Total Fats[c]	45	7.5	64	6.2	83	4.3	Total Fats[c]	1	7.7	1	6.3	1	3.8

[a] All individuals in this sample group below the 75th percentile consumed 0 g/day of fruits and vegetables. Therefore, only high-end and low-end consumer groups are reported.

[b] Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.

[c] Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Dairy Intake

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/day)						
Total Foods[a]	12	100.0	60	100.0	185	100.0
Total Dairy	0	0.0	40	67.3	127	69.0
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.3	0	0.0	4	2.2
Total Vegetables	8	66.1	2	3.4	1	0.4
Total Fruits	0	0.0	0	0.0	0	0.0
Total Fats[b]	3	27.1	18	29.2	52	28.4
Age Group: 1 to <3 months (g/day)						
Total Foods[a]	36	100.0	84	100.0	166	100.0
Total Dairy	0	0.0	19	22.4	109	65.6
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.9	1	1.2	0	0.8
Total Vegetables	21	58.8	42	50.7	4	2.7
Total Fruits	2	4.3	0	0.0	6	3.7
Total Fats[b]	10	26.7	21	25.4	45	27.2
Age Group: 3 to <6 months (g/day)						
Total Foods[a]	132	100.0	217	100.0	346	100.0
Total Dairy	0	0.0	59	27.0	160	46.3
Total Meats	1	0.4	2	1.0	4	1.1
Total Fish	0	0.0	0	0.0	0	0.1
Total Eggs	0	0.0	0	0.2	1	0.2
Total Grains	6	4.5	8	3.8	12	3.4
Total Vegetables	46	34.9	37	17.0	26	7.6
Total Fruits	58	44.1	84	38.8	87	25.1
Total Fats[b]	16	11.9	26	12.1	55	15.8

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: Birth to <1 month (g/kg-day)						
Total Foods[a]	4	100.0	18	100.0	56	100.0
Total Dairy	0	0.0	12	67.1	39	69.0
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.2	0	0.0	1	2.1
Total Vegetables	2	64.4	1	3.7	0	0.5
Total Fruits	0	0.0	0	0.0	0	0.0
Total Fats[b]	1	27.5	5	29.2	16	28.4
Age Group: 1 to <3 months (g/kg-day)						
Total Foods[a]	7	100.0	14	100.0	41	100.0
Total Dairy	0	0.0	3	24.0	26	64.1
Total Meats	0	0.0	0	0.0	0	0.0
Total Fish	0	0.0	0	0.0	0	0.0
Total Eggs	0	0.0	0	0.0	0	0.0
Total Grains	0	0.8	0	2.0	0	0.6
Total Vegetables	4	57.8	7	48.7	0	1.1
Total Fruits	0	5.4	0	0.0	3	7.7
Total Fats[b]	2	26.4	4	25.0	11	26.5
Age Group: 3 to <6 months (g/kg-day)						
Total Foods[a]	19	100.0	32	100.0	44	100.0
Total Dairy	0	0.0	8	24.8	24	54.9
Total Meats	0	0.5	0	0.7	0	1.0
Total Fish	0	0.0	0	0.0	0	0.1
Total Eggs	0	0.0	0	0.3	0	0.1
Total Grains	1	4.5	1	3.8	2	3.4
Total Vegetables	7	35.6	4	13.7	2	5.0
Total Fruits	8	43.0	14	45.8	7	15.9
Total Fats[b]	2	12.2	3	10.7	8	19.2

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Dairy Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/day)						
Total Foods[a]	317	100.0	368	100.0	1,285	100.0
Total Dairy	0	0.0	71	19.2	833	64.8
Total Meats	11	3.4	16	4.4	41	3.2
Total Fish	0	0.0	1	0.3	0	0.0
Total Eggs	3	0.9	5	1.4	6	0.5
Total Grains	27	8.6	23	6.3	46	3.6
Total Vegetables	114	35.9	75	20.4	106	8.2
Total Fruits	137	43.3	147	39.9	211	16.4
Total Fats[b]	20	6.4	30	8.2	40	3.1
Age Group: 1 to <2 years (g/day)						
Total Foods[a]	601	100.0	989	100.0	1,700	100.0
Total Dairy	40	6.7	451	45.6	1,170	68.8
Total Meats	43	7.1	51	5.2	45	2.6
Total Fish	3	0.5	4	0.4	3	0.2
Total Eggs	14	2.3	15	1.5	18	1.1
Total Grains	57	9.5	65	6.5	63	3.7
Total Vegetables	139	23.1	120	12.1	112	6.6
Total Fruits	268	44.7	240	24.3	226	13.3
Total Fats[b]	29	4.8	38	3.8	58	3.4
Age Group: 2 to <3 years (g/day)						
Total Foods[a]	661	100.0	996	100.0	1,528	100.0
Total Dairy	48	7.3	348	34.9	885	57.9
Total Meats	61	9.3	63	6.3	55	3.6
Total Fish	2	0.3	6	0.6	5	0.3
Total Eggs	25	3.8	20	2.1	19	1.3
Total Grains	78	11.9	82	8.2	86	5.6
Total Vegetables	163	24.7	144	14.5	137	9.0
Total Fruits	237	35.8	279	28.0	277	18.1
Total Fats[b]	37	5.5	41	4.1	55	3.6

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 6 to <12 months (g/kg-day)						
Total Foods[a]	36	100.0	43	100.0	135	100.0
Total Dairy	0	0.0	8	18.2	87	64.8
Total Meats	1	3.5	2	4.8	4	3.0
Total Fish	0	0.0	0	0.3	0	0.0
Total Eggs	0	1.0	1	2.1	1	0.5
Total Grains	3	7.9	3	7.7	5	3.5
Total Vegetables	13	35.3	8	17.9	11	8.2
Total Fruits	16	44.6	18	40.7	22	16.6
Total Fats[b]	2	6.3	4	8.1	4	3.1
Age Group: 1 to <2 years (g/kg-day)						
Total Foods[a]	55	100.0	86	100.0	154	100.0
Total Foods[a]	3	6.1	38	44.0	106	68.5
Total Dairy	4	7.2	4	4.8	4	2.6
Total Meats	0	0.5	1	0.6	0	0.1
Total Fish	1	2.3	2	1.8	1	0.8
Total Eggs	5	9.5	6	6.9	6	3.7
Total Grains	12	21.8	11	13.0	10	6.7
Total Vegetables	25	46.3	21	24.5	21	13.8
Total Fruits	3	4.7	3	3.7	5	3.4
Age Group: 2 to <3 years (g/kg-day)						
Total Foods[a]	47	100.0	72	100.0	114	100.0
Total Dairy	3	7.2	24	33.7	67	58.4
Total Meats	4	9.4	4	6.2	4	3.6
Total Fish	0	0.3	0	0.4	0	0.2
Total Eggs	2	3.7	1	1.5	1	1.3
Total Grains	5	11.6	6	8.5	6	5.7
Total Vegetables	12	24.6	10	14.0	11	9.3
Total Fruits	17	36.4	22	30.2	20	17.3
Total Fats[b]	3	5.5	3	4.2	4	3.6

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Dairy Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/day)						
Total Foods[a]	725	100.0	1,047	100.0	1,612	100.0
Total Dairy	64	8.9	355	33.9	886	55.0
Total Meats	75	10.4	72	6.9	70	4.3
Total Fish	4	0.6	6	0.5	6	0.4
Total Eggs	19	2.6	15	1.4	18	1.1
Total Grains	87	12.1	104	9.9	116	7.2
Total Vegetables	168	23.2	173	16.	183	11.3
Total Fruits	253	34.9	257	24.5	251	15.6
Total Fats[b]	40	5.6	49	4.7	63	3.9
Age Group: 6 to <11 years (g/day)						
Total Foods[a]	766	100.0	1,053	100.0	1,722	100.0
Total Dairy	63	8.2	372	35.4	892	51.8
Total Meats	99	12.9	80	7.6	87	5.1
Total Fish	6	0.8	5	0.5	6	0.4
Total Eggs	17	2.2	14	1.3	17	1.0
Total Grains	105	13.7	113	10.7	152	8.8
Total Vegetables	221	28.9	214	20.3	242	14.0
Total Fruits	194	25.3	175	16.6	227	13.2
Total Fats[b]	49	6.4	56	5.3	70	4.1
Age Group: 11 to <16 years (g/day)						
Total Foods[a]	747	100.0	1,094	100.0	2,020	100.0
Total Dairy	22	3.0	307	28.0	1,017	50.3
Total Meats	102	13.6	101	9.2	134	6.7
Total Fish	8	1.1	9	0.8	12	0.6
Total Eggs	20	2.7	18	1.6	25	1.2
Total Grains	104	13.9	133	12.2	181	9.0
Total Vegetables	239	32.0	265	24.2	322	16.0
Total Fruits	197	26.4	180	16.4	204	10.1
Total Fats[b]	47	6.2	62	5.6	100	5.0

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 3 to <6 years (g/kg-day)						
Total Foods[a]	41	100.0	58	100.0	97	100.0
Total Dairy	4	8.8	20	34.2	52	54.0
Total Meats	4	10.6	4	6.6	4	4.4
Total Fish	0	0.5	0	0.5	0	0.3
Total Eggs	1	2.6	1	1.5	1	1.0
Total Grains	5	12.1	6	9.9	7	7.2
Total Vegetables	10	23.8	9	16.3	11	11.6
Total Fruits	14	34.0	14	24.7	16	16.5
Total Fats[b]	2	5.7	3	4.7	4	4.0
Age Group: 6 to <11 years (g/kg-day)						
Total Foods[a]	25	100.0	38	100.0	67	100.0
Total Dairy	2	8.1	13	34.2	35	51.9
Total Meats	3	13.2	2	8.0	3	4.9
Total Fish	0	0.8	0	0.5	0	0.4
Total Eggs	1	2.3	1	1.8	1	0.9
Total Grains	3	13.6	4	10.7	6	9.0
Total Vegetables	7	29.5	8	19.7	9	13.7
Total Fruits	6	24.4	7	17.8	9	13.5
Total Fats[b]	2	6.6	2	5.2	3	4.2
Age Group: 11 to <16 years (g/kg-day)						
Total Foods[a]	13	100.0	22	100.0	42	100.0
Total Dairy	0	2.9	6	27.3	21	49.4
Total Meats	2	13.8	2	9.6	3	6.4
Total Fish	0	1.0	0	0.6	0	0.8
Total Eggs	0	2.6	0	1.7	1	1.2
Total Grains	2	13.7	3	12.2	4	9.1
Total Vegetables	4	33.0	5	23.3	6	15.1
Total Fruits	3	25.7	4	17.8	5	11.9
Total Fats[b]	1	6.2	1	5.9	2	4.8

Table 14-11. Per Capita Intake of Total Foods and Major Food Groups, and Percent of Total Food Intake for Individuals with Low-End, Mid-Range, and High-End Total Dairy Intake (continued)

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 16 to <21 years (g/day)						
Total Foods[a]	647	100.0	1,095	100.0	2,233	100.0
Total Dairy	8	1.2	197	18.0	950	42.5
Total Meats	101	15.7	125	11.4	197	8.8
Total Fish	8	1.2	16	1.5	8	0.4
Total Eggs	12	1.8	28	2.5	27	1.2
Total Grains	90	13.9	162	14.8	217	9.7
Total Vegetables	228	35.2	324	29.6	438	19.6
Total Fruits	152	23.5	154	14.1	249	11.2
Total Fats[b]	37	5.8	73	6.7	114	5.1
Age Group: 20 years and older (g/day)						
Total Foods[a]	741	100.0	1,030	100.0	1,810	100.0
Total Dairy	9	1.2	155	15.1	725	40.1
Total Meats	117	15.8	129	12.6	156	8.6
Total Fish	16	2.2	16	1.6	19	1.1
Total Eggs	20	2.7	23	2.3	26	1.4
Total Grains	113	15.2	130	12.6	176	9.7
Total Vegetables	258	34.8	304	29.6	361	20.0
Total Fruits	159	21.4	189	18.4	226	12.5
Total Fats[b]	42	5.6	62	6.0	89	4.9

Food Group	Low-End Consumer		Mid-Range Consumer		High-End Consumer	
	Intake	%	Intake	%	Intake	%
Age Group: 16 to <21 years (g/kg-day)						
Total Foods[a]	10	100.0	17	100.0	33	100.0
Total Dairy	0	1.2	3	16.6	14	42.8
Total Meats	2	15.1	2	13.6	3	8.9
Total Fish	0	1.1	0	0.9	0	0.3
Total Eggs	0	1.7	0	2.2	0	1.2
Total Grains	1	14.1	2	14.0	3	9.6
Total Vegetables	4	35.8	5	28.6	7	20.0
Total Fruits	2	23.9	3	16.1	3	10.6
Total Fats[b]	1	5.6	1	6.5	2	5.1
Age Group: 20 years and older (g/kg-day)						
Total Foods[a]	10	100.0	14	100.0	25	100.0
Total Dairy	0	1.2	2	14.8	10	41.0
Total Meats	2	15.8	2	12.3	2	7.3
Total Fish	0	2.1	0	1.6	0	1.0
Total Eggs	0	2.7	0	2.3	0	1.4
Total Grains	2	15.0	2	12.5	2	9.5
Total Vegetables	4	34.5	4	29.5	5	19.4
Total Fruits	2	21.9	3	19.4	3	14.2
Total Fats[b]	1	5.5	1	5.9	1	4.5

a Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups.
b Includes added fats such as butter, margarine, dressings and sauces, vegetable oil, etc.; does not include fats eaten as components of other foods such as meats.

Source: U.S. EPA analysis of 1994–1996, 1998 CSFII.

Table 14-12. Intake of Total Food[a] (g/kg-day), Edible Portion, Uncooked Weight

Age or Race/Ethnic Group	*N*	Mean	SE[b]	LCL[c]	UCL[d]	Percentiles										
						Min[e]	1st	5th	10th	25th	50th	75th	90th	95th	99th	Max[f]
<1 year	865	90.9	3.50	Age	98.1	0*	0*	0*	3.8	32.0	90.0	134.2	179.9	207.7*	277.8*	355.2*
1 to <3 years	1,052	113.1	2.46	108.0	118.1	0*	38.3*	54.0*	65.2	84.5	106.6	137.8	164.3	184.9*	244.2*	346.0*
3 to <6 years	978	78.6	1.27	76.0	81.2	0*	28.3*	41.3	45.9	55.5	73.0	96.5	119.0	136.5	167.4*	254.0*
6 to <13 years	2,256	47.1	1.15	44.7	49.4	0*	7.1*	16.1	21.3	30.1	42.2	59.3	76.8	92.3	128.1*	167.3*
13 to <20 years	3,450	27.5	0.69	26.0	28.9	0*	5.0	9.4	11.7	17.1	24.5	34.8	46.6	56.3	75.2	122.0*
20 to <50 years	4,289	29.4	0.74	27.9	30.9	0*	4.1	9.4	12.1	17.8	25.9	37.6	52.3	62.8	82.1	211.2*
≥50 years	3,893	29.1	0.55	28.0	30.3	0*	0	10.0	13.0	18.6	26.2	36.3	49.5	58.5	80.8	119.6*
All Ages	16,783	36.1	0.56	35.0	37.2	0*	3.4	10.0	13.0	19.4	28.8	43.1	66.7	89.4	148.0	355.2*
Female 13 to 49 years	4,103	28.8	0.85	27.1	30.5	0*	3.1	9.0	11.5	17.1	24.9	36.7	52.7	62.9	84.1	211.2*
Mexican American	4,450	40.2	0.86	38.4	42.0	0*	4.8	11.1	14.0	19.7	29.5	48.7	82.6	108.4	163.5	278.1*
Non−Hispanic Black	4,265	30.7	0.85	29.0	32.4	0*	0	7.1	9.6	14.6	22.3	36.8	60.8	83.4	147.4	304.1*
Non−Hispanic White	6,757	36.0	0.72	34.6	37.5	0*	5.4	10.5	13.5	20.2	29.5	43.1	64.9	84.1	141.9	355.2*
Other Hispanic	562	39.5	2.01	35.4	43.7	0*	0*	12.1	14.1	20.8	27.9	42.9	83.1	115.2	170.7*	346.0*
Other	749	40.3	1.94	36.3	44.3	0*	0*	11.2	14.1	21.9	31.9	50.1	76.6	99.0	157.1*	315.6*

[a] Total food includes all foods, beverages, and water ingested.
[b] SE = Standard error of the mean.
[c] LCL = Lower confidence limit of the mean.
[d] UCL = Upper confidence limit of the mean.
[e] Min = Minimum value.
[f] Max = Maximum value.
* Estimates are less statistically reliable based on guidance published in the *Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports: NHIS/NCHS Analytical Working Group Recommendations* (NCHS, 1993).

Source: U.S. EPA analysis of NHANES 2003−2006 data.

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15. HUMAN MILK INTAKE

15.1. INTRODUCTION

Human lactation is known to impart a wide range of benefits to nursing infants, including protection against infection, increases in cognitive development, and avoidance of allergies due to intolerance to cow's milk (AAP, 2005). Ingestion of human milk also has been associated with a reduction in risk of postneonatal death in the United States. (Chen and Rogan, 2004). The American Academy of Pediatrics (AAP) recommends exclusive breast-feeding for approximately the first 6 months and supports the continuation of breast-feeding for the first year and beyond if desired by the mother and child (AAP, 2005). However, contaminants may find their way into human milk of lactating mothers because mothers are themselves exposed, thus making human milk a potential source of exposure to toxic substances for nursing infants. Lipid-soluble chemical compounds accumulate in body fat and may be transferred to breast-fed infants in the lipid portion of human milk. Water soluble chemicals also may partition into the aqueous phase and be excreted via human milk. Because nursing infants obtain most—if not all—of their dietary intake from human milk, they are especially vulnerable to exposures to these compounds. Estimating the magnitude of the potential dose to infants from human milk requires information on the milk intake rate (quantity of human milk consumed per day) and the duration (months) over which breast-feeding occurs. Information on the fat content of human milk also is needed for estimating dose from human milk residue concentrations that have been indexed to lipid content.

Several studies have generated data on human milk intake. Typically, human milk intake has been measured over a 24-hour period by weighing the infant before and after each feeding without changing its clothing (test weighing). The sum of the difference between the measured weights over the 24-hour period is assumed to be equivalent to the amount of human milk consumed daily. Intakes measured using this procedure often are corrected for evaporative water losses (insensible water losses) between infant weighings (NAS, 1991). Neville et al. (1988) evaluated the validity of the test weight approach among bottle-fed infants by comparing the weights of milk taken from bottles with the differences between the infants' weights before and after feeding. When test weight data were corrected for insensible weight loss, they were not significantly different from bottle weights. Conversions between weight and volume of human milk consumed are made using the density of human milk (approximately 1.03 g/mL) (NAS, 1991). Techniques for measuring human milk intake using stable isotopes such as deuterium have been developed. The advantages of these techniques over test weighing procedures are that they are less burdensome for the mother and do not interfere with normal behavior (Albernaz et al., 2003). However, few data based on this technique were found in the literature.

Among infants born in 2004, 73.8% were breast-fed postpartum, 41.5% at 6 months, and 20.9% at 12 months. Studies of nursing mothers in industrialized countries have shown that average intakes among infants ranged from approximately 500 to 800 mL/day, with the highest intake reported for infants 3 to <6 months old (see Table 15-1).

The recommendations for human milk intake rates and lipid intake rates are provided in the next section along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. Environmental Protection Agency (EPA) for this factor. Following the recommendations, key studies on human milk intake are summarized. Relevant data on lipid content and fat intake, breast-feeding duration, and the estimated percentage of the U.S. population that breast-feeds also are presented.

A number of other studies exist in the literature, but they focus on other aspects of lactation such as growth patterns of nursing infants, supplementary food and energy intake, and nutrition of lactating mothers (Dewey et al., 1992; Drewett et al., 1993; Gonzalez-Cossio et al., 1998). These studies are not included in this chapter because they do not focus on the exposure factor of interest. Other studies in the literature focus on formula intake. Because some baby formula is prepared by adding water, these data are presented in Chapter 3-Ingestion of Water and Other Select Liquids.

15.2. RECOMMENDATIONS

The studies described in Section 15.3 were used in selecting recommended values for human milk intake and lipid intake. Although different survey designs, testing periods, and populations were used by the studies to estimate intake, the mean and standard deviation estimates reported in these studies are relatively consistent. There are, however, limitations with the data. With the exception of Butte et al. (1984) and Arcus-Arth et al. (2005), data were not presented on a body weight basis. This is particularly important because intake rates may be higher on a body weight basis for younger infants than older infants. Also, the data used to derive the recommendations are more than 15 years old and the sample size of the studies was small. Other populations of concern—such as mothers highly committed to breast-feeding, sometimes for periods longer than 1 year—may not be captured by the studies presented in this chapter. Note that data for infants 12 months old are not included in the recommendation table because the U.S. EPA's standard age group for children, as described in chapter 1 of this handbook, is 6 to <12 months and it may not be appropriate to use this value to represent the next age group of 1 to <2 years old.

15.2.1. Human Milk Intake

Table 15-1 presents a summary of recommended values for human milk and lipid intake rates, and Table 15-2 presents the confidence ratings for these recommendations. The human milk intake rates for nursing infants that have been reported in the studies described in this section are summarized in Table 15-3 in units of mL/day and in Table 15-4 in units of mL/kg-day (i.e., indexed to body weight). It should be noted that the decrease in human milk with age is likely a result of complementary foods being introduced as the child grows and not necessarily a decrease in total energy intake. To conform to the new standardized age groupings used in this handbook (see Chapter 1), data from Pao et al. (1980), Dewey and Lönnerdal (1983), Butte et al. (1984), Neville et al. (1988), Dewey et al. (1991a), Dewey et al. (1991b), Butte et al. (2000), and Arcus-Arth et al. (2005) were compiled for each month of the first year of life. Recommendations were converted to mL/day by using a density of human milk of 1.03 g/mL, and rounded to two significant figures. Only two studies (i.e., Butte et al., 1984, and Arcus-Arth et al., 2005) provided data on a body weight basis. For some months, multiple studies were available; for others only one study was available. Weighted means were calculated for each age in months. When upper percentiles were not available from a study, they were estimated by adding two standard deviations to the mean value. When multiple studies were available, recommendations for upper percentiles were calculated as the midpoint of the range of upper percentile values of the studies available for each age in months. These month-by-month intakes were composited to yield intake rates for the standardized age groups by calculating a weighted average. Recommendations are provided for the population of exclusively breast-fed infants because this population may have higher exposures than partially breast-fed infants. *Exclusively breast-fed* in this chapter refers to infants whose sole source of milk comes from human milk, with no other milk substitutes. *Partially breast-fed* refers to infants whose source of milk comes from both human milk and other milk substitutes (i.e., formula). Note that some studies define partially breast-fed as infants whose dietary intake comes from not only human milk and formula, but also from other solid foods (e.g., strained fruits, vegetables, meats).

15.2.2. Lipid Content and Lipid Intake

Table 15-5 presents recommended lipid intake rates in units of mL/day. The table parallels the human milk intake tables (see Table 15-3). With the exception of the data from Butte et al. (1984), the rates were calculated assuming a lipid content of 4% (Butte et al., 1984; NAS, 1991; Mitoulas et al., 2002, 2003; Arcus-Arth et al., 2005; Kent et al., 2006). In the case of the Butte et al. (1984) study, lipid intake rates were provided and were used in place of the estimated lipid intakes. Table 15-6 presents lipid intake rates on a body weight basis (mL/kg-day). These were calculated from the values presented in Table 15-4 multiplied by 4% lipid content.

Table 15-1. Recommended Values for Human Milk And Lipid Intake Rates for Exclusively Breast-Fed Infants

	Mean		Upper Percentile[a]		
Age Group	mL/day	mL/kg-day	mL/day	mL/kg-day	Source
Human Milk Intake					
Birth to <1 month	510	150	950	220	b, c
1 to <3 months	690	140	980	190	b, c, d, e, f
3 to <6 months	770	110	1,000	150	b, c, d, e, f, g, h
6 to <12 months	620	83	1,000	130	b, c, d, f, g, h
Lipid Intake[i]					
Birth to <1 month	20	6.0	38	8.7	b, c
1 to <3 months	27	5.5	40	8.0	b, c, d, e, f
3 to <6 months	30	4.2	42	6.1	b, c, d, e, f, g, h
6 to <12 months	25	3.3	42	5.2	b, c, d, f, g, h

[a] Upper percentile is reported as mean plus 2 standard deviations.
[b] Neville et al., 1988.
[c] Arcus-Arth et al., 2005.
[d] Pao et al., 1980.
[e] Butte et al., 1984.
[f] Dewey and Lönnerdal, 1983.
[g] Butte et al., 2000.
[h] Dewey et al., 1991b.
[i] The recommended value for the lipid content of human milk is 4.0 %. See Section 15.4.

Table 15-2. Confidence in Recommendations for Human Milk Intake		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Methodology uses changes in body weight as a surrogate for total ingestion. More sophisticated techniques measuring stable isotopes have been developed, but data with this technique were not available. Sample sizes from individual studies were relatively small (7–108). Mothers selected for the studies were volunteers. The studies analyzed primary data.	
Minimal (or defined) Bias	Mothers were instructed in the use of infant scales to minimize measurement errors. Three out of the eight studies indicated correcting data for insensible water loss. Some biases may be introduced by including partially breast-fed infants.	
Applicability and Utility		Medium
Exposure Factor of Interest	The studies focused on estimating human milk intake.	
Representativeness	Most studies focused on the U.S. population, but were not national samples. Populations studied were mainly from high socioeconomic status. One study included populations from Sweden and Finland. However, this may not affect the amount of intake, but, rather, the prevalence and initiation of lactation.	
Currency	Studies were conducted between 1980 and 2000. However, this may not affect the amount of intake but rather the prevalence and initiation of lactation.	
Data Collection Period	Infants were not studied long enough to fully characterize day-to-day variability.	
Clarity and Completeness		Medium
Accessibility	All key studies are available from the peer-reviewed literature.	
Reproducibility	The methodology was clearly presented, but some studies did not discuss adjustments due to insensible weight loss.	
Quality Assurance	Some steps were taken to ensure data quality. For example, mothers were trained to use the scales. However, this element could not be fully evaluated from the information presented in the published studies.	
Variability and Uncertainty		Low
Variability in Population	Variability was not very well-characterized. Mothers committed to breast-feeding more than 1 year were not captured.	
Uncertainty	Not correcting for insensible water loss may underestimate intake.	
Evaluation and Review		High
Peer Review	The studies appeared in peer-review journals.	
Number and Agreement of Studies	There are eight key studies. The results of studies from different researchers are in agreement.	
Overall Rating		**Medium**

Table 15-3. Human Milk Intake Rates Derived from Key Studies for Exclusively Breast-Fed Infants (mL/day)

Age (months)	Number of Children	Mean Intake (mL/day)	Upper Percentile Consumption (mL/day)[a]	Source	Weighted Mean Intake and Upper Percentile Consumption (across all key studies) (mL/day)			
					Individual Age		Composite Age Groups	
					Mean[b]	Upper[c]	Mean[b]	Upper[c]
0 <1	6 to 13	511	951	Neville et al., 1988	511	951	511	951
1	11	600	918	Pao et al., 1980	670	973	692	983
	37	729	981	Butte et al., 1984				
	10 to 12	679[d]	889	Neville et al., 1988				
	16	673	1,057	Dewey and Lönnerdal, 1983				
2	10 to 12	679[d]	889	Neville et al., 1988	713	992		
	19	756	1,096	Dewey and Lönnerdal, 1983				
	40	704	958	Butte et al., 1984				
3	2	833	–[e]	Pao et al., 1980	758	1,025	769	1,024
	37	702	924	Butte et al., 1984				
	10	713	935	Neville et al., 1988				
	16	782	1,126	Dewey and Lönnerdal, 1983				
	73	788	1,047	Dewey et al., 1991b				
	40	728	988	Butte et al., 2000				
4	12	690	888	Neville et al., 1988	739	991		
	13	810	1,094	Dewey and Lönnerdal, 1983				
	41	718	996	Butte et al., 1984				
5	12	814	1,074	Neville et al., 1988	810	1,057		
	11	805	1,039	Dewey and Lönnerdal, 1983				
6	1	682	–[e]	Pao et al., 1980	741	1,059	622	1,024
	13	744	978	Neville et al., 1988				
	11	896	1,140	Dewey and Lönnerdal, 1983				
	60	747	1,079	Dewey et al., 1991b				
	30	637	1,050	Butte et al., 2000				
7	12	700	1,000	Neville et al., 1988	700	1,000		
8	9	604	1,012	Neville et al., 1988	604	1,012		
9	12	600	1,028	Neville et al., 1988	614	1,039		
	50	627	1,049	Dewey et al., 1991b				
10	11	535	989	Neville et al., 1988	535	989		
11	8	538	1,004	Neville et al., 1988	538	1,004		
12	8	391	877	Neville et al., 1988	410	904	410	904
	42	435	922	Dewey et al., 1991a, b				
	13	403	931	Butte et al., 2000				

[a] Upper percentile is reported as mean plus 2 standard deviations.
[b] Calculated as the mean of the means.
[c] Middle of the range of upper percentiles.
[d] Calculated for infants 1 to <2 months old.
[e] Standard deviations and upper percentiles not calculated for small sample sizes.

Table 15-4. Human Milk Intake Rates Derived from Key Studies for Exclusively Breast-Fed Infants (mL/kg-day)

Age (months)	Number of Children	Mean Intake (mL/kg-day)	Upper Percentile Consumption (mL/kg-day)[a]	Source	Weighted Mean Intake and Upper Percentile Consumption (cross all key studies) (mL/kg-day): Individual Age Mean[b]	Individual Age Upper[c]	Composite Age Groups Mean	Composite Age Groups Upper[c]
0 <1	9 to 25	150	217	Arcus-Arth et al., 2005	150	217	150	217
1	37	154	200	Butte et al., 1984	152	199	144	187
	25	150	198	Arcus-Arth et al., 2005				
2	40	125	161	Butte et al., 1984	135	175		
	25	144	188	Arcus-Arth et al., 2005				
3	37	114	152	Butte et al., 1984	121	158	110	149
	108	127	163	Arcus-Arth et al., 2005				
4	41	108	142	Butte et al., 1984	110	145		
	57	112	148	Arcus-Arth et al., 2005				
5	26	100	140	Arcus-Arth et al., 2005	100	140		
6	39	101	141	Arcus-Arth et al., 2005	101	141	83	130
7	8	75	125	Arcus-Arth et al., 2005	75	125		
9	57	72	118	Arcus-Arth et al., 2005	72	118		
12	42	47	101	Arcus-Arth et al., 2005	47	101	47	101

[a] Upper percentile is reported as mean plus two standard deviations.
[b] Calculated as the mean of the means.
[c] Middle of the range of upper percentiles.

Table 15-5. Lipid Intake Rates Derived from Key Studies for Exclusively Breast-Fed Infants (mL/day)[a]

Age (months)	Number of Children	Mean Intake (mL/day)	Upper Percentile Consumption (mL/day)[b]	Source	Weighted Mean Intake and Upper Percentile Consumption (across all key studies) (mL/day)			
					Individual Age		Composite Age Groups	
					Mean[c]	Upper[d]	Mean[c]	Upper[d]
0 <1	6 to 13	20	38	Neville et al., 1988	20	38	20	38
1	11 37 10 to 12 16	24 27 27 27	37 43 36 42	Pao et al., 1980 Butte et al., 1984 Neville et al., 1988 Dewey and Lönnerdal, 1983	26	39	27	40
2	10 to 12 19 40	27 30 24	36 44 38	Neville et al., 1988 Dewey and Lönnerdal, 1983 Butte et al., 1984	27	40		
3	2 37 10 16 73 40	33 23 29 31 32 29	–[e] 37 37 45 42 40	Pao et al., 1980 Butte et al., 1984 Neville et al., 1988 Dewey and Lönnerdal, 1983 Dewey et al., 1991b Butte et al., 2000	30	41	30	42
4	12 13 41	28 32 25	36 44 41	Neville et al., 1988 Dewey and Lönnerdal, 1983 Butte et al., 1984	28	40		
5	12 11	33 32	43 42	Neville et al., 1988 Dewey and Lönnerdal, 1983	33	43		
6	1 13 11 60 30	27 30 36 30 25	–[e] 39 46 43 42	Pao et al., 1980 Neville et al., 1988 Dewey and Lönnerdal, 1983 Dewey et al., 1991b Butte et al., 2000	30	40	25	42
7	12	28	40	Neville et al., 1988	28	40		
8	9	24	40	Neville et al., 1988	24	40		
9	12 50	24 25	41 42	Neville et al., 1988 Dewey et al., 1991b	24	41		
10	11	21	40	Neville et al., 1988	21	40		
11	9	22	40	Neville et al., 1988	22	40		
12	9 42 13	16 17 16	35 37 37	Neville et al., 1988 Dewey et al., 1991a, b Butte et al., 2000	16	36	16	36

[a] Except for Butte et al. (1984), values were calculated from Table 15-3 using 4% lipid content.
[b] Upper percentile is reported as mean plus 2 standard deviations.
[c] Calculated as the mean of the means.
[d] Middle of the range of upper percentiles.
[e] Standard deviations and upper percentiles not calculated for small sample sizes.

Table 15-6. Lipid Intake Rates Derived from Key Studies for Exclusively Breast-Fed Infants (mL/kg-day)[a]

Age (months)	Number of Children	Mean Intake (mL/kg-day)	Upper Percentile Consumption (mL/kg-day)[b]	Source	Weighted Mean Intake and Upper Percentile Consumption[b] (across all key studies) (mL/kg-day)			
					Individual Age		Composite Age Groups	
					Mean[c]	Upper[d]	Mean[e]	Upper[d]
0 <1	9 to 25	6.0	8.7	Arcus-Arth et al., 2005	6.0	8.7	6.0	8.7
1	37	5.7	9.1	Butte et al., 1984	5.9	8.9	5.5	8.0
	25	6.0	8.7	Arcus-Arth et al., 2005				
2	40	4.3	6.7	Butte et al., 1984	5.1	7.1		
	25	5.8	7.5	Arcus-Arth et al., 2005				
3	37	3.7	6.1	Butte et al., 1984	4.4	6.3	4.2	6.1
	108	5.1	6.5	Arcus-Arth et al., 2005				
4	41	3.7	6.3	Butte et al., 1984	4.1	6.1		
	57	4.5	5.9	Arcus-Arth et al., 2005				
5	26	4.0	5.6	Arcus-Arth et al., 2005	4.0	5.8		
6	39	4.0	5.6	Arcus-Arth et al., 2005	4.0	5.6	3.3	5.2
7	8	3.0	5.0	Arcus-Arth et al., 2005	3.0	5.0		
9	57	2.9	4.7	Arcus-Arth et al., 2005	2.9	4.7		
12	42	1.9	4.0	Arcus-Arth et al., 2005	1.9	4.0	1.9	4.0

[a] Except for Butte et al. (1984), values were calculated from Table 15-4 using 4% lipid content.
[b] Upper percentile is reported as mean plus two standard deviations.
[c] Calculated as the mean of the means.
[d] Middle of the range of upper percentiles.

15.3. KEY STUDIES ON HUMAN MILK INTAKE

15.3.1. Pao et al. (1980)—Milk Intakes and Feeding Patterns of Breast-Fed Infants

Pao et al. (1980) conducted a study of 22 healthy nursing infants to estimate human milk intake rates. Infants were categorized as completely breast-fed or partially breast-fed. Breast-feeding mothers were recruited through La Leche League groups. Except for one Black infant, all other infants were from White middle-class families in southwestern Ohio. The goal of the study was to enroll infants as close to 1 month of age as possible and to obtain records near 1, 3, 6, and 9 months of age (Pao et al., 1980). However, not all mother-infant pairs participated at each time interval. Data were collected for these 22 infants using the test weighing method. Records were collected for three consecutive 24-hour periods at each test interval. The weight of human milk was converted to volume by assuming a density of 1.03 g/mL. Daily intake rates were calculated for each infant based on the mean of the three 24-hour periods. Table 15-7 presents mean daily human milk intake rates for the infants surveyed at each time interval. These data are presented as they are reported in Pao et al. (1980). For completely breast-fed infants, the mean intake rates were 600 mL/day at 1 month of age, 833 mL/day at 3 months of age, and 682 mL/day at 6 months of age. Partially breast-fed infants had mean intake rates of 485 mL/day, 467 mL/day, 395 mL/day, and <554 mL/day at 1, 3, 6, and 9 months of age, respectively. Pao et al. (1980) also noted that intake rates for boys in both groups were slightly higher than for girls.

The advantage of this study is that data for both exclusively and partially breast-fed infants were collected for multiple time periods. Also, data for individual infants were collected over 3 consecutive days, which would account for some individual variability. However, the number of infants in the study was relatively small. In addition, this study did not account for insensible weight loss, which may underestimate the amount of human milk ingested.

15.3.2. Dewey and Lönnerdal (1983)—Milk and Nutrient Intake of Breast-Fed Infants from 1 to 6 Months: Relation to Growth and Fatness

Dewey and Lönnerdal (1983) monitored the dietary intake of 20 nursing infants between age 1 and 6 months. The number of study participants dropped to 13 by the end of the 6th month. Most of the infants in the study were exclusively breast-fed. One infant's intake was supplemented by formula during the first and second month of life. During the 3rd, 4th, and 5th months, three, four, and five infants, respectively, were given some formula to supplement their intake. Two infants were given only formula (no human milk) during the 6th month. According to Dewey and Lönnerdal (1983), the mothers were all well-educated and recruited through Lamaze childbirth classes in the Davis area of California. Human milk intake volume was estimated based on two 24-hour test weighings per month. Table 15-8 presents human milk intake rates for the various age groups. Human milk intake averaged 673, 782, and 896 mL/day at 1, 3, and 6 months of age, respectively.

The advantage of this study is that it evaluated nursing infants for a period of 6 months based on two 24-hour observations per infant per month. However, corrections for insensible weight loss apparently were not made. Also, the number of infants in the study was relatively small, and the study participants were not representative of the general population. During the study period, some infants were given some formula (i.e., up to five infants during the 5th month). Without the raw data, these subjects could not be excluded from the study results. Thus, these subjects may affect the results when deriving recommendations for exclusively breast-fed infants.

15.3.3. Butte et al. (1984)—Human Milk Intake and Growth in Exclusively Breast-Fed Infants

Human milk intake was studied in exclusively breast-fed infants during the first 4 months of life (Butte et al., 1984). Nursing mothers were recruited through the Baylor Milk Bank Program in Texas. Forty-five mother-infant pairs participated in the study. However, data for some time periods (i.e., 1, 2, 3, or 4 months) were missing for some mothers as a result of illness or other factors. The mothers were from the middle-to-upper socioeconomic stratum and had a mean age of 28.0 ± 3.1 years. A total of 41 mothers were White, 2 were Hispanic, 1 was Asian, and 1 was West Indian. Infant growth progressed satisfactorily during the course of the study.

The amount of milk ingested over a 24-hour period was determined by weighing the infant before and after feeding. The study did not indicate whether the data were corrected for insensible water or weight loss. The study evaluated the accuracy of the test weighing procedure using a bottle-fed infant. Test weighing occurred over a 24-hour period for most study participants, but intake among several infants was studied over longer periods (48 to 96 hours) to assess individual variation in intake. Eight of the infants received some food supplementation during the study period. Six of them received less than 60 kcal/day of formula, oatmeal, glucose water, or rice water for 1 or 2 days. One infant received an additional 90 kcal/day of infant formula and rice water for 6 days during the 4th month because of inadequate milk production. When converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake ranged from 702 mL/day at 3 months to 729 mL/day at 1 month, with an overall mean of 712 mL/day for the entire study period (see Table 15-9). Intakes also were calculated on the basis of body weight (see Table 15-9).

The advantage of this study is that data for a larger number of exclusively breast-fed infants were collected than in previous studies. However, data were collected for infants up to 4 months and day-to-day variability was not characterized for all infants. Eighteen percent (i.e., 8 out of 45) of the infants received some formula supplementation during the study period. Without the raw data, these subjects could not be excluded from the study results. Therefore, values derived from this study for exclusively breast-fed infants may be somewhat underestimated.

15.3.4. Neville et al. (1988)—Studies in Human Lactation: Milk Volumes in Lactating Women During the Onset of Lactation and Full Lactation

Neville et al. (1988) studied human milk intake among 13 infants during the 1st year of life. The mothers were all multiparous, non-smoking, White women of middle- to upper-socioeconomic status living in Denver, CO. All women in the study practiced exclusive breast-feeding for at least 5 months. Solid foods were introduced at mean age of 7 months. Daily milk intake was estimated by the test weighing method with corrections for insensible weight loss. Data were collected daily from birth to 14 days, weekly from weeks 3 through 8, and monthly until the study period ended at 1 year after inception. One infant was weaned at 8 months, while all others were weaned on or after the 12 months. Formula was used occasionally (≤ 240 mL/week) after 4 months in three infants. Table 15-10 lists the estimated human milk intakes for this study. Converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intakes were 748 mL/day, 713 mL/day, 744 mL/day, and 391 mL/day at 1, 3, 6, and 12 months of age, respectively.

In comparison to the previously described studies, Neville et al. (1988) collected data on numerous days over a relatively long time period (12 months) and they were corrected for insensible weight loss. However, the intake rates presented in Table 15-10 are estimated based on intake only during a 24-hour period. Consequently, these intake rates are based on short-term data that do not account for day-to-day variability among individual infants. Also, a smaller number of subjects was included than in the previous studies. Three infants were given some formula after 4 months. Without the raw data, these subjects could not be excluded from the study results. Thus, data presented for infants between 5 and 12 months may underestimate the intake of exclusively breast-fed infants.

15.3.5. Dewey et al. (1991a, b)—(a) Maternal Versus Infant Factors Related to Human Milk Intake and Residual Volume: The DARLING Study; (b) Adequacy of Energy Intake among Breast-Fed Infants in the DARLING Study: Relationships to Growth, Velocity, Morbidity, and Activity Levels

The Davis Area Research on Lactation, Infant Nutrition and Growth (DARLING) study was conducted in 1986 to evaluate growth patterns, nutrient intake, morbidity, and activity levels in infants who were breast-fed for at least their first 12 months of life (Dewey et al., 1991a, b). Subjects were non-randomly selected through letters to new parents using birth listings. One of the criteria used for selection was that mothers did not plan to feed their infants more than 120 mL/day of other milk or formula for the first 12 months of life. Seventy-three infants aged 3 months were included in the study. At subsequent time intervals, the number of infants included in the study was somewhat lower as a result of attrition. All infants in the study were healthy and of normal gestational age and weight at birth, and they did not consume solid foods until after they were 4 months old. The mothers were highly educated and of "relatively high socioeconomic status."

Human milk intake was estimated by weighing the infants before and after each feeding and correcting for insensible water loss. Test weighings were conducted over a 4-day period every 3 months. The results of the study indicate that human milk intake declines over the first 12 months of life. This decline is associated with the intake of solid food. When converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake was estimated to be 788 mL/day, 747 mL/day, 627 mL/day, and 435 mL/day at 3, 6, 9, and 12 months, respectively (see Table 15-11). Based on the estimated intakes at 3 months of age, variability between individuals (coefficient of variation ([CV] = 16.3%) was higher than the average day-to-day variability ([CV] = 8.9 ± 5.4%)) for the infants in the study (Dewey et al., 1991a).

The advantages of this study are that data were collected over a relatively long-time (4 days) period at each test interval, which would account for some day-to-day infant variability, and corrections for insensible water loss were made. Data from this study are assumed to represent exclusively breast-fed infants because mothers were specifically recruited for that purpose. It is, however, unclear from the Dewey et al. (1991a) study if this criterion was met throughout the length of the study period.

15.3.6. Butte et al. (2000)—Infant Feeding Mode Affects Early Growth and Body Composition

Butte et al. (2000) conducted a study to assess the effect of infant feeding mode on growth and body composition during the first 2 years of life. The study was conducted in the Houston, TX, area, recruited through the Children's Nutrition Research Center (CNRC) referral system. The study was approved by the Baylor Affiliates Review Boards for Human Subject Research. The overall sample was 76 healthy term infants at 0.5, 3, 6, 9, 12, 18, and 24 months of age. The sample size varied between 71 to 76 infants for each age group. Repeated measurements for body composition and anthropometric were performed. The mothers agreed to either exclusively breast-feed or formula feed the infants for the first 4 months of life.

At 3-month or 6-month study intervals, the feeding history was taken. The mothers or caretakers were questioned about breast-feeding frequency, and the use of formula, milk, juice, solids, water, and vitamin or mineral supplements. Also, infant food intake was quantified at 3, 6, 12, and 24 months with a 3-day weighted intake record completed by the mother or caretaker (Butte et al., 2000). The intake of human milk was assessed by test weighing; the infant weights were calculated before and after each feeding. Using a pre-weighing and post-weighing method, the intake of formula and other foods and beverages was measured for 3 days by the mothers using a digital scale and recorded on predetermined forms.

The average duration of breast-feeding was 11.4 months (standard deviation [SD] = 5.8). Butte et al. (2000) reported that infants were exclusively breast-fed for at least the first 4 months—except for one who was weaned at 109 days, another who received formula at 102 days, and another who was given cereal at 106 days. Table 15-12 shows the infant feeding characteristics. Table 15-13 shows the intakes of human milk for the infants. When converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake was estimated to be 728 mL/day at 3 months (weighted average of boys and girls), 637 mL/day at 6 months (weighted average of boys and girls), and 403 mL/day at 12 months (weighted average of boys and girls) (see Table 15-13). Table 15-14 shows feeding practices by percentage for infants. Table 15-15 provides the mean body weights of breast-fed infants.

Advantages of this study are that it provides intake data for breast-fed infants for their first 4 months. The study also provides the mean weights for the infants by feeding type and by sex. The limitations of the study are that the sample size is small and limited to one geographical location. The authors did not indicate if results were corrected for insensible weight loss. Because mothers could introduce formula after 4 months, only the data for the 3-month old infants can be considered exclusively breast-fed.

15.3.7. Arcus-Arth et al. (2005)—Human Milk and Lipid Intake Distributions for Assessing Cumulative Exposure and Risk

Arcus-Arth et al. (2005) derived population distributions for average daily milk and lipid intakes in g/kg-day for infants age 0–6 months and 0–12 months for infants fed according to the AAP recommendations. The AAP recommends exclusively breast-feeding for the first 6 months of life, with human milk as the only source of milk until age 1 year and the introduction of solid foods after 6 months. The distributions were derived based on data in the peer-reviewed literature and data sets supplied by the publication authors for infants 7 days and older (Arcus-Arth et al., 2005). As cited in Arcus-Arth et al. (2005), data sources included Dewey et al. (1991a, b), Hofvander et al. (1982), Neubauer et al. (1993), Ferris et al. (1993), Salmenpera et al. (1985), and Stuff and Nichols (1989). The authors also evaluated intake rates for infants breast-fed exclusively over the 1st year and provided a regression line of intake versus age for estimating short-term exposures. Arcus-Arth et al. (2005) derived human milk intake rates for the entire infant population (nursing and non-nursing) from U.S. data on consumption, prevalence and duration.

Arcus-Arth et al. (2005) defined *exclusive breast-feeding* (EBF) as "breast milk is the sole source of calories, with no or insignificant calories from other liquid or solid food sources," and *predominant breast-feeding* as "breast milk is the sole milk source with significant calories from other foods." The data that were consistent with AAP advice were used to construct the AAP data set (Arcus-Arth et al., 2005). The 0–12 months EBF data set was created using 0–6 month AAP data and data from the EBF infants older than 6 months of age. Because there are no data in the AAP data set for any individual infant followed at regular, frequent intervals during the 12-month period, population distributions were derived with assumptions regarding individual intake variability over time (Arcus-Arth et al., 2005). Two methods were used. In Method 1, the average population daily intake at each age was described by a regression line, assuming normality. Arcus-Arth et al. (2005) noted that age specific intake data were consistent with the assumption of normality. In Method 2, intake over time was simulated for 2,500 hypothetical infants and the distribution intakes derived from 2,500 individual intakes (Arcus-Arth et al., 2005). The population intake distribution was derived following Method 1. Table 15-16 presents the means and standard deviations for intake data at different ages; the variability was greatest for the two youngest and three oldest age groups. The values in Table 15-16 using Method 1 were used to derive the recommendations presented in Table 15-1 because it provides data for the fine age categories. When converting values reported as g/day to mL/day, using a conversion factor of 1.03 g/mL, mean human milk intake was estimated to be 150 mL/kg-day at 1 month, 127 mL/kg-day at 3 months, 101 mL/kg-day at 6 months, and 47 mL/kg-day at 12 months (see Table 15-16). Time weighted average intakes for larger age groups (i.e., 0–6 months, 0–12 months) are presented in Table 15-17.

An advantage of this study is that it was designed to represent the infant population whose mothers follow the AAP recommendations. Intake was calculated on a body weight basis. In addition, the data used to derive the distributions were from peer-reviewed literature and data sets supplied by the publication authors. The distributions were derived from data for infants fed in accordance to AAP recommendations, and they most likely represent daily average milk intake for a significant portion of breast-fed infants today (Arcus-Arth et al., 2005). The limitations of the study are that the data used were from mothers who were predominantly White, well-nourished, and from middle or high socioeconomic status. Arcus-Arth et al. (2005) also included data from Sweden and Finland. However, human milk volume in mL/day is similar among all women except for severely malnourished women (Arcus-Arth et al., 2005). According to Arcus-Arth et al. (2005): "Although few infants are exclusively breast-fed for 12 months, the EBF distributions may represent a more highly exposed subpopulation of infants exclusively breast-fed in excess of 6 months."

15.4. KEY STUDIES ON LIPID CONTENT AND LIPID INTAKE FROM HUMAN MILK

Human milk contains more than 200 constituents, including lipids, various proteins, carbohydrates, vitamins, minerals, and trace elements as well as enzymes and hormones. The lipid content of human milk varies according to the length of time that an infant nurses, and it increases from the beginning to the end of a single nursing session (NAS, 1991). The lipid portion accounts for approximately 4% of human milk (3.9% ± 0.4%) (NAS, 1991). This value is supported by various studies that evaluated lipid content from human milk (Butte et al., 1984; Mitoulas et al., 2002, 2003; Arcus-Arth et al., 2005; Kent et al., 2006). Several studies also estimated the quantity of lipid consumed by breast-feeding infants. These values are appropriate for performing exposure assessments for nursing infants when the contaminant(s) have residue concentrations that are indexed to the fat portion of human milk.

15.4.1. Butte et al. (1984)—Human Milk Intake and Growth in Exclusively Breast-Fed Infants

Butte et al. (1984) analyzed the lipid content of human milk samples taken from women who participated in a study of human milk intake among exclusively breast-fed infants. The study was conducted with more than 40 women during a 4-month period. Table 15-18 presents the mean lipid content of human milk at various infants' ages. The overall lipid content for the 4-month study period was 3.43 ± 0.69% (3.4%). Butte et al. (1984) also calculated lipid intakes from 24-hour human milk intakes and the lipid content of the human milk samples. Lipid intake was estimated to range from 22.9 mL/day (3.7 mL/kg-day) to 27.2 mL/day (5.7 mL/kg-day).

The number of women included in this study was small, and these women were selected primarily from middle to high socioeconomic classes. Thus, data on human milk lipid content from this study may not be entirely representative of human milk lipid content among the U.S. population. Also, these estimates are based on short-term data, and day-to-day variability was not characterized.

15.4.2. Mitoulas et al. (2002)—Variation in Fat, Lactose, and Protein in Human Milk Over 24 h and Throughout the First Year of Lactation

Mitoulas et al. (2002) conducted a study of healthy nursing women to determine the volume and composition of human milk during the 1st year of lactation. Nursing mothers were recruited through the Nursing Mothers' Association of Australia. All infants were completely breast-fed on demand for at least 4 months. Complementary solid food was introduced between 4 and 6 months of age. Mothers consumed their own ad libitum diets throughout the study. Seventeen mothers initially provided data for milk production and fat content, whereas lactose, protein, and energy were initially obtained from nine mothers. The number of mothers participating in the study decreased at 6 months because of the cessation of sample collection from 11 mothers, the maximum period of exclusive breast-feeding.

Milk samples were collected before and after each feed from each breast over a 24–28 hour period. Milk yield was determined by weighing the mother before and after each feed from each breast. Insensible water loss was accounted for by weighing the mother 20 minutes after the end of each feeding. The rate of water loss during this 20-minute period was used to calculate insensible water loss during the feeding. Samples of milk produced at the beginning of the feeding (foremilk) and at the end of the feeding (hindmilk) were averaged to provide the fat, protein, lactose, and energy content for each feed. In all cases the left and right breasts were treated separately; therefore, *N* represents the number of individual breasts sampled.

Table 15-19 presents mean human milk production and composition at each age interval. The mean fat, lactose, and protein contents (g/L) were 37.4 (standard error [SE] = 0.6), 61.4 (SE = 0.6), and 9.2 (SE = 0.2), respectively. Composition did not vary between left and right breasts or preferred and non-preferred breasts. Milk production was constant for the first 6 months and thereafter steadily declined. Mitoulas et al. (2002) reported a mean 24-hour milk production from both breasts was 798 (SD = 232) mL. The fat content of milk decreased between 1 and 4 months before increasing to 12 months of lactation. The concentration of protein decreased to 6 months and then remained steady. Lactose remained constant throughout the 12 months of lactation. The decrease of energy at 2 months and subsequent increase by 9 months can be attributed to changes in fat content. Assuming a density of human milk of 1.03 g/mL, the overall fat content in human milk was 3.6%. Milk production, as well as concentrations of fat, lactose, protein, and energy, differed significantly between women.

The focus of this study was on human milk composition and production, not on infant's human milk intake. The advantage of this study is that it evaluated nursing mothers for a period of 12 months. However, the number of mother-infant pairs in the study was small (17 mothers with infants) and may not be entirely representative of the U.S. population. This study accounted for insensible water loss, which increases the accuracy of the amount of human milk produced.

15.4.3. Mitoulas et al. (2003)—Infant Intake of Fatty Acids from Human Milk Over the First Year of Lactation

Mitoulas et al. (2003) conducted a study of five healthy nursing women to determine the content of fat in human milk and fat intake by infants during the 1st year of lactation. Thirty nursing mothers were recruited through the Australian Breast-feeding Association or from private healthcare facilities. All infants were completely breast-fed on demand for at least 4 months. Complementary solid food was introduced between 4 and 6 months of age. Mothers consumed their own ad libitum diets throughout the study.

Milk samples were collected before and after each feed from each breast over a 24–28 hour period. Fore- and hind-milk samples were averaged to provide the fat content for each feed. Milk yield was determined by weighing the mother before and after each feed from each breast. Insensible water loss was accounted for by weighing the mother 20 minutes after the end of each feeding. The rate of water loss during those 20 minutes was used to calculate insensible water loss during the feeding.

Table 15-20 presents changes in volume of human milk produced and milk fat content over the 1st year of lactation. The mean volumes of milk produced for both breasts combined were 813, 791, 912, 810, 677, and 505 mL/day at 1, 2, 4, 6, 9, and 12 months, respectively. The average daily production over the 12 months was 751 mL/day with a mean fat content of 35.5 g/L. Assuming a density of human milk of 1.03 g/mL, the fat content in human milk was 3.4% over the 12 month period. There was a significant difference in the proportional composition of fatty acids during the course of lactation. Table 15-21 provides average fatty acid composition during the first 12 months of lactation. Additionally, fatty acid composition varied during the course of the day.

The focus of this study was on human milk composition and production—not on infant's human milk intake. The advantage of this study is that it evaluated the human milk composition for a period of 12 months. However, the number of mother-infant pairs in the study was small (five mothers with infants) and may not be entirely representative of the entire U.S. population. This study accounted for insensible water loss, which increases the accuracy of the amount of human milk produced.

15.4.4. Arcus-Arth et al. (2005)—Human Milk and Lipid Intake Distributions for Assessing Cumulative Exposure and Risk

Arcus-Arth et al. (2005) derived population distributions for average daily milk and lipid intakes in g/kg a day for infants 0–6 months and 0–12 months of age for infants fed according to the AAP recommendations. Lipid intakes were calculated from lipid content and milk intakes measured on the same infant (Arcus-Arth et al., 2005). Table 15-22 provides lipid intakes based on data from Dewey et al. (1991a) and Table 15-23 provides lipid intakes calculated assuming 4% lipid content and milk intake in the AAP data set. The mean measured lipid content ranged from 3.67%–4.16%, with a mean of 3.9% over the 12 month period. Arcus-Arth et al. (2005) noted that the distributions presented are intended to represent the U.S. infant population.

An advantage of this study is that it was designed to represent the population of infants who are breast-fed according to the AAP recommendations. In addition, the data used to derive the distributions were from peer-review literature and data sets supplied by the publication authors. The limitation of the study are that the data used were from mothers that were predominantly white, well-nourished, and from mid- or upper-socioeconomic status; however, human milk volume in mL/day is similar among all women except for severely malnourished women (Arcus-Arth et al., 2005). The authors noted that "although few infants are exclusively breast-fed for 12 months, the exclusively breast-fed distributions may represent a more highly exposed subpopulation of infants exclusively breast-fed in excess of 6 months." The distributions were derived from data for infants fed in accordance to AAP recommendations, and they most likely represent daily average milk intake for a significant portion of breast-fed infants today (Arcus-Arth et al., 2005).

15.4.5. Kent et al. (2006)—Volume and Frequency of Breast-Feeding and Fat Content of Breast Milk Throughout the Day

Kent et al. (2006) collected data from 71 Australian mothers who were exclusively nursing their 1–6 month-old infants. The study focused on examining the variation of milk consumed from each breast, the degree of fullness of each breast before and after feeding, and the fat content of milk consumed from each breast during daytime and nighttime feedings. The volume of milk was measured using test-weighing procedures with no correction for infant insensible water loss. On average, infants had 11 ± 3 breast-feedings per day (range = 6–18). The interval between feedings was 2 hours and 18 minutes ± 43 minutes (range = 4 minutes to 10 hours, 58 minutes). The 24-hour average human milk intake was 765 ± 164 mL/day (range = 464–1,317 mL/day). The fat content of milk ranged from 22.3 g/L to 61.6 g/L (2.2%–6.0%) with an average of 41.1 g/L (4.0%).

This study examined breast-feeding practices of volunteer mothers in Australia. Although amounts of milk consumed by Australian infants may be similar to infants in the U.S. population, results could not be broken out by smaller age groups to examine variability with age. The study provides estimates of fat content from a large number of samples.

15.5. RELEVANT STUDY ON LIPID INTAKE FROM HUMAN MILK

15.5.1. Maxwell and Burmaster (1993)—A Simulation Model to Estimate a Distribution of Lipid Intake from Human Milk During the First Year of Life

Maxwell and Burmaster (1993) used a hypothetical population of 5,000 infants between birth and 1 year of age to simulate a distribution of daily lipid intake from human milk. The hypothetical population represented both bottle-fed and breast-fed infants aged 1–365 days. A distribution of daily lipid intake was developed based on data in Dewey et al. (1991b) on human milk intake for infants at 3, 6, 9, and 12 months and human milk lipid content, and survey data in Ryan et al. (1991) on the percentage of breast-fed infants under 12 months (i.e., approximately 22%). A model was used to simulate intake among 1,113 of the 5,000 infants expected to be breast-fed. The results indicated that lipid intake among nursing infants under 12 months can be characterized by a normal distribution with a mean of

26.0 mL/day and a standard deviation of 7.2 mL/day (see Table 15-24). The model assumes that nursing infants are completely breast-fed and does not account for infants who are breast-fed longer than 1 year. Based on data collected by Dewey et al. (1991b), Maxwell and Burmaster (1993) estimated the lipid content of human milk to be 36.7 g/L at 3 months (35.6 mg/g or 3.6%), 39.2 g/L at 6 months (38.1 mg/g or 3.8%), 41.6 g/L at 9 months (40.4 mg/g or 4.0%), and 40.2 g/L at 12 months (39.0 mg/g or 3.9%).

The limitation of this study is that it provides a snapshot of daily lipid intake from human milk for breast-fed infants. These results also are based on a simulation model and there are uncertainties associated with the assumptions made. Another limitation is that lipid intake was not derived for the U.S. EPA recommended age categories. The estimated mean lipid intake rate represents the average daily intake for nursing infants under 12 months. The study also did not generate new data. A reanalysis of previously reported data on human milk intake and human milk lipid intake were provided.

15.6. OTHER FACTORS

Many factors influence the initiation, continuation, and amount of human milk intake. These factors are complex and may include considerations such as maternal nutritional status, parity, parental involvement, support from lactation consultants, mother's working status, infant's age, weight, sex, food supplementation, the frequency of breast-feeding sessions each day, the duration of breast-feeding for each event, the duration of breast-feeding during childhood, ethnicity, geographic area, and other socioeconomic factors. For example, a study conducted in the United Kingdom found that social and educational factors most influenced the initiation and continuation of lactation (Wright et al., 2006). Prenatal and postnatal lactation consultant intervention was found to be effective in increasing lactation duration and intensity (Bonuck et al., 2005).

15.6.1. Population of Nursing Infants

Breast-feeding rates in the United States have consistently increased since 1993. McDowell et al. (2008) reported that the percentage of infants who were ever breast-fed increased from 60% in 1993–1994 to 77% among infants born in 2005–2006 according to the data from the National Health and Nutrition Examination Surveys (NHANES). This exceeded the goal of 75% set in the Healthy People 2010 McDowell et al. (2008). Rates among non-Hispanic black women increased significantly from 36% in 1993–1994 to 65% in 2005–2006. Income and age had a significant impact on breast-feeding rates. Breast-feeding rates among higher income women were 74% compared to 57% among lower income women (McDowell et al., 2008).

In another study to monitor progress toward achieving the Centers for Disease Control and Prevention (CDC) *Healthy People 2010* breast-feeding objectives (initiation and duration), Scanlon et al. (2007) analyzed data from the National Immunization Survey (NIS). NIS uses random-digit dialing to survey households to survey age-eligible children, followed by a mail survey to eligible children's vaccination providers to validate the vaccination information. NIS is conducted annually by the CDC to obtain national, state, and selected urban area estimation on vaccinations rates among U.S. children ages 19–35 months. The interview response rate for years 2001–2006 ranged between 64.5% and 76.1%. Questions regarding breast-feeding were added to the NIS survey in 2001. The sample population was infants born during 2000–2004. Scanlon et al. (2007) noted that because data in their analysis are for children ages 19–35 months at the time of the NIS interview, each cross-sectional survey includes children from birth cohorts that span 3 calendar years; the breast-feeding data were analyzed by year-of-birth during 2000–2004 (birth year cohort instead if survey year).

Among infants born in 2000, breast-feeding rates were 70.9% (CI = 69.0–72.8) for the postpartum period (in hospital before discharge), 34.2% (CI = 32.2–36.2) at 6 months, and 15.7 (CI = 14.2–17.2) at 12 months. For infants born in 2004, these rates had increased to 73.8% (CI = 72.8–74.8) for the postpartum period, 41.5% (CI = 40.4–42.6) at 6 months, and 20.9 (CI = 20.0–21.8) at 12 months. Rates of breast-feeding through 3 months were lowest among black infants (19.8%), infants whose mothers were <20 years of age (16.8%), those whose mothers had a high school education or less (22.9% and 23.9%), those whose mothers were unmarried (18.8%), those who resided in rural areas (23.9%), and those whose families had an income-to-poverty ratio of <100% (23.9%). Table 15-25 shows data for exclusive breast-feeding through 3 and 6 months by socioeconomic characteristics for infants born in 2004.

Scanlon et al. (2007) noted the following limitations could affect the utility of these data: (1) breast-feeding behavior was based on retrospective self-report by mothers or other caregivers, whose responses might be subject to recall bias; (2) the NIS question defining early postpartum breast-feeding or initiation—"Was [child's name] ever breast-fed or fed breast milk?"—collects information that might differ from the HP2010 objective for initiation; and (3) although survey data were weighted to make them representative of all U.S. children ages 19–35 months, some bias might remain. The advantage of the study is that is representative of the U.S. infant population.

In 2007, CDC released the CDC Breast-feeding Report Card, which has been updated every year since. The CDC National Immunization Program in partnership with the CDC National Center for Health Statistics conducts the NIS within all 50 states, the District of Columbia, and selected geographic areas within the states. Five breast-feeding goals are in the *Healthy People 2010* report. The Breast-feeding Report Card presents data for each state for the following categories of infants: ever breast-fed, breast-fed at 6 months, breast-fed at 12 months, exclusive breast-feeding through 3 months, and exclusive breast-feeding through 6 months (CDC, 2009). These indicators are used to measure a state's ability to promote, protect, and support breast-feeding. Table 15-26 presents these data for the estimated percentage of infants born in 2006. The advantage of this report is that it provides data for each state and is representative of the U.S. infant population.

Analysis of breast-feeding practices in other developing countries also was found in the literature. Marriott et al. (2007) researched feeding practices in developing countries in the first year of life, based on 24-hour recall data. Marriott et al. (2007) used secondary data from the Demographic and Health Surveys (DHS) for more than 35,000 infants in 20 countries. This survey has been conducted since 1986 and was expanded to provide a standardized survey instrument that can be used by developing countries to collect data on maternal-infant health and intake and household variables, as well as to build national health statistics (Marriott et al., 2007). The analysis was based on the responses of the survey mothers for questions on whether they were currently breast-feeding and had fed other liquids and solid foods to their infants in the previous 24 hours. The data incorporated were from between 1999 and 2003. Marriott et al. (2007) selected the youngest infant (i.e., less than 1 year old) in each of the families; multiples were included such as twins or triplets. Separate analyses were conducted for infants less than 6 months old and infants 6 months and older, but less than 12 months old. Food and liquid variables other than water and infant formulas were collapsed into broader food categories for cross-country comparisons (Marriott et al., 2007). Tinned, powdered, and any other specified animal milks were collapsed. In addition, all other liquids such as herbal teas, fruit juices, and sugar water (excluding unique country-specific liquids) were collapsed into other liquids and the 10 types of solid food groups into an any-solid-foods category (Marriott et al., 2007). Data were pooled from the 20 countries to provide a large sample size and increase statistical power. Tables 15-27 and 15-28 present the percentage of mothers who were currently breast-feeding and separately had fed their infants other liquids or solid food by age groups. Table 15-29 presents the pooled data summary for the study period. The current breast-feeding was consistent across countries for both age groups; the countries that reported the highest percentages of current breast-feeding for the 0- to 6-month-old infants also reported the highest percentages in the 6- to 12-month-old infants. Pooled data show that 96.6% of the 0- to 6-month-old infants and 87.9% of the 6- to 12-month-old infants were breast-feeding. Feeding of other fluids was lowest in the 0- to 6-month-old infants, with the percentage feeding water the highest of this category. The percentage of mothers feeding commercial infant formulas was the lowest in most countries.

There are other older studies that analyze ethnic and racial differences in breast-feeding practices. Li and Grummer-Strawn (2002) investigated ethnic and racial disparities in lactation in the United States using data from the NHANES III that was conducted between 1988 and 1994. NHANES II participants were ages 2 months and older. The data were collected during a home interview from a parent or a proxy respondent for the child (Li and Grummer-Strawn, 2002). The sample population consisted of children 12–71 months of age at time of interview. The NHANES III response rate for children participating was approximately 94% (Li and Grummer-Strawn, 2002). Data for a total of 2,863 exclusively breast-fed, 6,140 ever breast-fed, and 6,123 continued breast-fed children were included in the analysis (Li and Grummer-Strawn, 2002). The percentage of children ever breast-fed was 60% among non-Hispanic Whites, 26% among non-Hispanic Blacks, and 54% among Mexican Americans. This percentage decreased to 27%, 9%, and 23% respectively by 6 months. The percentage of children fed exclusively human milk at 4 months also was significantly lower for Blacks at 8.5%, compared to 22.6% for Whites and 14.1% for Mexican Americans. The racial and ethnic differences in proportion of children ever breast-fed is presented in Table 15-30, the proportion of children who received any breast milk at 6 months are presented in

Table 15-31, and the proportion of children exclusively breast-fed at 4 months is presented in Table 15-32.

Li and Grummer-Strawn (2002) noted that there may have been some lag time between birth and the time of the interview. This may have caused misclassification if the predicator variables changed considerably between birth and the time of interview. Also, NHANES III did not collect information on maternal education. Instead, the educational level of the household head was used as a proxy. The advantage of this study is that it is representative of the U.S. children's population.

Data from some older studies provide historical information on breast-feeding practices in the United States. These data are provided in this chapter to show trends in the U.S. population. In 1991, the National Academy of Sciences (NAS) reported that the percentage of breast-feeding women has changed dramatically over the years (NAS, 1991). The Ross Products Division of Abbott Laboratories conducted a large national mail survey in 1995 to determine patterns of breast-feeding during the first 6 months of life. The Ross Laboratory Mothers' Survey was first developed in 1955 and has been expanded to include many more infants. Before 1991, the survey was conducted on a quarterly basis, and approximately 40,000 to 50,000 questionnaires were mailed each quarter (Ryan, 1997). Beginning in 1991, the survey was conducted monthly; 35,000 questionnaires were mailed each month. Over time, the response rate has been consistently in the range of 50 ± 5%. In 1989 and 1995, 196,000 and 720,000 questionnaires were mailed, respectively. Ryan (1997) reported rates of breast-feeding through 1995 and compared them with those in 1989.

The survey demonstrates increases in both the initiation of breast-feeding and continued breast-feeding at 6 months of age between 1989 and 1991. Table 15-33 presents the percentage of breast-feeding in hospitals and at 6 months of age by selected demographic characteristics. In 1995, the incidence of breast-feeding at birth and at 6 months for all infants was approximately 59.7% and 21.6%, respectively. The largest increases in the initiation of breast-feeding between 1989 and 1995 occurred among women who were black, were less than 20 years of age, earned less than $10,000 per year, had no more than a grade school education, were living in the South Atlantic region of the United States, had infants of low birth weight, were employed full time outside the home at the time they received the survey, and participated in the Women, Infants, and Children program (WIC). In 1995, as in 1989, the initiation of breast-feeding was highest among women who were more than 35 years of age, earned more than $25,000 per year, were college-educated, did not participate in the WIC program, and were living in the Mountain and Pacific regions of the United States.

Data on the actual length of time that infants continue to breast-feed beyond 5 or 6 months were limited (NAS, 1991). However, Maxwell and Burmaster (1993) estimated that approximately 22% of infants under 1 year are breast-fed. This estimate was based on a reanalysis by Ryan et al. (1991) of survey data collected by Ross Laboratories (Maxwell and Burmaster, 1993). Studies also have indicated that breast-feeding practices may differ among ethnic and socioeconomic groups and among regions of the United States. More recently, the Ross Products Division of Abbott Laboratories reported the results of their ongoing *Ross Mothers Survey* in 2003 (Abbott Laboratories, 2003). Table 15–34 presents the percentages of mothers who breast-feed, based on ethnic background and demographic variables. These data update the values presented in the NAS 1991 report.

15.6.2. Intake Rates Based on Nutritional Status

Information on differences in the quality and quantity of human milk on the basis of ethnic or socioeconomic characteristics of the population is limited. Lönnerdal et al. (1976) studied human milk volume and composition (nitrogen, lactose, proteins) among underprivileged and privileged Ethiopian mothers. No significant differences were observed between the data for these two groups. Similar data were observed for well-nourished Swedish mothers. Lönnerdal et al. (1976) stated that these results indicate that human milk quality and quantity are not affected by maternal malnutrition. However, Brown et al. (1986a, b) noted that the lactational capacity and energy concentration of marginally nourished women in Bangladesh were "modestly less than in better nourished mothers." Human milk intake rates for infants of marginally nourished women in this study were 690 ± 122 g/day at 3 months, 722 ± 105 g/day at 6 months, and 719 ± 119 g/day at 9 months (Brown et al., 1986a). Brown et al. (1986a) observed that human milk from women with larger measurements of arm circumference and triceps skinfold thickness had higher concentrations of fat and energy than mothers with less body fat. Positive correlations between maternal weight and milk fat concentrations also were observed. These results suggest that milk composition may be affected by maternal nutritional status.

15.6.3. Frequency and Duration of Feeding

Hofvander et al. (1982) reported on the frequency of feeding among 25 bottle-fed and 25 breast-fed infants at ages 1, 2, and 3 months. The mean number of meals for these age groups was approximately five meals a day (see Table 15-35). Neville et al. (1988) reported slightly higher mean feeding frequencies. The mean number of meals per day for exclusively breast-fed infants was 7.3 at ages 2–5 months and 8.2 at ages 2 weeks to 1 month. Neville et al. (1988) reported that, for infants between the ages of 1 week and 5 months, the average duration of a breast-feeding session is 16–18 minutes.

Buckley (2001) studied the breast-feeding patterns, dietary intake, and growth measurement of children who continued to breast-feed beyond 1 year of age. The sample was 38 mother-child pairs living in the Washington, DC, area. The criteria for inclusion in the study were that infants or their mothers had no hospitalization of either subject 3 months prior to the study and that the mother was currently breast-feeding a 1-year-old or older child (Buckley, 2001). The participants were recruited through local medical consultants and the La Leche League members. The children selected as the final study subjects consisted of 22 boys and 16 girls with ages ranging from 12 to 43 months old. The data were collected using a 7-day breast-feeding diary. The frequency and length of breast-feeding varied with the age of the child (Buckley, 2001). The author noted a statistically significant difference in the mean number of breast-feeding episodes each day and the average total minutes of breast-feeding between the 1-, 2-, and 3-year-old groups. Table 15-36 provides the comparison of breast-feeding patterns between age groups. An advantage of this study is that the frequency and duration data are based primarily on a 7-day diary and some dietary recall. Limitations of the study are the small sample size and that it is limited to one geographical area.

15.7. REFERENCES FOR CHAPTER 15

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Table 15-7. Daily Intakes of Human Milk

Age	Number of Infants	Intake	
		Mean ± SD (mL/day) [a]	Intake Range (mL/day)
Completely Breast-fed			
1 month	11	600 ± 159	426–989
3 months	2	833	645–1,000
6 months	1	682	616–786
Partially Breast-fed			
1 month	4	485 ± 79	398–655
3 months	11	467 ± 100	242–698
6 months	6	395 ± 175	147–684
9 months	3	<554	451–732

[a] Data expressed as mean ± standard deviation.

Source: Pao et al., 1980.

Table 15-8. Human Milk Intakes for Infants Aged 1–6 Months

Age	Number of Infants	Intake	
		Mean ± SD (mL/day)	Intake Range (mL/day)
1 month	16	673 ± 192	341–1,003
2 months	19	756 ± 170	449–1,055
3 months	16	782 ± 172	492–1,053
4 months	13	810 ± 142	593–1,045
5 months	11	805 ± 117	554–1,045
6 months	11	896 ± 122	675–1,096

Source: Dewey and Lönnerdal, 1983.

Table 15-9. Human Milk Intake Among Exclusively Breast-Fed Infants During the First 4 Months of Life

Age	Number of Infants	Intake (mL/day)[a] Mean ± SD	Intake (mL/kg-day)[a] Mean ± SD	Feedings/Day	Body Weight[b] (kg)
1 month	37	729 ± 126	154 ± 23	8.3 ± 1.9	4.7
2 months	40	704 ± 127	125 ± 18	7.2 ±1.9	5.6
3 months	37	702 ± 111	114 ± 19	6.8 ± 1.9	6.2
4 months	41	718 ± 124	108 ± 17	6.7 ± 1.8	6.7

[a] Values reported by the author in units of g/day and g/kg-day were converted to units of mL/day and mL/kg-day by dividing by 1.03 g/mL (density of human milk).

[b] Calculated by dividing human milk intake (g/day) by human milk intake (g/kg-day).

SD = Standard deviation.

Source: Butte et al., 1984.

Table 15-10. Human Milk Intake During a 24-Hour Period

Age (days)	Number of Infants	Intake (mL/day)[a]		Intake by Age Category (mL/day)[a, b]
		Mean ± SD	Range	
1	6	43 ± 68	-30–145[c]	511 ± 220
2	9	177 ± 83	43–345	
3	10	360 ± 149	203–668	
4	10	438 ± 171	159–674	
5	11	483 ± 125	314–715	
6	9	493 ± 162	306–836	
7	7	556 ± 162	394–817	
8	8	564 ± 154	398–896	
9	9	563 ± 74	456–699	
10	9	569 ± 128	355–841	
11	8	597 ± 163	386–907	
14	9	634 ± 150	404–895	
21	10	632 ± 82	538–763	
28	13	748 ± 174	481–1,111	
35	12	649 ± 114	451–903	679 ± 105
42	12	690 ± 108	538–870	
49	10	688 ± 112	543–895	
56	12	674 ± 95	540–834	
90	10	713 ± 111	595–915	713 ± 111
120	12	690 ± 97	553–822	690 ± 97
150	12	814 ± 130	668–1,139	814 ± 130
180	13	744 ± 117	493–909	744 ± 117
210	12	700 ± 150	472–935	700 ± 150
240	9	604 ± 204	280–973	604 ± 204
270	12	600 ± 214	217–846	600 ± 214
300	11	535 ± 227	125–868	535 ± 227
330	8	538 ± 233	117–835	538 ± 233
360	8	391 ± 243	63–748	391 ± 243

a Values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk).

b Multiple data sets were combined by producing simulated data sets fitting the known mean and SD for each age, compositing the data sets to correspond to age groups of 0 to <1 month and 1 to <2 months, and calculating new means and SD's on the composited data.

c Negative value due to insensible weight loss correction.

SD = Standard deviation.

Source: Neville et al., 1988.

Table 15-11. Human Milk Intake Estimated by the Darling Study		
Age	Number of Infants	Intake (mL/day)[a] Mean ± SD
3 months	73	788 ± 129
6 months	60	747 ± 166
9 months	50	627 ± 211
12 months	42	435 ± 244

[a] Values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk).
SD = Standard deviation.

Source: Dewey et al., 1991b.

Table 15-12. Mean Breast-Fed Infants Characteristics[a]		
	Boys (*N* = 14)	Girls (*N* = 26)
Ethnicity (White, Black, Hispanic, Asian) (*N*)	10/1/2/1	21/1/3/1
Duration of Breast-feeding (days)	315 ± 152	362 ± 190
Duration of Formula Feeding (days)	184 ± 153	105 ± 121
Age at Introduction of Formula (months)	6.2 ± 2.9	5.2 ± 2.3
Age at Introduction of Solids (months)	5.0 ± 1.5	5.0 ± 0.09
Age at Introduction of Cow's Milk (months)	13.1 ± 3.1	12.5 ± 3.8

[a] Mean ± standard deviation.
N = Number of infants.

Source: Butte et al., 2000.

Table 15-13. Mean Human Milk Intake of Breast-Fed Infants (mL/day)[a]		
Age Group	Boys	Girls
3 months	790 ± 172 (*N* = 14)	694 ± 108 (*N* = 26)
6 months	576 ± 266 (*N* = 12)	678 ± 250 (*N* = 18)
12 months	586 ± 286 (*N* = 2)	370 ± 260 (*N* = 11)
24 months	–	–

[a] 3-day average; values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk); mean ± standard deviation.
N = Number of infants.
– = Not quantitated.

Source: Butte et al., 2000.

Table 15-14. Feeding Practices by Percent of Infants

Infants	Age					
	3 months	6 months	9 months	12 months	18 months	24 months
Percentage						
Infants Still Breast-fed	100	80	58	38	25	5
Breast-fed Infants Given Formula	0	40	48	30	10	2
Formula-Fed Infants Given Breast Milk	100	100	94	47	6	0
Use of Cow's Milk for Breast-fed Infants	–	–	8	65	82	88
Use of Cow's Milk for Formula-Fed Infants	–	–	28	67	89	92

Source: Butte et al., 2000.

Table 15-15. Body Weight of Breast-Fed Infants[a]

Age	Weight (kg)	
	Boys	Girls
0.5 months	3.9 ± 0.4 (*n* = 14)	3.7 ± 0.5 (*n* = 19)
3 months	6.4 ± 0.6 (*n* = 14)	6.0 ± 0.6 (*n* = 19)
6 months	8.1 ± 0.8 (*n* = 14)	7.5 ± 0.6 (*n* = 18)
9 months	9.3 ± 1.0 (*n* = 14)	8.4 ± 0.6 (*n* = 19)
12 months	10.1 ± 1.1 (*n* = 14)	9.2 ± 0.7 (*n* = 19)
18 months	11.6 ± 1.2 (*n* = 14)	10.7 ± 1.0 (*n* = 19)
24 months	12.7 ± 1.3 (*n* = 12)	11.8 ± 1.1 (*n* = 19)

[a] Mean ± standard deviation.
n = Number of infants.

Source: Butte et al., 2000.

Table 15-16. AAP Data Set Milk Intake Rates at Different Ages

Age	Mean (mL/kg-day)[a]	SD (mL/kg-day)[a]	CV	Skewness Statistic[b]	*N*
7 days	143	37	0.26	0.598	10
14 days	156	40	0.26	-1.39	9
30 days	150	24	0.16	0.905	25
60 days	144	22	0.15	0.433	25
90 days	127	18	0.14	-0.168	108
120 days	112	18	0.16	0.696	57
150 days	100	21	0.21	-1.077	26
180 days	101	20	0.20	-1.860	39
210 days	75	25	0.33	-0.844	8
270 days	72	23	0.32	-0.184	57
360 days	47	27	0.57	0.874	42

a Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).
b Statistic/SE: -2 < Statistic/SE < +2 suggests a normal distribution.
SD = Standard deviation.
CV = Coefficient of variation.
N = Number of infants.

Source: Arcus-Arth et al., 2005.

Table 15-17. Average Daily Human Milk Intake (mL/kg-day)[a]

Averaging Period	Mean (SD)	Population Percentile							
		5	10	25	50	75	90	95	99
AAP 0 to 6 months									
Method 1	126 (21)	92	99	112	126	140	152	160	174
Method 2	123 (7)	112	114	118	123	127	131	133	138
AAP 0 to 12 months									
Method 1	98 (22)	61	69	83	98	113	127	135	150
Method 2	99 (5)	90	92	95	99	102	105	107	110
EBF 0 to 12 months	110 (21)	75	83	95	110	124	137	144	159
General Pop.									
0 to 6 months	79	0	0	24	92	123	141	152	170
0 to 12 months	51	0	0	12	49	85	108	119	138

a Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).
AAP = American Academy of Pediatrics.
EBF = Exclusively breast-fed.

Source: Arcus-Arth et al., 2005.

Table 15-18. Lipid Content of Human Milk and Estimated Lipid Intake Among Exclusively Breast-Fed Infants					
Age (months)	Number of Observations	Lipid Content (mg/g) Mean ± SD	Lipid Content %[a]	Lipid Intake (mL/day)[b] Mean ± SD	Lipid Intake (mL/kg-day)[b] Mean ± SD
1	37	36.2 ± 7.5	3.6	27 ± 8	5.7 ± 1.7
2	40	34.4 ± 6.8	3.4	24 ± 7	4.3 ± 1.2
3	37	32.2 ± 7.8	3.2	23 ± 7	3.7 ± 1.2
4	41	34.8 ± 10.8	3.5	25 ± 8	3.7 ± 1.3

[a] Percents calculated from lipid content reported in mg/g.
[b] Values reported by the author in units of g/day and g/kg-day were converted to units of mL/day and mL/kg-day by dividing by 1.03 g/mL (density of human milk).

Source: Butte et al., 1984.

Table 15-19. Human Milk Production and Composition During the First 12 Months of Lactation[a]															
Age Group (months)	Volume, per Breast (mL/24 hours)			Fat (g/L)			Lactose (g/L)			Protein (g/L)			Energy (kJ/mL)		
	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*	Mean	SE	*N*
1	416	24	34	39.9	1.4	34	59.7	0.8	18	10.5	0.4	18	2.7	0.06	18
2	408	23	34	35.2	1.4	34	60.4	1.1	18	9.6	0.4	18	2.5	0.06	18
4	421	20	34	35.4	1.4	32	62.6	1.3	16	9.3	0.4	18	2.6	0.09	16
6	413	25	30	37.3	1.4	28	62.5	1.7	16	8.0	0.4	16	2.6	0.09	16
9	354	47	12	40.7	1.7	12	62.8	1.5	12	8.3	0.5	12	2.8	0.09	12
12	252	51	10	40.9	3.3	10	61.4	2.9	10	8.3	0.6	10	2.8	0.14	10
1 to 12	399	11	154	37.4	0.6	150	61.4	0.6	90	9.2	0.2	92	2.7	0.04	90

[a] Infants were completely breast-fed to 4 months and complementary solid food was introduced between 4 and 6 months.
SE = Standard error.
N = Number of individual breasts.

Source: Mitoulas et al., 2002.

Table 15-20. Changes in Volume of Human Milk Produced and Milk Fat Content During the First Year of Lactation[a]

Age Group (months)		Volume, Left Breast (mL/day)		Volume, Right Breast (mL/day)		Fat, Left Breast (g/L)		Fat, Right Breast (g/L)	
	N	Mean	SE	Mean	SE	Mean	SE	Mean	SE
1	5	338	52	475	69	38	1.5	38	2.6
2	5	364	52	427	42	31	2.2	30	2.9
4	5	430	51	482	58	32	3.3	29	2.6
6	5	373	75	437	56	33	2.5	33	2.5
9	5	312	65	365	94	43	2.2	38	3.3
12	5	203	69	302	85	40	4.8	42	5.0
1 to 12	30	337	26	414	28	36	1.4	35	1.5
Statistical significance: *P*		NS		NS		0.004		0.008	

[a] Infants were completely breast-fed to 4 months, and complementary solid food was introduced between 4 and 6 months.
N = Number of mothers.
SE = Standard error.
NS = No statistical difference.
P = Probability.

Source: Mitoulas et al., 2003.

Table 15-21. Changes in Fatty Acid Composition of Human Milk During the First Year of Lactation (g/100 g total fatty acids)

Fatty Acid	1 month		2 months		4 months		6 months		9 months		12 months	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Medium-Chain Saturated	14.2	0.4	13.9	0.6	12.0	0.5	11.5	0.2	14.1	0.3	17.0	0.4
Odd-Chain Saturated	0.9	0.01	0.9	0.02	0.8	0.02	0.8	0.03	0.8	0.02	0.8	0.02
Long-Chain Saturated	34.1	0.3	33.7	0.3	32.8	0.3	31.8	0.6	31.4	0.6	33.9	0.6
Mono-Unsaturated	37.5	0.2	33.7	0.4	38.6	0.5	37.5	0.5	37.3	0.5	33.0	0.5
Trans	2.0	0.08	2.2	0.1	2.2	0.09	4.6	0.02	1.7	0.2	1.8	0.09
Poly-Unsaturated	12.7	0.2	9.5	0.2	11.8	0.4	13.4	0.6	8.0	0.1	6.7	0.03

SE = Standard error.

Source: Mitoulas et al., 2003.

Table 15-22. Comparison Daily Lipid Intake Based on Lipid Content Assumptions (mL/kg-day)[a,b]									
Lipid Content Used in Calculation	Mean	Population Percentile							
		5	10	25	50	75	90	95	99
Measured Lipid Content[c]	3.6	2.0	2.3	2.9	3.6	4.3	4.9	5.2	5.9
4% Lipid Content[d]	3.9	2.5	2.8	3.3	3.8	4.4	4.9	5.2	5.8

[a] Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).
[b] Estimates based on data from Dewey et al. (1991a).
[c] Lipid intake derived from lipid content and milk intake measurements.
[d] Lipid intake derived using 4% lipid content value and milk intake.

Source: Arcus-Arth et al., 2005.

Table 15-23. Distribution of Average Daily Lipid Intake (mL/kg-day) Assuming 4% Milk Lipid Content[a]									
	Mean	Population Percentile							
		5	10	25	50	75	90	95	99
AAP Infants 0–12 months	3.9	2.4	2.8	3.3	3.9	4.5	5.1	5.4	6.0

[a] Values reported by the author in units of g/kg-day were converted to units of mL/kg-day by dividing by 1.03 g/mL (density of human milk).
AAP = American Academy of Pediatrics.

Source: Arcus-Arth et al., 2005.

Table 15-24. Predicted Lipid Intakes for Breast-Fed Infants Under 12 Months of Age	
Statistic	Value
Number of Observations in Simulation	1,113
Minimum Lipid Intake	1.0 mL/day[a]
Maximum Lipid Intake	51.0 mL/day[a]
Arithmetic Mean Lipid Intake	26.0 mL/day[a]
Standard Deviation Lipid Intake	7.2 mL/day[a]

[a] Values reported by the author in units of g/day were converted to units of mL/day by dividing by 1.03 g/mL (density of human milk).

Source: Maxwell and Burmaster, 1993.

Table 15-25. Socioeconomic Characteristics of Exclusively Breast-Fed Infants Born in 2004

	Percent of Exclusive Breast-Feeding Infants Through 3 and 6 Months			
	3 months		6 months	
Characteristic	%	95% CI	%	95% CI
U.S. Overall (*N* = 17,654)	30.5	29.4–31.6	11.3	10.5–12.1
Infant Sex				
Male	30.7	29.1–32.3	10.8	9.8–11.8
Female[a]	30.3	28.7–31.9	11.7	10.5–12.9
Race/Ethnicity (child)				
Hispanic	30.8	28.3–33.3	11.5	9.7–13.3
White, non-Hispanic[a]	33.0	31.6–34.4	11.8	10.9–12.7
Black, non-Hispanic	19.8[b]	17.0–22.6	7.3[b]	5.5–9.1
Asian, non-Hispanic	30.6	25.0–36.2	14.5	10.0–19.0
Other	29.3	24.9–33.7	12.2	9.2–15.2
Maternal Age (years)				
<20	16.8[b]	10.3–23.3	6.1[b]	1.5–10.7
20 to 29	26.2[b]	24.4–28.0	8.4[b]	7.3–9.5
≥30[a]	34.6	33.2–36.0	13.8	12.7–14.9
Household Head Education				
<High school	23.9[b]	21.0–26.8	9.1[b]	7.1–11.1
High school	22.9[b]	20.9–24.9	8.2[b]	7.0–9.4
Some college	32.8[b]	30.3–35.3	12.3[b]	10.2–14.4
College graduate[a]	41.5	39.7–43.3	15.4	14.1–16.7
Marital Status				
Married[a]	35.4	34.0–36.8	13.4	12.4–14.4
Unmarried	18.8[b]	16.9–20.7	6.1[b]	5.0–7.2
Residence				
MSA, center city[a]	30.7	29.0–32.4	11.7	10.5–12.9
MSA, non-center city	32.8	30.9–34.7	12.1	10.8–13.4
Non-MSA	23.9[b]	21.8–26.0	8.2[b]	6.9–9.5
Poverty income ratio (%)				
<100	23.9[b]	21.6–26.2	8.3[b]	6.9–9.7
100 to <184	26.6[b]	23.8–29.4	8.9[b]	7.2–10.6
185 to <349	33.2[b]	30.9–35.5	11.8[b]	10.3–13.3
≥350[a]	37.7	35.7–39.7	14.0	12.6–15.4

[a] Referent group.
[b] $p < 0.05$ by chi-square test, compared with referent group.
N = Number of infants.
MSA = Metropolitan statistical area.

Source: Scanlon et al., 2007.

Table 15-26. Geographic-Specific Breast-Feeding Percent Rates Among Children Born in 2006[a]

State	Ever Breast-Fed	Breast-Fed at 6 Months	Breast-Fed at 12 Months	Exclusive Breast-Feeding Through 3 Months	Exclusive Breast-Feeding Through 6 Months
U.S. National	73.9	43.4	22.7	33.1	13.6
Alabama	58.8	26.6	11.4	24.2	6.3
Alaska	88.5	48.9	26.2	45.5	16.9
Arizona	76.5	45.3	22.3	29.7	11.9
Arkansas	61.5	26.9	10.6	23.6	6.3
California	84.7	53.0	31.1	42.4	18.6
Colorado	82.5	59.5	30.5	49.2	22.6
Connecticut	74.9	41.9	23.3	35.1	14.4
Delaware	66.7	32.8	15.4	28.1	7.5
Dist of Columbia	69.6	45.6	20.2	31.3	13.3
Florida	75.7	37.2	18.2	30.7	11.9
Georgia	62.5	36.4	18.1	28.0	14.8
Hawaii	88.2	56.3	35.0	44.9	22.4
Idaho	79.8	55.1	25.3	46.7	17.7
Illinois	69.5	38.7	15.9	28.5	11.9
Indiana	71.1	37.2	18.9	28.9	10.6
Iowa	68.1	33.2	15.8	32.3	10.6
Kansas	78.1	43.8	23.6	36.0	16.8
Kentucky	53.6	28.9	15.8	27.2	9.4
Louisiana	49.1	20.7	9.9	17.8	5.0
Maine	75.0	45.7	26.0	38.7	18.1
Maryland	76.4	43.3	25.4	28.5	10.1
Massachusetts	78.2	44.7	24.5	39.0	13.5
Michigan	64.8	31.2	14.4	23.5	10.7
Minnesota	79.9	51.6	24.7	39.8	15.0
Mississippi	48.3	20.1	8.7	16.8	4.6
Missouri	65.3	33.1	14.9	24.8	8.5
Montana	82.7	56.8	30.6	40.8	20.5

Table 15-26. Geographic-Specific Breast-Feeding Percent Rates Among Children Born in 2006[a] (continued)

State	Ever Breast-Fed	Breast-Fed at 6 Months	Breast-Fed at 12 Months	Exclusive Breast-Feeding Through 3 Months	Exclusive Breast-Feeding Through 6 Months
Nebraska	76.8	46.2	22.6	31.7	11.9
Nevada	79.3	45.3	22.5	31.8	9.7
New Hampshire	78.4	55.1	30.5	42.6	20.6
New Jersey	81.4	53.0	27.4	29.7	13.2
New Mexico	72.6	42.2	25.7	33.2	14.0
New York	76.4	49.4	28.9	24.9	9.6
North Carolina	66.9	36.7	18.9	30.2	13.1
North Dakota	71.1	37.6	20.6	33.7	11.1
Ohio	58.5	29.7	12.0	22.4	9.1
Oklahoma	65.6	27.4	12.4	30.6	8.4
Oregon	91.4	63.0	37.0	56.6	20.8
Pennsylvania	67.6	35.8	19.4	29.3	10.1
Rhode Island	75.4	40.4	19.8	31.8	8.7
South Carolina	61.3	30.4	13.9	25.5	9.6
South Dakota	76.8	47.5	22.1	36.5	17.6
Tennessee	58.8	37.9	14.8	28.2	12.8
Texas	78.2	48.7	25.3	34.2	14.2
Utah	92.8	69.5	33.9	50.8	24.0
Vermont	80.1	59.5	38.4	49.2	23.5
Virginia	79.7	48.3	25.8	38.7	18.8
Washington	86.4	58.0	35.0	48.8	25.3
West Virginia	58.8	27.2	12.6	21.3	8.4
Wisconsin	75.3	48.6	25.9	45.2	16.8
Wyoming	84.2	50.8	26.7	46.2	16.8

[a] Exclusive breast-feeding information is from the 2006 NIS survey data only and is defined as ONLY breast milk: no solids, no water, no other liquids.

Source: CDC, 2009.

Table 15-27. Percentage of Mothers in Developing Countries by Feeding Practices for Infants 0–6 Months Old[a]

Country	Breast-Feeding	Water	Milk	Formula	Other Liquids	Solid Foods
Armenia	86.1	62.7	22.9	13.1	48.1	23.9
Bangladesh	99.6	30.2	13.6	5.3	19.7	20.3
Cambodia	98.9	87.9	2.1	3.3	6.7	16.6
Egypt	95.5	22.9	11.1	4.3	27.6	13.2
Ethiopia	98.8	26.3	19	0	10.8	5.3
Ghana	99.6	41.9	6.7	3.5	4.3	15.6
India	98.1	40.2	21.2	0	7.1	6.5
Indonesia	92.8	37	0.7	24.2	8.7	43
Jordan	92.4	58.5	3	25.1	13.8	20.2
Kazakhstan	94.4	53.7	21.4	8.2	37.4	15.4
Kenya	99.7	60	35.1	4.8	35.9	46.3
Malarwi	100	46	1.4	1.7	5.2	42.3
Nambia	95.3	65.4	0	0	17.9	33.4
Nepal	100	23.3	12.3	0	2.8	9.3
Nigeria	99.1	78.2	9.2	12.7	17.9	18.5
Philippines	80.5	53.4	4.4	30	12.4	16.8
Uganda	98.7	15.1	20.3	1.5	10.3	11.4
Vietnam	98.7	45.9	16.9	0.8	8.9	18.7
Zamibia	99.6	52.6	2.1	2.7	6.7	31.2
Zimbabwe	100	63.9	1.6	3.2	9	43.7
Pooled	96.6	45.9	11.9	9	15.1	21.9

[a] Percentage of mothers who stated that they currently breast-feed and separately had fed their infants four categories of liquid or solid food in the past 24 hours by country for infants age 0 to 6 months old.

Source: Marriott et al., 2007.

Table 15-28. Percentage of Mothers in Developing Countries by Feeding Practices for Infants 6–12 Months Old[a]

Country	Breast-Feeding	Water	Milk	Formula	Other Liquids	Solid Foods
Armenia	53.4	91.1	56.9	11.6	85.3	88.1
Bangladesh	96.2	87.7	29.8	10.1	21.9	65.2
Cambodia	94.4	97.5	3.7	6.7	29	81
Egypt	89.1	85.9	36.8	16.7	48.5	75.7
Ethiopia	99.4	69.2	37.6	0	23.9	54.7
Ghana	99.3	88.8	14.6	9.6	23.9	71.1
India	94.9	81.4	45	0	25.2	44.1
Indonesia	84.8	85.4	4.9	38.8	35.4	87.9
Jordan	65.7	99.3	24.3	28.8	57.7	94.9
Kazakhstan	81.2	74.3	85.4	11.4	91.8	85.9
Kenya	96.5	77.7	58.7	6	56.4	89.6
Malarwi	99.4	93.5	5.9	3.2	31.2	94.9
Nambia	78.7	91.9	0	0	42.7	79.5
Nepal	98.8	84.3	32	0	15.8	71.5
Nigeria	97.8	91.6	14.4	13.4	27.4	70.4
Philippines	64.4	95.1	12.2	47.1	31	88
Uganda	97.4	65.9	32.1	1.6	56.2	82.1
Vietnam	93.2	95	36.1	5.3	37.9	85.8
Zamibia	99.5	91.7	8.2	5	25.9	90.2
Zimbabwe	96.7	92.5	8.7	2.4	49.9	94.8
Pooled	87.9	87.4	29.6	15.1	41.6	80.1

[a] Percentage of mothers who stated that they currently breast-feed and separately had fed their infants four categories of liquid or solid food in the past 24 hours by country for infants age 6 to 12 months old.

Source: Marriott et al., 2007.

Table 15-29. Population Weighted Averages of Mothers Who Reported Selected Feeding Practices During the Previous 24 Hours

Feeding Practices	Infant Age	
	0–6 months	6–12 months
	Percentage (weighted *N*)	
Current Breast-Feeding	96.6 (22,781)	87.9 (18,944)
Gave Infant:		
Water	45.9 (10,767)	87.4 (18,663)
Tinned, Powdered, or Other Milk	11.9 (2,769)	29.6 (6,283)
Commercial Formula	9.0 (1,261)	15.1 (1,911)
Other Liquids	15.1 (3,531)	41.6 (8,902)
Any Solid Food	21.9 (5,131)	80.1 (17,119)

N = Number of infants.

Source: Marriott et al., 2007.

Table 15-30. Racial and Ethnic Differences in Proportion of Children Ever Breast-Fed, NHANES III (1988–1994)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%, SE)[a] White vs. Black		Absolute Difference (%, SE)[a] White vs. Mexican American	
Characteristic	*N*	%	(SE)	*N*	%	(SE)	*N*	%	(SE)	%	(SE)	%	(SE)
All Infants	1,869	60.3	2.0	1,845	25.5	1.4	2,118	54.4	1.9	34.8	(2.0)[b]	6.0	(2.3)[a]
Infant Sex													
Male	901	60.4	2.6	913	24.4	1.6	1,033	53.8	1.8	35.9	(2.9)[b]	6.6	(2.8)[a]
Female	968	60.3	2.3	932	26.7	1.9	1,085	54.9	2.9	33.7	(2.6)[b]	5.4	(3.4)[c]
Infant Birth Weight (g)													
<2,500	118	40.1	5.3	221	14.9	2.6	165	34.1	3.9	25.1	(5.8)[b]	5.9	(6.4)[c]
≥2,500	1,738	62.1	2.1	1,584	26.8	1.6	1,838	55.7	2.0	35.3	(2.1)[b]	6.4	(2.5)[a]
Maternal Age (years)													
<20	175	33.7	4.4	380	13.1	2.1	381	43.7	3.0	20.6	(4.8)[b]	-10	(5.1)[c]
20–24	464	48.3	3.0	559	22.0	2.0	649	54.8	2.6	26.4	(3.7)[b]	-6.4	(4.2)[c]
25–29	651	65.4	2.2	504	30.6	2.5	624	56.9	3.3	34.8	(3.1)[b]	8.6	(4.0)[a]
≥30	575	71.9	2.7	391	36.1	2.3	454	59.6	2.8	35.8	(3.4)[b]	12.3	(3.4)[b]
Household Head Education													
<High school	313	32.3	4.0	583	14.7	2.5	1,262	51.0	2.6	17.6	(5.0)[b]	-18.8	(4.8)[b]
High school	623	52.6	2.8	773	21.9	2.0	479	51.4	3.4	30.7	(3.2)[b]	1.2	(4.1)[c]
Some college	397	63.8	2.3	317	37.2	3.5	226	68.0	5.2	26.6	(3.7)[b]	-4.1	(5.6)[c]
College graduate	505	83.0	2.4	139	54.4	4.9	74	78.3	7.4	28.6	(5.3)[b]	4.6	(7.6)[c]
Smoking During Pregnancy													
Yes	526	39.8	3.0	403	18.0	2.1	198	31.2	3.9	21.8	(3.7)[b]	8.6	(4.7)[c]
No	1,334	68.2	2.0	1,429	27.8	1.7	1,917	56.7	1.9	40.4	(2.1)[b]	11.5	(2.5)[b]
Maternal Body Mass Index													
<25.0	1,331	64.9	2.0	872	26.8	2.0	961	54.1	2.5	38.0	(2.5)[b]	10.8	(2.7)[b]
25.0–29.9	283	50.9	3.4	484	24.1	3.2	534	57.8	2.1	26.8	(4.5)[b]	-6.8	(4.1)[c]
≥30	204	48.6	4.8	415	24.3	2.7	359	47.1	4.4	24.3	(5.3)[b]	1.5	(6.1)[c]
Residence													
Metropolitan	762	67.2	3.0	943	32.0	1.9	1,384	56.1	2.0	35.3	(2.6)[b]	11.2	(2.9)[b]
Rural	1,107	54.9	3.1	902	18.3	1.9	734	51.3	3.1	36.6	(2.7)[b]	3.6	(4.0)[c]
Region													
Northeast	317	51.6	4.6	258	34.2	4.4	12	74.1	10.4	17.3	(3.6)[b]	-22.5	(14.5)[c]
Midwest	556	61.7	2.3	346	26.5	2.4	170	51.5	3.7	35.2	(3.3)[b]	10.2	(5.0)[a]
South	748	52.7	2.7	1,074	19.4	2.0	694	42.7	3.5	33.3	(2.7)[b]	10	(4.6)[a]
West	248	82.4	3.9	167	45.1	5.1	1,242	59.1	2.2	37.3	(7.1)[b]	23.4	(3.3)[b]

Table 15-30. Racial and Ethnic Differences in Proportion of Children Ever Breast-Fed, NHANES III (1988–1994) (continued)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%, SE)[a] White vs. Black		Absolute Difference (%, SE)[a] White vs. Mexican American	
Poverty Income Ratio (%)	*N*	%	(SE)	*N*	%	(SE)	*N*	%	(SE)	%	(SE)	%	(SE)
<100	257	38.5	4.2	905	18.2	1.9	986	48.2	2.8	20.3	(4.4)[b]	-9.6	(4.7)[a]
100 to <185	388	55.7	2.6	391	26.8	2.1	490	54.1	3.4	28.9	(3.5)[b]	1.5	(4.2)[c]
185 to <350	672	61.9	2.5	294	32.0	3.0	288	64.7	4.7	30.0	(3.7)[b]	2.8	(5.3)[c]
≥350	444	77.0	2.5	105	58.1	5.1	74	71.9	9.0	19.0	(5.6)[b]	5.2	(9.0)[c]
Unknown	108	44.7	7.1	150	25.5	3.9	280	59.5	2.8	19.2	(7.9)[a]	-14.8	(7.9)[c]

[a] $p < 0.05$.
[b] $p < 0.01$.
[c] No statistical difference.
N = Number of infants.
SE = Standard error.

Source: Li and Grummer-Strawn, 2002.

Table 15-31. Racial and Ethnic Differences in Proportion of Children Who Received Any Human Milk at 6 Months (NHANES III, 1988–1994)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%, SE)			
										White vs. Black		White vs. Mexican American	
Characteristic	*N*	%	(SE)	No.	%	(SE)	*N*	%	(SE)	%	(SE)	%	(SE)
All Infants	1,863	26.8	1.6	1,842	8.5	0.9	2,112	23.1	1.4	18.3	(1.7)[a]	3.7	(2.1)[b]
Infant Sex													
Male	900	27.6	2.3	912	8.5	1.1	1,029	22.3	1.6	19.1	(2.6)[a]	5.2	(2.6)[c]
Female	963	26.1	1.8	930	8.6	1.1	1,083	24.0	2.0	17.5	(2.1)[c]	2.1	(2.7)[b]
Infant Birth Weight (g)													
<2,500	118	10.9	3.1	221	4.2	1.8	165	15.2	4.7	6.7	(3.3)[c]	-4.3	(5.7)[b]
≥2,500	1,733	28.3	1.8	1,581	9.0	0.9	1,832	23.1	1.7	19.3	(1.8)[a]	5.2	(2.3)[c]
Maternal Age (years)													
<20	174	10.2	2.9	380	4.7	1.4	380	11.6	1.7	5.5	(3.0)[b]	-1.3	(3.8)[b]
20–24	461	13.4	2.4	559	7.5	1.1	646	23.8	2.4	5.9	(2.5)[c]	-10.4	(3.3)[a]
25–29	651	29.3	2.6	503	10.9	2.0	624	24.6	2.6	18.4	(3.5)[a]	4.8	(3.6)[b]
≥30	573	39.0	2.6	389	10.7	1.7	452	30.0	2.8	28.4	(3.3)[a]	9.0	(3.6)[c]
Household Head Education													
<High school	312	14.6	3.8	582	4.4	1.2	1,258	20.7	1.4	10.2	(4.5)[c]	-6.2	(4.1)[b]
High school	622	19.9	1.7	771	5.0	1.0	478	22.4	2.5	14.9	(2.0)[a]	2.5	(3.1)[b]
Some college	396	26.8	2.4	317	16.6	2.5	225	28.4	5.3	10.2	(3.5)[a]	-1.6	(6.1)[b]
College graduate	502	42.2	2.9	139	21.1	3.2	74	45.5	7.3	21.1	(5.2)[a]	3.4	(7.6)[b]
Smoking During Pregnancy													
Yes	524	11.3	1.5	402	4.3	1.1	198	9.3	2.2	7.0	(1.9)[a]	2.1	(2.7)[b]
No	1,331	32.7	2.1	1,427	9.8	1.1	1,911	24.5	1.5	22.9	(2.3)[a]	8.1	(2.6)[a]
Maternal Body Mass Index													
<25.0	1,326	29.6	1.8	871	8.9	1.2	959	21.9	2.1	20.7	(2.1)[a]	7.8	(2.7)[a]
25.0–29.9	282	19.0	2.4	482	8.2	1.9	534	26.4	1.9	10.8	(3.2)[a]	7.4	(3.0)[c]
≥30	204	20.4	4.1	415	7.3	1.6	357	17.2	3.0	13.1	(4.4)[a]	3.3	(5.2)[b]
Residence													
Metropolitan	760	29.7	2.5	941	11.8	1.3	1,378	23.5	1.7	17.9	(2.4)[a]	6.1	(3.1)[b]
Rural	1,103	24.6	2.4	901	4.9	0.9	734	22.5	2.8	19.7	(2.2)[a]	2.2	(3.4)[b]
Region													
Northeast	316	21.0	2.2	258	9.7	1.8	12	43.6	16.0	11.3	(1.8)[a]	-22.6	(16.5)[b]
Midwest	553	28.8	2.1	344	9.8	2.4	170	18.2	4.7	19.0	(3.7)[a]	10.6	(6.2)[b]
South	746	20.1	2.8	1,073	5.9	1.0	693	17.2	2.8	14.3	(2.8)[a]	2.9	(4.2)[b]
West	248	42.7	4.7	167	19.3	3.3	1,237	25.9	1.4	23.4	(5.3)[a]	16.8	(5.1)[a]

Table 15-31. Racial and Ethnic Differences in Proportion of Children Who Received Any Human Milk at 6 Months (NHANES III, 1988–1994) (continued)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE)			
										White vs. Black		White vs. Mexican American	
Poverty Income Ratio (%)	*N*	%	(SE)	No.	%	(SE)	*N*	%	(SE)	%	(SE)	%	(SE)
100 to <185	387	23.5	2.9	390	9.9	1.8	486	23.4	2.7	13.6	(3.9)[a]	0	(4.1)[b]
185 to <350	670	30.4	2.7	293	10.0	2.4	287	27.6	4.4	20.4	(4.0)[a]	2.9	(4.8)[b]
≥350	443	33.0	3.0	105	15.2	2.8	74	32.3	9.0	17.8	(4.2)[a]	0.7	(9.5)[b]
Unknown	108	13.3	3.8	149	6.4	2.9	280	26.7	4.5	7.0	(5.3)[b]	-13.4	(6.6)[c]

[a] $p < 0.01$.
[b] No statistical difference.
[c] $p < 0.05$.
N = Number of individuals.
SE = Standard error.

Source: Li and Grummer-Strawn, 2002.

Table 15-32. Racial and Ethnic Differences in Proportion of Children Exclusively Breast-Fed at 4 Months (NHANES III, 1991–1994)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%,SE)			
										White vs. Black		White vs. Mexican American	
Characteristic	*N*	%	(SE)	*N*	%	(SE)	*N*	%	(SE)	%	(SE)	%	(SE)
All Infants	824	22.6	1.7	906	8.5	1.5	957	20.4	1.4	14.1	(2.2)[a]	2.3	(1.6)[b]
Infant Sex													
Male	394	22.3	1.9	454	7.0	1.6	498	20.7	1.5	15.3	(2.6)[a]	1.5	(1.8)[b]
Female	430	23.0	2.2	452	10.0	2.2	459	20.0	1.8	12.9	(3.0)[a]	3.0	(2.1)[b]
Infant Birth Weight (g)													
<2,500	50	15.2	7.1	118	7.0	2.3	66	5.6	1.8	8.2	(8.1)[b]	9.5	(6.9)[b]
≥2,500	774	23.1	1.8	786	8.8	1.6	880	21.6	1.4	14.4	(2.2)[a]	1.5	(1.6)[b]
Maternal Age (years)													
<20	76	6.6	3.2	172	6.4	2.1	170	12.1	2.5	0.2	(3.7)[b]	-5.6	(3.8)[b]
20–24	205	11.4	2.2	273	7.4	2.4	319	21.0	2.3	4.0	(2.7)[b]	-9.6	(3.2)[a]
25–29	271	21.6	2.3	254	8.6	2.5	256	22.1	2.5	13.0	(3.2)[a]	-0.5	(3.2)[b]
≥30	270	34.8	2.7	201	11.9	2.6	210	23.6	3.1	22.9	(4.2)[a]	11.1	(3.7)[a]
Household Head Education													
<High school	146	9.5	3.5	256	2.0	0.7	563	19.7	1.8	7.5	(3.6)[c]	-10.2	(4.0)[c]
High school	277	14.5	2.7	406	7.1	2.1	222	18.8	3.6	7.4	(3.2)[c]	-4.3	(4.7)[b]
Some college	175	30.8	3.8	141	17.4	3.0	120	21.0	3.9	13.4	(4.7)[a]	9.8	(6.1)[b]
College graduate	219	34.1	3.9	92	17.4	4.7	37	31.5	4.5	16.7	(6.9)[c]	2.6	(6.3)[b]
Smoking During Pregnancy													
Yes	224	10.0	2.8	168	5.4	2.2	64	3.2	1.8	4.6	(3.7)[b]	6.8	(3.4)[b]
No	596	27.2	2.1	730	9.4	1.9	892	21.7	1.5	17.8	(2.8)[a]	5.6	(2.0)[c]
Maternal Body Mass Index													
<25.0	597	24.8	2.1	407	8.0	1.9	417	19.4	1.9	16.8	(3.0)[a]	5.4	(2.3)[c]
25.0–29.9	117	19.7	4.3	230	8.6	1.9	261	23.1	3.4	11.1	(4.6)[c]	-3.4	(4.9)[b]
≥30	91	15.4	3.8	230	9.0	2.9	184	15.9	2.3	6.4	(5.2)[b]	-0.5	(4.6)[b]
Residence													
Metropolitan	312	24.4	3	535	11.0	2.0	608	19.6	1.6	13.4	(3.5)[a]	4.8	(2.8)[b]
Rural	512	21.3	1.8	371	4.2	1.3	349	22.3	3.3	17.1	(1.8)[a]	-1.1	(3.0)[b]
Region													
Northeast	138	20.0	1.4	131	11.1	2.9	10	9.4	9.5	8.8	(2.2)[a]	10.6	(8.7)[b]
Midwest	231	26.5	3.2	143	12.6	5.6	98	19.2	4.1	13.9	(7.6)[b]	7.4	(3.7)[b]
South	378	14.1	2.8	574	5.9	1.4	383	15.9	3.1	8.2	(1.9)[a]	-1.8	(3.7)[b]
West	77	34.7	2.7	58	12.5	5.0	466	23.0	1.3	22.2	(5.4)[a]	11.7	(2.5)

Table 15-32. Racial and Ethnic Differences in Proportion of Children Exclusively Breast-Fed at 4 Months (NHANES III, 1991–1994) (continued)

	Non-Hispanic White			Non-Hispanic Black			Mexican American			Absolute Difference (%, SE) White vs. Black		Absolute Difference (%, SE) White vs. Mexican American	
Poverty Income Ratio (%)	*N*	%	(SE)	*N*	%	(SE)	*N*	%	(SE)	%	(SE)	%	(SE)
<100	116	13.1	3.3	448	5.7	1.6	471	18.4	1.8	7.4	(3.5)[c]	-5.3	(3.1)[b]
100 to <185	166	18.9	3.2	197	10.6	2.8	234	21.9	4.1	8.3	(3.3)[c]	-3	(6.1)[b]
185 to <350	274	25.1	3.2	145	12.9	4.3	132	26.4	4.2	12.2	(5.0)[c]	-1.3	(4.1)[b]
≥350	235	27.4	4.1	57	12.8	3.5	37	17.0	5.0	14.6	(5.0)[a]	10.4	(5.2)[b]
Unknown	33	16.5	7.6	59	7.3	3.7	83	16.1	5.1	9.2	(8.6)[b]	0.4	(9.5)[b]

[a] $p < 0.05$.
[b] $p < 0.01$.
[c] No statistical difference.
N = Number of individuals.
SE = Standard error.

Source: Li and Grummer-Strawn, 2002.

Table 15-33. Percentage of Mothers Breast-Feeding Newborn Infants in the Hospital and Infants at 5 or 6 Months of Age in the United States in 1989 and 1995, by Ethnic Background and Selected Demographic Variables

Characteristic	Percentage of Mothers Breast-Feeding					
	In Hospital			At 6 Months		
	1989	1995	Change[a]	1989	1995	Change[a]
All Infants	52.2	59.7	14.4	18.1	21.6	19.3
White	58.5	64.3	9.9	21.0	24.1	14.8
Black	23.0	37.0	60.9	6.4	11.2	75.0
Hispanic	48.4	61.0	26.0	13.9	19.6	41.0
Maternal Age (years)						
<20	30.2	42.8	41.7	5.6	9.1	62.5
20 to 24	45.2	52.6	16.4	11.5	14.6	27.0
25 to 29	58.8	63.1	7.3	21.1	22.9	8.5
30 to 34	65.5	68.1	4.0	29.3	29.0	(1.0)[b]
35+	66.5	70.0	5.3	34.0	33.8	(0.6)[b]
Total Family Income						
<$10,000	31.8	41.8	31.4	8.2	11.4	39.0
$10,000 to $14,999	47.1	51.7	9.8	13.9	15.4	10.8
$15,000 to $24,999	54.7	58.8	7.5	18.9	19.8	4.8
≥25,000	66.3	70.7	6.6	25.5	28.5	11.8
Maternal Education						
Grade School	31.7	43.8	38.2	11.5	17.1	48.7
High School	42.5	49.7	16.9	12.4	15.0	21.0
College	70.7	74.4	5.2	28.8	31.2	8.3
Maternal Employment						
Employed Full Time	50.8	60.7	19.5	8.9	14.3	60.7
Employed Part Time	59.4	63.5	6.9	21.1	23.4	10.9
Not Employed	51.0	58.0	13.7	21.6	25.0	15.7
Birth Weight						
Low (≤2,500 g)	36.2	47.7	31.8	9.8	12.6	28.6
Normal	53.5	60.5	13.1	18.8	22.3	18.6
Parity						
Primiparous	52.6	61.6	17.1	15.1	19.5	29.1
Multiparous	51.7	57.8	11.8	21.1	23.6	11.8
WIC Participation[c]						
Participant	34.2	46.6	36.3	8.4	12.7	51.2
Non-participant	62.9	71.0	12.9	23.8	29.2	22.7
U.S. Census Region						
New England	52.2	61.2	17.2	18.6	22.2	19.4
Middle Atlantic	47.4	53.8	13.5	16.8	19.6	16.7
East North Central	47.6	54.6	14.7	16.7	18.9	13.2
West North Central	55.9	61.9	10.7	18.4	21.4	16.3
South Atlantic	43.8	54.8	25.1	13.7	18.6	35.8
East South Central	37.9	44.1	16.4	11.5	13.0	13.0
West South Central	46.0	54.4	18.3	13.6	17.0	25.0
Mountain	70.2	75.1	7.0	28.3	30.3	7.1
Pacific	70.3	75.1	6.8	26.6	30.9	16.2

[a] The percent change was calculated using the following formula: % breast-fed in 1984 – % breast-fed in 1989 ÷ % breast-fed in 1984.
[b] Figures in parentheses indicate a decrease in the rate of breast-feeding from 1989 to 1995.
[c] WIC indicates Women, Infants, and Children supplemental food program.

Source: Ryan, 1997.

Table 15-34. Percentage of Mothers Breast-Feeding Newborn Infants in the Hospital and Infants at 6 and 12 Months of Age in the United States in 2003, by Ethnic Background and Selected Demographic Variables

Characteristic	Percentage of Mothers Breast-Feeding		
	In Hospital	At 6 Months	At 12 Months
All Infants	44	18	10
White	53	20	12
Black	26	10	5
Hispanic	33	15	12
Asian	39	23	12
Maternal Age (years)			
<20	28	9	4
20 to 24	40	13	8
25 to 29	48	20	10
30 to 34	50	23	14
35+	47	23	14
Maternal Education			
Any Grade School	26	13	17
Any High School	35	12	8
No College	35	12	8
College	55	24	14
Maternal Employment			
Employed Full Time	44	11	6
Employed Part Time	49	19	11
Total Employed	45	14	8
Not Employed	43	21	13
Low Birth Weight <5 lbs 9oz	27	10	6
Parity			
Primiparous	48	17	10
Multiparous	43	19	11
WIC Participation[a]			
Participant	32	11	7
Non-participant	55	25	14
U.S. Census Region			
New England	52	22	11
Middle Atlantic	36	17	9
East North Central	44	17	9
West North Central	55	18	9
South Atlantic	42	16	10
East South Central	37	11	7
West South Central	37	15	8
Mountain	53	23	16
Pacific	50	24	15

[a] WIC indicates Women, Infants, and Children supplemental food program.

Source: Abbott Laboratories, 2003.

Table 15-35. Number of Meals Per Day		
Age (months)	Bottle-Fed Infants (meals/day)[a]	Breast-Fed (meals/day)[a]
1	5.4 (4–7)	5.8 (5–7)
2	4.8 (4–6)	5.3 (5–7)
3	4.7 (3–6)	5.1 (4–8)

[a] Data expressed as mean with range in parentheses.

Source: Hofvander et al., 1982.

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Breast-Feeding Episodes per Day	5.8 ± 2.6	6.8 ± 2.4	2.5 ± 2.0
Total Time Breast-Feeding (minute/day)	65.2 ± 44.0	102.2 ± 51.4	31.2 ± 24.6
Length of Breast-Feeding (minute/episode)	10.8 ± 6.1	14.2 ± 6.1	11.6 ± 5.6

SD = Standard deviation.

Source: Buckley, 2001.

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16. ACTIVITY FACTORS

16.1. INTRODUCTION

Individual or group activities are important determinants of potential exposure. Toxic chemicals introduced into the environment may not cause harm to an individual until an activity is performed that brings the individual into contact with those contaminants. An activity or time spent in a given activity will vary among individuals depending on culture, ethnicity, hobbies, location, sex, age, socioeconomic characteristics, and personal preferences. However, limited information is available regarding ethnic, cultural, and socioeconomic differences in individuals' choice of activities or time spent in a given activity. Children are of special concern because certain activities and behaviors specific to children place them at a higher risk of exposure to certain environmental agents and expose them to higher levels of many chemicals (Chance and Harmsen, 1998). Trends associated with activity patterns include increases in the proportion of the population engaging in sedentary activities and decreases in physical activity in the home and related to work, including walking to work, as there has been a strong trend toward Americans living in the suburbs (Brownson, 2005). Recent trends in occupational mobility include the facts that average tenure increases directly with age, and that a large proportion of American workers show substantial job stability (U.S. Census Bureau, 2010). For population mobility, the U.S. Census Bureau reported that the national residential move rate increased to 12.5% in 2009 following a record low of 11.9% in 2008 (U.S. Census Bureau, 2010).

In calculating exposure, a person's average daily dose is determined from a combination of variables including the pollutant concentration, exposure duration, and frequency of exposure (see Chapter 1). These variables can be dependent on human activity patterns and time spent at each activity and/or location.

Time activity data are generally obtained using recall questionnaires and diaries to record the person's activities and microenvironments. Other methods include the use of videotaping and global positioning system technology to provide information on individuals' locations (Phillips et al., 2001; Elgethun et al., 2003).

Obtaining accurate information on time and activities can be challenging. This is especially true for children (Cohen Hubal et al., 2000). Children engage in more contact activities than adults; therefore, a much wider distribution of activities need to be considered when assessing children's exposure (Cohen Hubal et al., 2000). Mouthing behavior, which includes all activities in which objects, including fingers, are touched by the mouth or put into the mouth are provided in Chapter 4. Chapter 7 provides frequency and duration data for dermal (hand) contact.

This chapter summarizes data on how much time individuals spend participating in various activities in various microenvironments and on the frequency of performing various activities. Information is also provided on occupational mobility and population mobility. The data in this chapter cover a wide range of activities and populations, arranged by age group when such data are available. One of the objectives of this handbook is to provide recommended exposure factor values using a consistent set of age groups. In this chapter, several studies are used as sources for activity pattern data. In some cases, the source data could be retrieved and analyzed using the standard age groupings recommended in *Guidance for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). In other cases, the original source data were not available, and the study results are presented here using the same age groups as the original study, whether or not they conform to the standard age groupings.

The recommendations for activity factors are provided in the next section, along with a summary of the confidence ratings for these recommendations. The recommended values are based on key studies identified by U.S. Environmental Protection Agency (U.S. EPA) for this factor. Following the recommendations, key studies on activity patterns are summarized. Relevant data on activity patterns are also presented to provide the reader with added perspective on the current state-of-knowledge pertaining to activity patterns in adults and children. Additional information on microactivity patterns (i.e., hand-to-mouth, object-to-mouth, and dermal [hand] contact with surfaces and objects) is provided in Chapters 4 and 7.

16.2. RECOMMENDATIONS

16.2.1. Activity Patterns

Assessors are commonly interested in quantitative information describing several types of time use data for adults and children including the following: time spent indoors and outdoors; time spent bathing, showering, and swimming; and time spent playing on various types of surfaces. Table 16-1 summarizes the recommended values for these factors. Note that, except for swimming, all activity factors are reported in units of minutes/day.

Time spent swimming is reported in units of minutes/month. These data are based on 2 key studies presented in this chapter: a study of children's activity patterns in California (Wiley et al., 1991) and the National Human Activity Pattern Survey (NHAPS) (U.S. EPA, 1996). Both mean and 95th percentile recommended values are provided. However, because these recommendations are based on short-term survey data, 95th percentile values may be misleading for estimating chronic (i.e., long-term) exposures and should be used with caution. Also, the upper percentile values for some activities are truncated as a result of the maximum response included in the survey (e.g., durations of more than 120 minutes/day were reported as 121 minutes/day), and could not be further refined). Table 16-2 presents the confidence ratings for the recommendations.

The recommendations for total time spent indoors and the total time spent outdoors are based on the U.S. EPA re-analysis of the source data from Wiley et al. (1991) for children <1 year of age and U.S. EPA (1996) for childhood age groups >1 year of age. Although Wiley et al. (1991) is a study of California children and the sample size was very small for infants, it provides data for children's activities for the younger age groups. Data from U.S. EPA (1996) are representative of the U.S. general population. In some cases, however, the time spent indoors or outdoors would be better addressed on a site-specific basis since the times are likely to vary depending on the climate, residential setting (i.e., rural versus urban), personal traits (e.g., health status), and personal habits. For children >1 year of age, the recommended values for time spent indoors at a residence, duration of showering and bathing, time spent swimming, and time spent playing on sand, gravel, grass or dirt are based on a U.S. EPA re-analysis of the source data from U.S. EPA (1996). For adults 18 years and older, the recommended values are taken directly from the source document (U.S. EPA, 1996).

16.2.2. Occupational Mobility

Occupational mobility may be an important factor in determining exposure. For example, the duration of exposure to occupationally-related contaminants, such as the chemicals used in an industrial or laboratory setting, will be directly associated with the period of time an individual spends in the occupation.

The median occupational tenure of the working population (109.1 million people) ages 16 years of age and older in January 1987 was 7.9 years for men and 5.4 years for women (Carey, 1988). Since the occupational tenure varies significantly according to age and sex, the recommended values are given by 5-year age groups separately for males and females in Table 16-3. Section 16.4 provides occupational tenure for males and females combined. Part-time employment, race and the position held are important to consider in determining occupational tenure. These data are also presented in Section 16.4. Table 16-3 also presents recommendations for occupational mobility rate, by age. This rate is the percentage of persons employed in an occupation who had voluntarily entered it from another occupation. The overall percent was 5.3 (Carey, 1990). The ratings indicating confidence in the occupational mobility recommendations are presented in Table 16-4. It should be noted that the recommended values are not for use in evaluating job tenure. These data can be used for determining time spent in an occupation and not for time spent at a specific job site.

16.2.3. Population Mobility

An assessment of population mobility can assist in determining the length of time a household is exposed in a particular location. For example, the duration of exposure to site-specific contamination, such as a polluted stream from which a family fishes or contaminated soil on which children play or vegetables are grown, will be directly related to the period of time residents live near the contaminated site.

There are two key studies from which the population mobility recommendations were derived: the U.S. Census Bureau American Housing Survey, (U.S. Census Bureau, 2008a) and Johnson and Capel (1992). The U.S. Bureau of Census (2008a) provides data on current residence time and Johnson and Capel (1992) provide data on residential occupancy period. Table 16-5 presents the recommendations for population mobility. Table 16-6 presents the confidence ratings for these recommendations.

The 50th and 90th percentiles for current residence time from the U.S. Census Bureau (2008a) are 8 years and 32 years, respectively. The mean and 90th percentile for residential occupancy period from Johnson and Capel (1992) are 12 years and 26 years, respectively.

Table 16-1. Recommended Values for Activity Patterns[a]

Age Group	Mean	95th Percentile	Source
Time Indoors (total) minutes/day			
Birth to <1 month	1,440	-	U.S. EPA analysis of source data from Wiley et al. (1991) for age groups from birth to <12 months. Average for boys and girls, whole population. See Table 16-14.
1 to <3 months	1,432	-	
3 to <6 months	1,414	-	
6 to <12 months	1,301	-	
1 to <2 years	1,353	-	U.S. EPA re-analysis of source data from U.S. EPA (1996) for age groups from 1 to <21 years, whole population. See Table 16-21.
2 to <3 years	1,316	-	
3 to <6 years	1,278	-	
6 to <11 years	1,244	-	
11 to <16 years	1,260	-	
16 to <21 years	1,248	-	
18 to <65 years	1,159	-	Adults, ≥18 years (U.S. EPA, 1996). Total minutes/24 hours (1,440) minus time outdoors, doers[b] only. See Table 16-22.
≥65 years	1,142	-	
Time Outdoors (total) minutes/day			
Birth to <1 month	0	-	U.S. EPA analysis of source data from Wiley et al. (1991) for age groups from birth to <12 months. Average for boys and girls, whole population. See Table 16-14.
1 to <3 months	8	-	
3 to <6 months	26	-	
6 to <12 months	139	-	
1 to <2 years	36	-	U.S. EPA re-analysis of source data from U.S. EPA (1996) for age groups from 1 to <21 years, whole population. See Table 16-21.
2 to <3 years	76	-	
3 to <6 years	107	-	
6 to <11 years	132	-	
11 to <16 years	100	-	
16 to <21 years	102	-	
18 to <65 years	281	-	Adults, ≥18 years (U.S. EPA, 1996). Sum of minutes spent outdoors away from the residence and minutes spent outdoors at the residence. Doers[b] only. See Table 16-22.
≥65 years	298	-	
Time Indoors (at residence) minutes/day			
Birth to <1year	1,108	1,440	Children, Birth to <21 years: U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-15.
1 to <2 years	1,065	1,440	
2 to <3 years	979	1,296	
3 to <6 years	957	1,355	
6 to <11 years	893	1,275	
11 to <16 years	889	1,315	
16 to <21 years	833	1,288	
18 to <65 years	948	1,428	Adults ≥18 years (U.S. EPA, 1996). Doers[b] only. See Table 16-16.
≥65 years	1,175	1,440	
Showering minutes/day			
Birth to <1year	15	-	U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-28.
1 to <2 years	20	-	
2 to <3 years	22	44	
3 to <6 years	17	34	
6 to <11 years	18	41	
11 to <16 years	18	40	
16 to <21 years	20	45	

Table 16-1. Recommended Values for Activity Patterns (continued)			
Age Group	Mean	95th Percentile	Source
Bathing minutes/day			
Birth to <1 year	19	30	U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-28.
1 to <2 years	23	32	
2 to <3 years	23	45	
3 to <6 years	24	60	
6 to <11 years	24	46	
11 to <16 years	25	43	
16 to <21 years	33	60	
Bathing/Showering minutes/day			
18 to <65 years	17	-	U.S. EPA (1996). Doers[b] only. See Table 16-29.
≥65 years	17	-	
Swimming minutes/month			
Birth to <1 year	96	-	Children, Birth to <21 years: U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-35. Adults, ≥18 years (U.S. EPA, 1996). Doers[b] only. See Table 16-37.
1 to <2 years	105	-	
2 to <3 years	116	181	
3 to <6 years	137	181	
6 to <11 years	151	181	
11 to <16 years	139	181	
16 to <21 years	145	181	
18 to <65 years	45[c]	181	
≥65 years	40[c]	181	
Playing on Sand/Gravel minutes/day			
Birth to <1 year	18	-	Children, <21 years: U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-38. Adults, ≥18 years (U.S. EPA, 1996). Doers[b] only. See Table 16-39.
1 to <2 years	43	121	
2 to <3 years	53	121	
3 to <6 years	60	121	
6 to <11 years	67	121	
11 to <16 years	67	121	
16 to <21 years	83	-	
18 to <65 years	0[c]	121	
≥65 years	0[c]	-	
Playing on Grass minutes/day			
Birth to <1 year	52	-	Children, <21 years: U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-38. Adults, ≥18 years (U.S. EPA, 1996). Doers[b] only. See Tables 16-39.
1 to <2 years	68	121	
2 to <3 years	62	121	
3 to <6 years	79	121	
6 to <11 years	73	121	
11 to <16 years	75	121	
16 to <21 years	60	-	
18 to <65 years	60[c]	121	
≥65 years	121[c]	-	

Table 16-1. Recommended Values for Activity Patterns (continued)

Age Group	Mean	95th Percentile	Source
Playing on Dirt minutes/day			
Birth to <1 year	33	-	Children, <21 years: U.S. EPA re-analysis of source data from U.S. EPA (1996). Doers[b] only. See Table 16-38. Adults, ≥18 years (U.S. EPA, 1996). Doers[b] only. See Table 16-39.
1 to <2 years	56	121	
2 to <3 years	47	121	
3 to <6 years	63	121	
6 to <11 years	63	121	
11 to <16 years	49	120	
16 to <21 years	30	-	
18 to <65 years	0[c]	120	
≥65 years	0[c]	-	

- Percentiles were not calculated for sample sizes less than 10 or in cases where the mean was calculated by summing the means from multiple locations or activities.

a These activities are averaged over seasons.

b Doers are those respondents who engaged or participated in the activity.

c Median value, mean not available in U.S. EPA, 1996.

Note: All activities are reported in units of minutes/day, except swimming, which is reported in units of minutes/month. There are 1,440 minutes in a day. Time indoors and outdoors may not add up to 1,440 minutes due to activities that could not be classified as either indoors or outdoors.

Table 16-2. Confidence in Recommendations for Activity Patterns

General Assessment Factors	Rationale	Rating
Soundness		High
Adequacy of Approach	The survey methodologies and data analyses were adequate. For the reanalysis of U.S. EPA (1996) study data, responses were weighted; however, adult data were not reanalyzed. The California children's activity pattern survey design (Wiley et al., 1991) and NHAPS (U.S. EPA, 1996) consisted of large overall sample sizes that varied with age. Data were collected via questionnaires and interviews.	
Minimal (or Defined) Bias	Measurement or recording error may have occurred since the diaries were based on 24 hour recall. The sample sizes for some age groups were small for some activity factors. The upper ends of the distributions were truncated for some factors. The data were based on short-term data.	
Applicability and Utility		Medium
Exposure Factor of Interest	The key studies focused on activities of children and adults.	
Representativeness	U.S. EPA (1996) was a nationally representative survey of the U.S. population and the reanalysis was weighted; the Wiley et al. (1991) survey was conducted in California and it was not representative of the U.S. population.	
Currency	The Wiley et al. (1991) study was conducted between April 1989 and February 1990; the U.S. EPA (1996) study was conducted between October 1992 and September 1994.	
Data Collection Period	Data were collected for a 24-hour period.	
Clarity and Completeness		Medium
Accessibility	The original studies are widely available to the public; U.S. EPA analysis of the original raw data from U.S. EPA (1996) is available upon request.	
Reproducibility	The methodologies were clearly presented; enough information was included to reproduce the results.	
Quality Assurance	Quality assurance methods were not well described in study reports.	
Variability and Uncertainty		Medium
Variability in Population	Variability was characterized across various age categories of children and adults.	
Uncertainty	The studies were based on short term recall data, and the upper ends of the distributions were truncated.	
Evaluation and Review		Medium
Peer Review	The original studies received a high level of peer review. The re-analysis of the U.S. EPA (1996) data to conform to the standardized age categories was not peer-reviewed.	
Number and Agreement of Studies	There were 2 key studies.	
Overall Rating		**Medium** for the mean; **low** for upper percentile

Table 16-3. Recommended Values for Occupational Mobility

Age Group	Median Tenure (years) Men	Median Tenure (years) Women	Source
All ages, ≥16 years	7.9	5.4	(Carey, 1988). See Table 16-82
16 to 24 years	2.0	1.9	
25 to 29 years	4.6	4.1	
30 to 34 years	7.6	6.0	
35 to 39 years	10.4	7.0	
40 to 44 years	13.8	8.0	
45 to 49 years	17.5	10.0	
50 to 54 years	20.0	10.8	
55 to 59 years	21.9	12.4	
60 to 64 years	23.9	14.5	
65 to 69 years	26.9	15.6	
≥70 years	30.5	18.8	

Age Group	Occupational Mobility Rate[a] (percent)	Source
16 to 24 years	12.7	(Carey, 1990). See Table 16-86
25 to 34 years	6.6	
35 to 44 years	4.0	
45 to 54 years	1.9	
55 to 64 years	1.0	
≥64 years	0.3	
Total, ≥16 years	5.3	

[a] Occupational mobility rate = percentage of persons employed in an occupation who had voluntarily entered it from another occupation.

Table 16-4. Confidence in Recommendations for Occupational Mobility

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Both studies are based on the U.S. Census Bureau's Current Population Survey which uses valid methodologies and approaches and is representative of the U.S. population with sample sizes of approximately 50,000 a month. Both studies are secondary analyses based on supplemental data to the January, 1987, Current Population Survey (a U.S. Census publication).	
Minimal (or Defined) Bias	Much of the original study data is not available. Only median values are reported. There is minimal concern about sampling and non-sampling error and non-response bias as in all surveys based on statistical samples.	
Applicability and Utility		Medium
Exposure Factor of Interest	Occupational tenure was the focus of both key studies.	
Representativeness	The data are statistically representative of the U.S. population.	
Currency	The data were collected over 20 years ago in 1986 and 1987. It is questionable whether the results would be the same if current data were analyzed based on changes in the economy that have occurred since the study was conducted.	
Data Collection Period	Data were collected in 1986–1987.	
Clarity and Completeness		Medium
Accessibility	The studies are widely available to the public. The Current Population Survey January, 1987: Occupational Mobility and Job Tenure data are available from the U.S. Census Bureau.	
Reproducibility	Results can be reproduced and methodology can be followed and evaluated.	
Quality Assurance	Quality assurance methods were not well described.	
Variability and Uncertainty		High
Variability in Population	The study provided averages according to sex, race, and education; age averages and percentiles were provided.	
Uncertainty	The studies are based on recall data.	
Evaluation and Review		Medium
Peer Review	The studies received a high level of peer review.	
Number and Agreement of Studies	There are 2 key studies based on the same data source.	
Overall Rating		**Medium**

Table 16-5. Recommended Values for Population Mobility			
	Mean	95th Percentile	Source
Residential Occupancy Period	12 years	33 years	(Johnson and Capel, 1992). See Table 16-87.
Current Residence Time	13 years	46 years	(U.S. Census Bureau, 2008a). See Table 16-90.

Table 16-6. Confidence in Recommendations for Population Mobility

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	Both key studies are based on U.S. Census Bureau studies which used valid data collection methodologies and approaches and are representative of the U.S. population.	
Minimal (or Defined) Bias	Data do not account for each member of the household; values are more realistic estimates for the individual's total residence time than the average time a household has been living at its current residence. The moving process was modeled in Johnson and Capel (1992). For the mean and percentile calculations of U.S. Census Bureau (2008a) data, an even distribution was assumed within different ranges which may bias the statistics.	
Applicability and Utility		Medium
Exposure Factor of Interest	The Census data provided length of time at current residence. The other study used modeling to estimate total time.	
Representativeness	The sample surveyed was statistically representative of the U.S. population.	
Currency	The data were collected in 2007 and 1985–1987, and reported in 2008 and 1992, respectively.	
Data Collection Period	Data were collected throughout the calendar year.	
Clarity and Completeness		High
Accessibility	The studies are widely available to the public.	
Reproducibility	Results can be reproduced or methodology can be followed and evaluated.	
Quality Assurance	Quality assurance is discussed in the documentation on the U.S. Census Bureau studies.	
Variability and Uncertainty		Medium
Variability in Population	The study provided data by age and sex. Variability across several geographic regions was noted. Type of ownership was also addressed.	
Uncertainty	The U.S. Census Bureau data was truncated at 65 years.	
Evaluation and Review		High
Peer Review	The studies received high levels of peer review and appear in publications.	
Number and Agreement of Studies	The 2 studies produced similar results.	
Overall Rating		**Medium**

16.3. ACTIVITY PATTERNS

16.3.1. Key Activity Pattern Studies

16.3.1.1. *Wiley et al. (1991)—Study of Children's Activity Patterns*

The California Study of Children's Activity Patterns survey (Wiley et al., 1991) provided estimates of the time children spent in various activities and locations (microenvironments) on a typical day. The sample population consisted of 1,200 children, under 12 years of age, selected from English-speaking households using Random Digit Dial (RDD) methods. This represented a survey response rate of 77.9%. One child was selected from each household. If the selected child was less than 9 years old, the adult in the household who spent the most time with the child responded. However, if the selected child was between 9 and 11 years old, that child responded. The population was also stratified to provide representative estimates for major regions of the state. The survey questionnaire included a time diary which provided information on the children's activity and location patterns based on a 24-hour recall period. In addition, the survey questionnaire included questions about potential exposure to sources of indoor air pollution (e.g., presence of smokers) on the diary day, and the socio-demographic characteristics of children and adult respondents. The questionnaires and the time diaries were administered via a computer-assisted telephone interviewing (CATI) technology (Wiley et al., 1991). The telephone interviews were conducted during April 1989 to February 1990 over 4 seasons: spring (April to June 1989), summer (July to September 1989), fall (October to December 1989), and winter (January to February 1990).

The data obtained from the survey interviews resulted in 10 major activity categories, 113 detailed activity codes, 6 major categories of locations, and 63 detailed location codes. The time respondents under 12 years of age spent in the 10 activity categories (plus a "don't know" or non-coded activity category) are presented in Table 6-7. For each of the 10 activity categories, this table presents the mean duration for all survey participants, the percentage of respondents who reported participating in the activity (i.e., percent doers), and the mean, median, and maximum duration for only those survey respondents who engaged in the activity (i.e., doers). It also includes the detailed activity with the highest mean duration of time for each activity category. The activity category with the highest time expenditure was personal needs and care, with a mean of 794 minutes/day (13.2 hours/day). Night sleep was the detailed activity that had the highest mean duration in that activity category. The activity category "don't know" had a mean duration of about 2 minutes/day and only 4% of the respondents reported missing activity time.

Table 16-8 presents the mean time spent in the 10 activity categories by age and sex. Because the original source data were available, U.S. EPA re-analyzed the data according to the standardized age categories used in this handbook. Differences between activity patterns in boys and girls tended to be small. Table 16-9 presents the mean time spent in the 10 activity categories grouped by season and geographic region in the state of California. There were seasonal differences for 5 activity categories: personal needs and care, education, entertainment/social, recreation, and communication/passive leisure. Time expenditure differences in various regions of the state were minimal for childcare, work-related, goods/services, personal needs and care, education, entertainment/social, and recreation.

Table 16-10 presents the distribution of time across 6 location categories. The mean duration for all survey participants, the percent of respondents engaging in the activity (i.e., percent doers); the mean, median, and maximum duration for doers only; and the detailed locations with the highest average time expenditure are shown. For all survey respondents, the largest mean amount of time spent was at home (1,078 minutes/day); 99% of respondents spent time at home (mean of 1,086 minutes/day for these individuals only). Tables 16-11 and 16-12 show the average time spent in the 6 locations grouped by age and sex, and season and region, respectively. Again, because the original source data were available, the age categories used by Wiley et al. (1991) have been replaced in Table 16-11 by the standardized age categories used in this handbook. There were relatively large differences among the age groups in time expenditure for educational settings (see Table 16-11). There were small differences in time expenditure at the 6 locations by region, but time spent in school decreased in the summer months compared with other seasons (see Table 16-12).

Table 16-13 shows the average time children spent in proximity to gasoline fumes and gas oven fumes. In general, the sampled children spent more time closer to gasoline fumes than to gas oven fumes. The age categories in Table 16-13 have been modified to conform to the standardized categories used in this handbook.

The U.S. EPA estimated the total time indoors and outdoors using the data from the Wiley et al. (1991) study. Activities performed indoors were assumed to include household work, child care, personal needs and care, education, and communication/passive leisure. The average times spent in these indoor activities and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., work-related, goods/services, organizational activities, entertainment/social, don't know/not coded) were summed. Table 16-14 summarizes the results of this analysis using the standard age groups.

A limitation of this study is that the sampling population was restricted to only English-speaking households; therefore, the data obtained do not represent the diverse population group present in California. Another limitation is that time use values obtained from this survey were based on short-term recall (24-hour) data; therefore, the data set obtained may be biased. Other limitations are as follows: the survey was conducted in California and is not representative of the national population, and the significance of the observed differences in the data obtained (i.e., sex, age, seasons, and regions) were not tested statistically. An advantage of this study is that time expenditure in various activities and locations were presented for children grouped by age, sex, and season. Also, potential exposures of respondents to pollutants were explored in the survey. Another advantage is the use of the CATI program in obtaining time diaries, which allows automatic coding of activities and locations onto a computer tape, and allows activities forgotten by respondents to be inserted into their appropriate position during interviewing.

16.3.1.2. *U.S. EPA (1996)— Descriptive Statistics Tables from a Detailed Analysis of the National Human Activity Pattern Survey (NHAPS) Data*

U.S. EPA (1996) analyzed data collected by the National Human Activity Pattern Survey. This survey was conducted by U.S. EPA and is the largest and most current human activity pattern survey available (U.S. EPA, 1996). Data for 9,386 respondents in the 48 contiguous United States were collected via minute-by-minute 24-hour diaries. NHAPS was conducted from October 1992 through September 1994 by the University of Maryland's Survey Research Center using CATI technology to collect 24-hour retrospective diaries and answers to a number of personal and exposure related questions from each respondent. Detailed data were collected for a maximum of 82 different possible locations, and a maximum of 91 different activities. Participants were selected using a RDD method. The response rate was 63% overall. If the chosen respondent was a child less than 10 years of age, an adult in the household gave a proxy interview. Each participant was asked to recount their entire daily routine from midnight to midnight immediately previous to the day that they were interviewed. The survey collected information on duration and frequency of selected activities and of the time spent in selected microenvironments. In addition, demographic information was collected for each respondent to allow for statistical summaries to be generated according to specific groups of the U.S. population (i.e., by sex, age, race, employment status, census region, season, etc.). Saturdays and Sundays were over sampled to ensure an adequate weekend sample.

For children, the source data from U.S. EPA have been reviewed and re-analyzed by U.S. EPA to conform to the age categories recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). This analysis was weighted according to geographic, socioeconomic, time/season, and other demographic factors to ensure that results were representative of the U.S. population. The weighted sample matched the 1990 U.S. census population for each sex, age group, census region, and the day-of-week and seasonal responses were equally distributed.

Tables 16-15 through 16-44 provide data from the NHAPS study. Because no data were available on subjects' age in months, age groups less than 1 year old were consolidated into a single group. These tables provide statistics for 24-hour cumulative time spent (mean, minimum, percentiles, and maximum) in selected locations or engaging in selected activities. The original analysis generated statistics for the subset of the survey population that reported being in the location or doing the activity in question (i.e., doers only). For the reanalysis, statistics were calculated for the entire survey population (i.e., whole population) and for doers only. When the sample size was 10 persons or fewer, percentile values were not calculated.

Data are presented for the time children, aged birth to less than 21 years, spent in various locations and doing various activities. Each children only table is followed by a table for the whole population which presents data for specific populations (i.e., by sex, age, race, ethnicity, employment, education, Census region, day of the week, season, asthma status, and bronchitis/emphysema status) and includes the time adults, aged 18 years and older, spent in various locations and doing various activities. Tables 16-15 and 16-16 present data for time spent in rooms of the house (e.g., kitchen, bathroom, bedroom, and garage), and all rooms combined, for children and by demographic characteristics (including adulthood) respectively. Tables 16-17 and 16-18 present data for time spent in other indoor locations (e.g., restaurants, indoors at school, and grocery/convenience stores). Tables 16-19 and 16-20 present data for the time survey participants spent outdoors on school grounds/playgrounds, parks or golf courses, or pool rivers, or lakes.

Table 16-21 provides data on time spent in indoor and outdoor environments for children birth to <21 years of age. The U.S. EPA estimated the time spent indoors by adding the average times spent indoors at the respondents' home (kitchen, living room, bathroom, etc.), at other houses, and inside other locations such as school, restaurants, etc. Time outdoors was estimated by adding the average time spent outdoors at the respondents' pool and yard, others' pool and yard, and outside other locations such as sidewalk, street, neighborhood, parking lot, service station/gas station, school grounds, park/golf course, pool, river, lake, farm, etc. Table 16-22 provides data on time spent in outdoor and indoor environments for adults aged 18 years and older. The average time spent outdoors was estimated by summing the average time spent outdoors away from the residence and the average time spent outdoors at the residence. Note that these averages are for doers only and thus over-estimate the total time spent in the environments for the population.

Tables 16-23 and 16-24 present data for the time spent in various types of vehicles (i.e., car, truck/van, bus), and in all vehicles combined. Tables 16-25 and 16-26 present data for the time children and adults spent in various major activity categories (i.e., sleeping, napping, eating, attending school, outdoor recreation, active sports, exercise, and walking).

Tables 16-27 through 16-31 provide data related to showering and bathing. Data on handwashing activities are in Tables 16-32 and 16-33. Tables 16-34 and 16-35 provide data for children on monthly swimming (in a freshwater pool) frequency and swimming duration, respectively. Tables 16-36 and 16-37 provide data by demographic characteristics (including adulthood) on monthly swimming (in a freshwater pool) frequency and swimming duration, respectively. Table 16-38 provides data on the time children spent playing on dirt, sand/gravel, or grass, and Table 16-39 displays these data by demographic characteristics (including adulthood). Tables 16-40 and 16-41 provide data on the number of minutes spent near excessive dust. Tables 16-42 and 16-43 provide information on time spent in the presence of smokers. For this data set, the authors' original age categories for children were used because the methodology used to generate these data could not be reproduced.

The advantages of the NHAPS data set are that it is representative of the U.S. population. The reanalysis done by U.S. EPA to get estimates for childhood age groups that correspond to the *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005) was weighted and thus the results presented are balanced geographically, seasonally, and for day/time. Also, the NHAPS is inclusive of all ages, sexes, and races. A disadvantage of the study is that for the standard age categories, the number of respondents is small for the "doers" of many activities. In addition, the durations exceeding 60, 120, and 181 minutes were not collected for some activities. Therefore, the actual time spent at the high end of the distribution for these activities could not be accurately estimated. In addition, some of the activities were not necessarily mutually exclusive (e.g., time spent in active sports likely overlaps with exercise time).

16.3.2. Relevant Activity Pattern Studies

16.3.2.1. *Hill (1985)—Patterns of Time Use*

Hill (1985) investigated the total amount of time American adults spend in 1 year performing various activities and the variation in time use across 3 different dimensions: demographic characteristics, geographical location, and seasonal characteristics. In this study, time estimates were based on data collected from time diaries in 4 waves (1/season) of a survey conducted in the fall of 1975 through the fall of 1976 for the 1975–1976 Time Allocation Study. The sampling periods included 2 weekdays, 1 Saturday and 1 Sunday. The information gathered was in response to the survey question "What were you doing?" The survey also provided information on secondary activities (i.e., respondents performing more than 1 activity at the same time). Hill (1985) analyzed time estimates from 971 individuals for 10 broad categories of activities based on data collected from 87 activities. These estimates included seasonal variation in time use patterns and comparisons of time use patterns for different days of the week.

Analysis of the 1975–1976 survey data revealed very small regional differences in time use among the broad activity patterns (Hill, 1985). The weighted mean hours/week spent performing the 10 major activity categories presented by region are shown in

Table 16-44. Table 16-45 presents the time spent per day, by the day of the week for the 10 major activity categories. Adult time use was dominated in descending order by personal care (including sleep), market work, passive leisure, and housework. Collectively, these activities represent about 80% of available time (Hill, 1985).

According to Hill (1985), sleep (included in personal care) was the single most dominant activity averaging about 56.3 hours/week. Television watching (included in passive leisure) averaged about 21.8 hours/week, and housework activities averaged about 14.7 hours/week. Weekdays were predominantly market-work oriented. Weekends (Saturday and Sunday) were predominantly devoted to household tasks ("sleeping in," socializing, and active leisure) (Hill, 1985). Table 16-46 presents the mean time spent performing these 10 groups of activities during each wave of interview (fall, winter, spring, and summer). Adjustments were made to the data to assure equal distributions of weekdays, Saturdays, and Sundays (Hill, 1985). The data indicate that the time periods adults spent performing market work, child care, shopping, organizational activities, and active leisure were fairly constant throughout the year (Hill, 1985). The mean hours spent per week in performing the 10 major activity patterns are presented by sex in Table 16-47. These data indicate that time use patterns determined by data collected for the mid-1970's survey show sex differences. Men spent more time on activities related to labor market work and education, and women spent more time on household work activities.

A limitation associated with this study is that the time use data were obtained from an old survey conducted in the mid-1970s. Because of fairly rapid changes in American society, applying these data to current exposure assessments may result in some biases. Another limitation is that time use data were not presented for children. An advantage of this study is that time diaries were kept and data were not based on recall. The former approach may result in a more accurate data set. Another advantage of this study is that the survey is seasonally balanced since it was conducted throughout the year and the data are from a large survey sample.

16.3.2.2. *Timmer et al. (1985)—How Children Use Time*

Timmer et al. (1985) conducted a study using the data obtained on children's time use from a 1981–1982 panel study. Data were obtained for 389 children between 3 and 17 years of age. Data were collected using a time diary and a standardized interview. The time diary involved children reporting their activities beginning at 12:00 a.m. the previous night, the duration and location of each activity, the presence of another individual, and whether they were performing other activities at the same time. The standardized interview was administered to the children to gather information about their psychological, intellectual (using reading comprehension tests), and emotional well-being; their hopes and goals; their family environment; and their attitudes and beliefs.

For preschool children, parents provided information about the child's previous day's activities. Children in first through third grades completed the time diary with their parents' assistance and, in addition, completed reading tests. Children in 4th grade and above provided their own diary information and participated in the interview. Parents were asked to assess their children's socioemotional and intellectual development, and a survey form was sent to a teacher of each school-age child to evaluate their socioemotional and intellectual development. The activity descriptor codes used in this study were developed by Juster et al. (1983).

The mean time spent performing major activities on weekdays and weekends by age, sex, and type of day is presented in Table 16-48. On weekdays, children spend about 40% of their time sleeping, 20% in school, and 10% eating, and performing personal care activities (Timmer et al., 1985). The data in Table 16-48 indicate that girls spent more time than boys performing household work and personal care activities and less time playing sports. Also, the children spent most of their free time watching television.

Table 16-49 presents the mean time children spent during weekdays and weekends performing major activities by 5 different age groups. The significant effects of each variable (i.e., age and sex) are also shown. Older children spent more time performing household and market work, studying, and watching television and less time eating, sleeping, and playing. The authors estimated that, on average, boys spent 19.4 hours a week and girls spent 17.8 hours/week watching television.

U.S. EPA estimated the total time indoors and outdoors using the Timmer et al. (1985) data. Activities performed indoors were assumed to include household work, personal care, eating, sleeping, attending school, studying, attending church, watching television, and engaging in household conversations. The average times spent in these indoor activities and half the time spent in each activity which could have occurred indoors or outdoors (e.g., market work, sports, hobbies, art activities, playing, reading, and other passive leisure) were summed. Table 16-50 summarizes the results of this analysis by age group and day of the week.

A limitation associated with this study is that it was conducted in 1981. It is likely that activity patterns of children have changed from 1981 to the present. Thus, the application of these data to current exposure assessments may bias their results. Another limitation is that the data do not provide overall annual estimates of children's time use since data were collected only during the time of the year when children attended school and not during school vacations. An advantage of this survey is that diary recordings of activity patterns were kept and the data obtained were not based entirely on recall. Another advantage is that parents assisted younger children with keeping their diaries and with interviews, minimizing any bias that may have been created by having younger children record their own data.

16.3.2.3. *Robinson and Thomas (1991)—Time Spent in Activities, Locations, and Microenvironments: A California-National Comparison*

Robinson and Thomas (1991) reviewed and compared data from the 1987–1988 California Air Resources Board (CARB) time-activity study for California residents and from a similar 1985 national study, *Americans' Use of Time*, conducted at the University of Maryland. Both studies used the diary approach to collect data. Time-use patterns were collected for individuals aged 12 years and older. Telephone interviews based on the RDD procedure were conducted for 1,762 and 2,762 respondents for the CARB study and the national study, respectively. Robinson and Thomas (1991) defined a set of 16 microenvironments based on the activity and location codes employed in the 2 studies. The mean durations of time spent in the 16 microenvironments by age, are presented in Table 16-51. In both studies, children and adults spent the majority of their time sleeping, and engaging in leisure and work/study-related activities.

Table 16-52 shows the mean time spent in the 10 major activities by sex and for all respondents between the ages of 18-64 years. Table 16-53 presents the mean time spent at 3 major locations for the CARB and national study grouped by total sample and sex, ages 18-64 years. The mean duration of time spent in locations for total sample population, 12 years and older, across 3 types of locations is presented in Table 16-54 for both studies.

The limitations associated with the Robinson and Thomas (1991) study are that the CARB survey was performed in California only and may not be representative of the U.S. population as a whole, and the studies were conducted in the 1980s and activity patterns may have changed over time. Another limitation is that the data are based on short-term studies. Finally, the available data could not be re-analyzed to conform to the standardized age categories used in this handbook.

16.3.2.4. *Funk et al. (1998)—Quantifying the Distribution of Inhalation Exposure in Human Populations: Distribution of Time Spent by Adults, Adolescents, and Children at Home, at Work, and at School*

Funk et al. (1998) used the data from the CARB study to determine distributions of exposure time by tracking the time spent participating in daily activities for male and female children, adolescents, and adults. CARB performed 2 studies from 1987 to 1990; the first was focused on adults (18 years and older) and adolescents (12 to 17 years old), and the second focused on children (6 to 11 years old). The targeted groups were non-institutionalized English speaking Californians with telephones in their residences. Individuals were contacted by telephone and asked to account for every minute within the previous 24 hours, including the amount of time spent on an activity and the location of the activity. The surveys were conducted on different days of the week as well as different seasons of the year.

Using the location descriptors provided in the CARB study, Funk et al. (1998) categorized the activities into 2 groups, "at home" (any activity at principal residence) and "away." Each activity was assigned to 1 of 3 inhalation rate levels (low, moderate, or high) based on the level of exertion expected from the activity. Ambiguous activities were assigned to moderate inhalation rate levels. Among the adolescents and children studied, means were determined for the aggregate age groups. Sample sizes are shown in Table 16-55.

Funk et al. (1998) used several statistical methods, such as Chi-square, Kolmogorov-Smirnov, and Anderson-Darling, to determine whether the time spent in an activity group had a known distribution. Most of the activities performed by all individuals were assigned a low or moderate inhalation rate (see Table 16-56).

The aggregate time periods spent at home in each activity are shown in Table 16-57. Aggregate time spent at home performing different activities was compared between sexes. There were no significant differences between adolescent males and females in any of the activity groups (see Table 16-58). There were significant differences between males and females among adults in all activity groups except for the low activity group (see Table 16-58). In children, ages 6 to 11 years, differences between sex and age were observed at the low inhalation rate levels. There were significant differences ($p < 0.05$) between 2 age groups (6 to 8 years, and 9 to 11 years) and sex at the moderate inhalation rate level (see Table 16-59).

A limitation of this study was that large proportions of the respondents in the study did not participate in high-inhalation rate-level activities. The Funk et al. (1998) study was based on data from 1 geographic location, collected more than a decade ago. Thus, it may not be representative of current activities among the general population of the United States.

16.3.2.5. *Cohen Hubal et al. (2000)—Children's Exposure Assessment: A Review of Factors Influencing Children's Exposure and the Date Available to Characterize and Assess That Exposure*

Cohen Hubal et al. (2000) reviewed available data from the Consolidated Human Activity Database (CHAD, U.S. EPA, 2000), including activity pattern data, to characterize and assess environmental exposures to children. Data from the 2 key studies in this chapter (Wiley et al., 1991; U.S. EPA, 1996) are included in CHAD. CHAD was developed by the U.S. EPA's National Exposure Research Laboratory to provide access to existing human activity pattern data for use in exposure and risk assessment efforts. It is available online at http://www.epa.gov/chadnet1/. Data from twelve activity pattern studies conducted at the city, state, and national levels are included in CHAD. CHAD contains both the original raw data from each study and data modified based on predefined format requirements. Modifications made to data included: recoding of variables to fit into them a common activity/location code system, and standardization of time diaries to an exact 24-hour length. Detailed information on the coding system and the studies included in CHAD is available in the CHAD User Manual, available at http://oaspub.epa.gov/chad/CHAD_Datafiles$.startup#Manual, and in McCurdy et al. (2000).

A total of 144 activity codes and 115 location codes were used in CHAD (McCurdy et al., 2000). Although some participants in a study conducted multiple activities, many activities were only conducted within a few studies. The same is true for activity locations. The selection of exposure estimates for a particular activity or particular location should be based on study parameters that closely relate to the exposure scenario being assessed. The maximum amount of time, on average, within a majority of the studies was sleeping or taking a nap, while the maximum amount of time spent at a particular location was at home or at work, depending on the study.

Many of the limitations of CHAD data arise from the incorporation of multiple studies into the time diary functions specified in CHAD. Activities and locations were coded similarly to the NHAPS study; studies with differing coding systems were modified to fit the NHAPS codes. In some cases start times and end times from a study had to be adjusted to fit a 24-hour period. Respondents were not randomly distributed in CHAD. For example, some cities or states were over sampled because entire studies were carried out in those places. Other studies excluded large groups of people such as smokers, or non-English speakers, or people without telephones. Many surveys were age restricted, or they preferentially sampled certain target groups. As a result, users are cautioned against using random individuals in CHAD to represent the U.S. population as a whole (Stallings et al., 2000).

CHAD contains 3,009 person-days of macroactivity data for 2,640 children less than 12 years of age (Cohen Hubal et al., 2000) (see Table 16-60). The number of hours these children spent in various microenvironments are shown in Table 16-61 and the time they spent in various activities indoors at home is shown in Table 16-62.

Cohen Hubal et al. (2000) noted that CHAD contains approximately "140 activity codes and 110 location codes, but the data generally are not available for all activity locations for any single respondent. In fact, not all of the codes were used for most of the studies. Even though many codes are used in macroactivity studies, many of the activity codes do not adequately capture the richness of what children actually do. They are much too broadly defined and ignore many child-oriented behaviors. Thus, there is a need for more and better-focused research into children's activities."

U.S. EPA updated the analysis performed by Cohen Hubal et al. (2000) using CHAD data downloaded in 2000, sorted according to the age groups recommended in *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (U.S. EPA, 2005). Tables 16-63 and 16-64 show the results. In this analysis, individual study participants within CHAD whose behavior patterns were measured over multiple days were treated as multiple 1-day activity patterns. This is a potential source of error or bias in the results because a single individual may contribute multiple data sets to the aggregate population being studied.

Advantages of the CHAD database are that it includes data from 12 activity pattern studies and is a fairly comprehensive tool for cohort development and for simulating individuals within exposure assessments. However, because the database is comprised of separate studies, issues such as quality assurance and consistency between the studies are difficult to assess. In addition, current human activity pattern surveys do not collect data on microactivities that are important to understanding exposures, especially for children, nor do they discriminate sufficiently among activities important to developing energy expenditure estimates.

16.3.2.6. *Wong et al. (2000)—Adult Proxy Responses to a Survey of Children's Dermal Soil Contact Activities*

Wong et al. (2000) conducted telephone surveys to gather information on children's activity patterns as related to dermal contact with soil during outdoor play on bare dirt or mixed grass and dirt surfaces. This study, the second Soil Contact Survey (SCS-II), was a follow-up to the initial Soil Contact Survey (SCS-I), conducted in 1996, that primarily focused on assessing adult behavior related to dermal contact with soil and dust (Garlock et al., 1999). As part of SCS-I, information was gathered on the behavior of children under the age of 18 years, however, the questions were limited to clothing choices and the length of time between soil contact and hand washing. Questions were posed for SCS-II to further define children's outdoor activities and hand washing and bathing frequency. For both soil contact surveys households were randomly phoned in order to obtain nationally representative results. The adult respondents were questioned as surrogates for 1 randomly chosen child under the age of 18 residing within the household.

In the SCS-II, of 680 total adult respondents with a child in their household, 500 (73.5%) reported that their child played outdoors on bare dirt or mixed grass and dirt surfaces (identified as "players"). Those children that reportedly did not play outdoors ("non-players") were typically very young (≤1 year) or relatively older (≥14 years). Of the 500 children that played outdoors, 497 played outdoors in warm weather months (April through October) and 390 were reported to play outdoors during cold weather months (November through March). These results are presented in Table 16-65. The frequency (days/week), duration (hours/day), and total hours/week spent playing outdoors was determined for those children identified as "players" (see Table 16-66). The responses indicated that children spent a relatively high percentage of time outdoors during the warmer months, and a lesser amount of time outdoors in cold weather. The median play frequency reported was 7 days/week in warm weather and 3 days/week in cold weather. Median play duration was 3 hours/day in warm weather and 1 hour/day during cold weather months.

Adult respondents were then questioned as to how many times per day their child washed his/her hands and how many times the child bathed or showered per week, during both warm and cold weather months. This information provided an estimate of the time between skin contact with soil and removal of soil by washing (i.e., exposure time). Hand washing and bathing frequencies for child players are reported in Table 16-67. Based on these results, hand washing occurred a median of 4 times per day during both warm and cold weather months. The median frequency for baths and showers was estimated to be 7 times per week for both warm and cold weather.

Based on reported household incomes, the respondents sampled in SCS-II tended to have higher incomes than that of the general population. This may be explained by the fact that phone surveys cannot sample households without telephones. Additional uncertainty or error in the study results may have occurred as a result of the use of surrogate respondents. Adult respondents were questioned regarding child activities that may have occurred in prior seasons, introducing the chance of recall error. In some instances, a respondent did not know the answer to a question or refused to answer. Table 16-68 compares mean play duration data from SCS-II to similar activities identified in NHAPS (U.S. EPA, 1996). Table 16-69 compares the number of times per day a child washed his or her hands, based on data from SCS-II and NHAPS. As indicated in Tables 16-68 and 16-69, where comparison is possible, NHAPS and SCS-II results showed similarities in observed behaviors.

An advantage of this study includes the fact that a random household survey was conducted to obtain nationally representative results. A limitation of the study is that questions were limited to clothing choices and the length of time between soil contact and hand washing. In addition, the participants were questioned about events from prior seasons, which may have introduced recall error.

16.3.2.7. *Graham and McCurdy (2004)—Developing Meaningful Cohorts for Human Exposure Models*

Graham and McCurdy (2004) used a statistical model (general linear model and analysis of variance [GLM/ANOVA]) to assess the significance of various factors in explaining variation in time spent outdoors, indoors and in motor vehicles. These factors, which are commonly used in developing cohorts for exposure modeling, included age, sex, weather, ethnicity, day type, and precipitation. Activity pattern data from CHAD, containing 30 or more records per day, were used in the analysis (Graham and McCurdy, 2004). Data from the 2 key studies in this chapter (Wiley et al., 1991; U.S. EPA, 1996) are included in CHAD.

Table 16-70 presents data on time spent outdoors for people who spent >0 time outdoors (i.e., doers). Graham and McCurdy (2004) found that all the factors evaluated were significant ($p < 0.001$) in explaining differences in time spent outdoors (Graham and McCurdy, 2004). An evaluation of sex differences in time spent outdoors by age cohorts was also conducted. Table 16-71 presents descriptive statistics and the results of the 2-sample Kolmogorov-Smirnov (K-S) test for this evaluation. As shown in Table 16-71, there were statistically significant sex differences in time spent outdoors starting with the 6 to 10 year old age category and continuing through all age groups, up to and including >64 years of age. In addition, Graham and McCurdy (2004) evaluated the effect of physical activity and concluded that this was the most important factor in explaining time spent outdoors. For time spent indoors (see Table 16-72), there were statistically significant effects for all the factors evaluated, with sex, weather, and day type being the most important variables. Regarding time spent in motor vehicles (see Table 16-73), precipitation was the only factor found to have no significant effects (Graham and McCurdy, 2004).

Based on the results of these analyses, Graham and McCurdy (2004) noted that "besides age and sex, other important attributes for defining cohorts are the physical activity level of individuals, weather factors such as daily maximum temperature in combination with months of the year, and combined weekday/weekend with employment status." The authors also noted that even though the factors evaluated were found to be statistically significant in explaining differences in time spent outdoors, indoors, and in motor vehicles, "parameters such as lifestyle and life stages that are absent from CHAD might have reduced the amount of unexplained variance." The authors recommended that, in defining cohorts for exposure modeling, age and sex should be used as ''first-order'' attributes, followed by physical activity level, daily maximum temperature, and day type (weekend/weekday or day-of-the-week/working status) (Graham and McCurdy, 2004).

The CHAD database is a fairly comprehensive tool for cohort development and for simulating individuals within exposure assessments. However, the database is comprised of 12 separate studies, and because of this, issues such as quality assurance and consistency between the studies are difficult to assess. In addition, current human activity pattern surveys do not collect data on microactivities that are important to understanding exposures, especially for children, nor do they discriminate sufficiently among activities important to developing energy expenditure estimates. Other limitations of the CHAD database are described earlier in this chapter by Cohen Hubal et al. (2000) in Section 16.3.2.5.

16.3.2.8. *Juster et al. (2004)—Changing Times of American Youth: 1983–2003*

Juster et al. (2004) evaluated changes in time use patterns of children by comparing data collected in a 1981–1982 pilot study of children ages 6 to 17 to data from the 2002–2003 Child Development Supplement (CDS) to the Panel Study of Income Dynamics (PSID). The 1981–1982 pilot study is the same study described in Timmer et al. (1985). The 2002–2003 CDS gathered 24-hour time diary data on 2,908 children ages 6 to 17; as was done in the 1997 CDS, information was collected on 1 randomly selected weekday and 1 randomly selected weekend day (Juster et al., 2004).

Tables 16-74 and 16-75 present the mean time children spent (in minutes/day) performing major activities on weekdays and weekend days, respectively, for the years 1981–1982 and 2002-2003. Table 16-76 shows the weekly time spent in these activities for the years 1981–1982 and 2002–2003. Juster et al. (2004) noted that the time spent in school and studying increased while time spent in active sports and outdoors activities decreased during the period studied.

An advantage of this survey is that diary recordings of activity patterns were kept and the data obtained were not based entirely on recall. Another advantage is that because parents assisted younger children with keeping their diaries and with interviews, minimizing any bias that may have been created by having younger children record their own data. A limitation associated with this study is that the data from the Timmer et al. (1985) study were collected in 1981 and it is likely that the activity patterns of children have changed from 1981 to the present. Another limitation is that the data from the CDS study do not provide overall annual estimates of children's time use since data were collected only during the time of the year when children attended school and not during school vacations.

16.3.2.9. *Vandewater et al. (2004)—Linking Obesity and Activity Level with Children's Television and Video Game Use*

Vandewater et al. (2004) evaluated children's media use and participation in active and sedentary activities using 24-hour time-use diaries collected in 1997, as part of the Child Development Supplement to the Panel Study of Income Dynamics. The PSID is an ongoing, longitudinal study of U.S. individuals and their families conducted by the Survey Research Center of the University of Michigan. In 1997, PSID families with children younger than 12 years of age completed the CDS and reported all activities performed by the children on 1 randomly selected weekday and 1 randomly selected weekend day. Since minorities, low-income families, and less educated individuals were oversampled in the PSID, sample weights were applied to the data (Vandewater et al., 2004). More information on the CDS can be found on-line at http://psidonline.isr.umich.edu/CDS/.

Using time use diary data from 2,831 children participating in the CDS, Vandewater et al. (2004) estimated the time in minutes over the 2-day study period (i.e., sum of time spent on 1 weekday and 1 weekend day) that children spent watching television, playing games on video games consoles or computers, reading, and using computers for other purposes besides playing games. In addition, the time spent participating in highly active (i.e., playing sports), moderately active (i.e., fishing, boating, camping, taking music lessons, and singing), and sedentary (i.e., using the phone, doing puzzles, playing board games, and relaxing) activities was determined. Table 16-77 presents the means and standard deviations for the time spent in the selected activities by age and sex.

A limitation of this study is that the survey was not designed for exposure assessment purposes. Therefore, the time use data set may be biased. However, the survey provides a database of current information on various human activities. This information can be used to assess various exposure pathways and scenarios associated with these activities.

16.3.2.10. *U.S. Department of Labor (2007)—American Time Use Survey, 2006 Results*

The American Time Use Study has been conducted annually since 2003 by the U.S. Department of Labor's (DOL) Bureau of Labor Statistics (DOL, 2007). The purpose of the study is to collect "data on what activities people do during the day and how much time they spend doing them." In 2006, the survey focused on "the time Americans worked, did household activities, cared for household children, participated in educational activities, and engaged in leisure and sports activities." Approximately 13,000 individuals, 15 years of age and older, were interviewed during 2006. Participants were randomly selected and interviewed using the CATI method and were asked to recall their activities on the day before the interview. The survey response rate was 55.1% (DOL, 2007). Data were collected for all days of the week, including weekends (i.e., 10% of the individuals were interviewed about their activities on 1 of the 5 weekdays, and 25% of the individuals were interviewed about their activities on 1 of the 2 weekend days). Demographic information, including age, sex, race/ethnicity, marital status, and educational level were also collected, and sample weights were applied to records to "reduce bias in the estimates due to differences in sampling and response rates across populations and days of the week." Data were collected for 17 major activities, which were subsequently combined into 12 categories for publication of the results. Table 16-78 provides information on the average amount of time spent in the 12 major time use categories by sex, age, race/ethnicity, marital status, and educational level (DOL, 2007). Estimates of time use in sub-categories of the 12 major categories are presented in Table 16-79. The majority of time was spent engaging in personal care activities (9.41 hours/day) which included sleeping (8.63 hours/day), followed by leisure and sports activities (5.09 hours/day), and work activities (3.75 hours/day). Note that because these data are averaged over both weekdays and weekends for the entire year, the amount of time spent daily on work-related activities does not reflect that of a typical work day.

Table 16-80 provides estimates of time use for all children ages 15 to 19 years by sex. It also provides a more detailed breakdown of the Leisure and Sports category for all children, ages 15 to 19 years old.

The limitation of this study is that it did not account for all activities during the day and therefore estimates about total time indoors and outdoors could not be calculated. The advantages are the large sample size, the representativeness of the sample, and the currency of the data.

16.3.2.11. *Nader et al. (2008)—Moderate-to-Vigorous Physical Activity from Ages 9 to 15 years*

Nader et al. (2008) conducted a longitudinal study of 1,032 children from ages 9 to 15 years. The purpose of the study was to determine the amount of time children 9 to 15 years of age engaged in moderate-to-vigorous physical activities (MVPA) and compare results with the recommendations issued by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture (U.S. DHHS/DOA, 2005) of a minimum of 60 minutes/day. Participants were recruited from university-based community hospitals located in Arkansas, California, Kansas, Massachusetts, Pennsylvania, Virginia, Washington, North Carolina, and Wisconsin. Children's activity levels were recorded for 4 to 7 days using an accelerometer, set so that it recorded minute-by-minute movement counts. The study participants included 517 boys and 515 girls.

The study found that at age nine years, children engaged in 3 hours of MVPA/day. By age 15 years, the amount of time engaged in MVPA was dropped to 49 minutes/day on weekdays and 35 minutes/day on weekends. Boys spent 18 more minutes/day of MVPA than girls on weekdays and 13 more minutes/day on weekends. Estimates of the mean time spent in MVPA by various age groups are presented in Table 16-81.

Advantages of this study include the fact that both weekdays and weekends were included in the study and the use of an accelerometer to measure physical activity. A limitation of the study is the fact that the sample of children was not nationally representative of the U.S. population. In addition, the study did not provide information about the amount of time spent at specific activities.

16.4. OCCUPATIONAL MOBILITY

16.4.1. Key Occupational Mobility Studies

16.4.1.1. *Carey (1988)—Occupational Tenure in 1987: Many Workers Have Remained in Their Fields*

Carey (1988) presented median occupational and employer tenure for different age groups, sex, earnings, ethnicity, and educational attainment. Occupational tenure was defined as "the cumulative number of years a person worked in his or her current occupation, regardless of number of employers, interruptions in employment, or time spent in other occupations" (Carey, 1988). The information presented was obtained from supplemental data to the January 1987 Current Population Study, a U.S. Census Bureau publication. Carey (1988) did not present information on the survey design.

The median occupational tenure by age and sex, race, and employment status are presented in Tables 16-82, 16-83, and 16-84, respectively. The median occupational tenure of the working population (109.1 million people) 16 years of age and older in January of 1987 was 6.6 years (see Table 16-82). Table 16-82 also shows that median occupational tenure increased from 1.9 years for workers 16 to 24 years old to 21.9 years for workers 70 years and older. The median occupational tenure for men 16 years and older was higher (7.9 years) than for women of the same age group (5.4 years). Table 16-83 indicates that Whites had longer occupational tenure (6.7 years) than Blacks (5.8 years), and Hispanics (4.5 years). Full-time workers had more occupational tenure than part-time workers 7.2 years and 3.1 years, respectively (see Table 16-84).

Table 16-85 presents the median occupational tenure among major occupational groups. The median tenure ranged from 4.1 years for service workers to 10.4 years for people employed in farming, forestry, and fishing.

The strength of an individual's attachment to a specific occupation has been attributed to the individual's investment in education (Carey, 1988). Carey (1988) reported the median occupational tenure for the surveyed working population by age and educational level. Workers with 5 or more years of college had the highest median occupational tenure of 10.1 years. Workers that were 65 years and older with 5 or more years of college had the highest occupational tenure level of 33.8 years. The median occupational tenure was 10.6 years for self-employed workers and 6.2 years for wage and salary workers (Carey, 1988).

A limitation associated with this study is that the survey design employed in the data collection was not presented, though it can be found on the U.S. Census Bureau's website. Therefore, the validity and accuracy of the data set cannot be determined. Another limitation is that only median values were reported in the study. An advantage of this study is that occupational tenure (years spent in a specific occupation) was obtained for various age groups by sex, ethnicity, employment status, and educational level. Another advantage of this study is that the data were based on a survey population which appears to represent the general U.S. population.

16.4.1.2. *Carey (1990)—Occupational Tenure, Employer Tenure, and Occupational Mobility*

Carey (1990) conducted another study that was similar in scope to the study of Carey (1988). The January 1987 Current Population Study was used. This study provided data on occupational mobility and employer tenure in addition to occupational tenure. Occupational tenure was defined in Carey (1988) as the "the cumulative number of years a person worked in his or her current occupation, regardless of number of employees, interruptions in employment, or time spent in other locations." Employer tenure was defined as "the length of time a worker has been with the same employer," while occupational mobility was defined as "the number of workers who change from 1 occupation to another" (Carey, 1990). Occupational mobility was measured by asking individuals who were employed in both January 1986 and January 1987 if they were doing the same kind of work in each of these months (Carey, 1990). Carey (1990) further analyzed the occupational mobility data and obtained information on entry and exit rates for occupations. These rates were defined as "the percentage of persons employed in an occupation who had voluntarily entered it from another occupation" and an exit rate was defined as "the percentage of persons employed in an occupation who had voluntarily left for a new occupation" (Carey, 1990).

Table 16-86 shows the voluntary occupational mobility rates in January 1987 for workers 16 years and older. For all workers, the overall voluntary occupational mobility rate during that year was 5.3%. These data also show that younger workers left occupations at a higher rate than older workers. Carey (1990) reported that 10 million of the 100.1 million individuals employed in January 1986 and in January 1987 had changed occupations during that period, resulting in an overall mobility rate of 9.9%. Executive, administrative, and managerial occupations had the highest entry rate of 5.3%, followed by administrative support (including clerical) at 4.9%. Sales had the highest exit rate of 5.3% and service had the 2nd highest exit rate of 4.8% (Carey, 1990). In January 1987, the median employer tenure for all workers was 4.2 years. The median employee tenure was 12.4 years for those workers that were 65 years of age and older (Carey, 1990).

Because the study was conducted by Carey (1990) in a manner similar to that of the previous study (Carey, 1988), the same advantages and disadvantages associated with Carey (1988) also apply to this data set.

16.5. POPULATION MOBILITY

16.5.1. Key Population Mobility Studies

16.5.1.1. *Johnson and Capel (1992)—A Monte Carlo Approach to Simulating Residential Occupancy Periods and It's Application to the General U.S. Population*

Johnson and Capel developed a methodology to estimate the distribution of the residential occupancy period (ROP) in the national population. ROP denotes the time (years) between a person moving into a residence and the time the person moves out or dies. The methodology used a Monte Carlo approach to simulate a distribution of ROP for 500,000 persons using data on population, mobility, and mortality.

The methodology consisted of 6 steps. The 1st step defined the population of interest and categorized them by location, sex, age, sex, and race. Next the demographic groups were selected and the fraction of the specified population that fell into each group was developed using U.S. Census Bureau data. A mobility table was developed based on census data, which provided the probability that a person with specified demographics did not move during the previous year. The fifth step used data on vital statistics published by the National Center for Health Statistics and developed a mortality table which provided the probability that individuals with specific demographic characteristics would die during the upcoming year. As a final step, a computer based algorithm was used to apply a Monte Carlo approach to a series of persons selected at random from the population being analyzed.

Table 16-87 presents the results for residential occupancy periods for the total population, by sex. The estimated mean ROP for the total population was 11.7 years. The distribution was skewed (Johnson and Capel, 1992): the 25th, 50th, and 75th percentiles were 3, 9, and 16 years, respectively. The 90th, 95th, and 99th percentiles were 26, 33, and 47 years, respectively. The mean ROP was 11.1 years for males and 12.3 years for females, and the median value was 8 years for males and 9 years for females.

Descriptive statistics for groups defined by current ages were also calculated. These data, presented by sex, are shown in Table 16-88. The mean ROP increases from age 3 to age 12 years and there is a noticeable decrease at age 24 years. However, there is a steady increase from age 24 through age 81 years.

There are a few biases within this methodology that have been noted by the authors. The probability of not moving is estimated as a function only of sex and age. The Monte Carlo process assumes that this probability is independent of (1) the calendar year to which it is applied, and (2) the past history of the person being simulated. These assumptions, according to Johnson and Capel (1992), are not entirely correct. They believe that extreme values are a function of sample size and will, for the most part, increase as the number of simulated persons increases.

16.5.1.2. *U.S. Census Bureau (2008a)—American Housing Survey for the United States in 2007*

This survey is a national sample of 55,000 interviews in which data were collected from present owners, renters, Black householders, and Hispanic householders. The data reflect the number of years a unit has been occupied and represent all occupied housing units that the residents' rented or owned at the time of the survey.

The results of the survey pertaining to residence time of owner/renter occupied units in the United States are presented in Table 16-89. Using the data in Table 16-89, the percentages of householders living in houses for specified time ranges were determined and are presented in Table 16-90. Based on the U.S. Census Bureau data in Table 16-90, the 50th percentile and the 90th percentile values were calculated for the number of years lived in the householder's current house. These values were calculated by apportioning the total sample size (110,692 households) to the indicated percentile associated with the applicable range of years lived in the current home. Assuming an even distribution within the appropriate range, the 50th and 90th percentile values for years living in the current home were determined to be 8.0 and 32.0 years, respectively. Based on the above data, 8 and 32 years are assumed to best represent a central tendency estimate of length of residence and upper percentile estimate of residence time, respectively.

A limitation associated with the above analysis is the assumption that there is an even distribution within the different ranges. As a result, the 50th and 90th percentile values may be biased.

16.5.2. Relevant Population Mobility Studies

16.5.2.1. *Israeli and Nelson (1992)—Distribution and Expected Time of Residence for U.S. Households*

In risk assessments, the average current residence time (time since moving into current residence) has often been used as a substitute for the average total residence time (time between moving into and out of a residence) (Israeli and Nelson, 1992). Israeli and Nelson (1992) have estimated distributions of expected time of residence for U.S. households. Distributions and averages for both current and total residence times were calculated for several housing categories using the 1985 and 1987 U.S. Census Bureau housing survey data. The total residence time distribution was estimated from current residence time data by modeling the moving process (Israeli and Nelson, 1992). Israeli and Nelson (1992) estimated the average total residence time for a household to be approximately 4.6 years or 1/6 of the expected life span (see Table 16-91). The maximal total residence time that a given fraction of households will live in the same residence is presented in Table 16-92. For example, only 5% of the individuals in the "All Households" category will live in the same residence for 23 years and 95% will move in less than 23 years.

The authors note that the data presented are for the expected time a household will stay in the same residence. The data do not predict the expected residence time for each member of the household, which is generally expected to be smaller (Israeli and Nelson, 1992). These values are more realistic estimates for the individual total residence time, than the average time a household has been living at its current residence. The expected total residence time for a household is consistently less than the average current residence time. This is the result of greater weighting of short residence time when calculating the average total residence time than when calculating the average current residence time (Israeli and Nelson, 1992). When averaging total residence over a time interval, frequent movers may appear several times, but when averaging current residence times, each household appears only once (Israeli and Nelson, 1992). According to Israeli and Nelson (1992), the residence time distribution developed by the model is skewed and the median values are considerably less than the means, which are less than the average current residence times.

Advantages of this study are the large sample size and its representativeness to the U.S. population, since it was based on U.S. Census Bureau housing survey data. Several limitations of the study have been noted by Israeli and Nelson (1992) above. An additional limitation is the age of the study and the fact that the U.S. Census Bureau housing survey is based on recall data.

16.5.2.2. *National Association of Realtors (NAR) (1993)—The Home Buying and Selling Process*

The NAR survey was conducted by mailing a questionnaire to 15,000 home buyers throughout the United States who purchased homes during the second half of 1993. The survey was conducted in December 1993 and 1,763 usable responses were received, equaling a response rate of 12% (NAR, 1993). Of the respondents, 41% were first time buyers. Home buyer names and addresses were obtained from Dataman Information Services (DIS). DIS compiles information on residential real estate transactions from more than 600 counties throughout the United States using courthouse deed records. Most of the 250 Metropolitan Statistical Areas are also covered in the DIS data compilation.

The home buyers were questioned on the length of time they owned their previous home. The typical homebuyer (40%) was found to have lived in their previous home between 4 and 7 years (see Table 16-93). The survey results indicate that the average tenure of home buyers is 7.1 years based on an overall residence history of the respondents (NAR, 1993). In addition, the median length of residence in respondents' previous homes was found to be 6 years (see Table 16-94).

The distances the respondents moved to their new homes were typically short distances. Data presented in Table 16-95 indicate that the mean distances range from 230 miles for new home buyers and 270 miles for repeat buyers to 110 miles for first time buyers and 190 for existing home buyers. Seventeen percent (17%) of respondents purchased homes over 100 miles from their previous homes and 49% purchased homes less than 10 miles away.

Advantages of this study are the large sample size and its representativeness to the U.S. population, since it was based on 15,000 home buyers throughout the United States. A limitation of the study is the fact that the data are over 17 years old.

16.5.2.3. *U.S. Census Bureau (2008b)—Current Population Survey 2007, Annual Social and Economic Supplement*

The Current Population Survey is conducted monthly by the U.S. Census Bureau. The sample is selected to be statistically representative of the civilian non-institutionalized U.S. population. The data presented in Tables 16-96 and 16-97 are yearly averages for the year 2006–2007. Approximately 50,000 people are surveyed each month.

Table 16-96 presents data on general mobility by demographic factors (i.e., sex, age, education, marital status, nativity, tenure, and poverty status). "Movers" are respondents who did not report living at the same residence 1 year earlier than the date of interview. Of the total number of respondents, 13% had moved residences. Of those, 65% moved within the same county. Table 16-97 presents data on these intercounty moves and shows that of these intercounty moves, over 60% moved less than 200 miles.

Advantages of this study are the large sample size, the currency of the data set, and its representativeness to the U.S. population. Limitations are that the study is based on recall data and that due to the Current Population Survey design, data for states are not as reliable as nationwide estimates.

16.6. REFERENCES FOR CHAPTER 16

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Table 16-7. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Ten Major Activity Categories, for All Respondents and Doers

Activity Category	Mean Duration (All)	% Doers[a]	Mean Duration (Doers)[a]	Median Duration (Doers)[a]	Maximum Duration (Doers)[a]	Detailed Activity with Highest Average Minutes
Work-related[b]	10	25	39	30	405	Eating at Work/School/Daycare
Household[c]	53	86	61	40	602	Travel to Household
Childcare[d]	<1	<1	83	30	290	Other Child Care
Good/Service[e]	21	26	81	60	450	Errands
Personal Needs and Care[f]	794	100	794	770	1,440	Night Sleep
Education[g]	110	35	316	335	790	School Classes
Organizational Activities[h]	4	4	111	105	435	Attend Meetings
Entertain/Social[i]	15	17	87	60	490	Visiting with Others
Recreation[j]	239	92	260	240	835	Games
Communication/Passive Leisure [k]	192	93	205	180	898	TV Use
Don't know/Not coded	2	4	41	15	600	-
All Activities	1,440	-	-	-	-	-

a Doers indicate the respondents who reported participating in each activity category.
b Includes: travel to and during work/school; children's paid work; eating at work/school/daycare; and accompanying or watching adult at work.
c Includes: food preparation; meal cleanup; cleaning; clothes care; car and home repair/painting; building a fire; plant and pet care; and traveling to household.
d Includes: baby and child care; helping/teaching children; talking and reading; playing while caring for children; medical care; travel related to child care; and other care.
e Includes: shopping; medical appointments; obtaining personal care services (e.g., haircuts), government and financial services, and repairs; travel related to goods and services; and errands.
f Includes: bathing, showering, and going to bathroom; medical care; help and care; meals; night sleep and daytime naps, dressing and grooming; and travel for personal care.
g Includes: student and other classes; daycare; homework; library; and travel for education.
h Includes: attending meetings and associated travel.
i Includes: sports events; eating and amusements; movies and theater; visiting museums, zoos, art galleries, etc.; visiting others; parties and other social events; and travel to social activities.
j Includes: active sports; leisure; hobbies; crafts; art; music/drama/dance; games; playing; and travel to leisure activities.
k Includes: radio and television use; reading; conversation; paperwork; other passive leisure; and travel to passive leisure activities.

Source: Wiley et al., 1991.

Table 16-8. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Ten Major Activity Categories, by Age and Sex

Activity Category[a]	Boys									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[b]	Birth to 11 Years
Work-related	0	0	0	1	8	9	10	12	13	11
Household	12	30	49	28	35	44	44	61	63	58
Childcare	0	0	0	0	0	0	0	0	3	2
Goods/Services	0	16	14	28	27	14	28	22	24	26
Personal Needs and Care	910	1,143	937	919	903	889	802	726	707	802
Education	180[c]	0	75	70	33	69	67	120	120	100
Organizational Activities	0	0	0	0	7	0	5	11	16	6
Entertainment/Social	0	0	0	0	8	6	15	15	43	18
Recreation	0	0	26	104	314	304	294	265	227	228
Communication/Passive Leisure	338	250	339	292	106	103	175	208	226	226
Sample Sizes (Unweighted)	3	7	15	31	54	62	151	239	62	624
Activity Category[a]	**Girls**									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[b]	Birth to 11 Years
Work-related	0	0	5	1	3	22	9	10	19	11
Household	28	29	23	25	45	65	49	67	78	58
Childcare	0	0	0	0	0	0	0	2	9	2
Goods/Services	0	18	14	24	24	34	31	26	15	26
Personal Needs and Care	1,123	1,115	971	922	894	858	820	747	703	802
Education	0	0	110	94	25	40	81	134	151	100
Organizational Activities	0	0	0	0	0	2	3	8	13	6
Entertainment/Social	0	0	0	1	13	6	16	17	52	18
Recreation	0	0	10	147	256	305	270	224	175	228
Communication/Passive Leisure	290	278	308	226	179	107	161	203	225	189
Sample Sizes (Unweighted)	4	10	11	23	43	50	151	225	59	576

a See Table 16-3 for a description of what is included in each activity category.
b The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.
c The data for this age group and category are 2 values of 0 and 1 of 540.
Note: Column totals may not sum to 1,440 due to rounding.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-9. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Ten Major Activity Categories, Grouped by Seasons and Regions

Activity Category[a]	Season					Region of California			
	Winter (Jan–Mar)	Spring (Apr–June)	Summer (July–Sept)	Fall (Oct–Dec)	All Seasons	Southern Coast	Bay Area	Rest of State	All Regions
Work-related	10	10	6	13	10	10	10	8	10
Household	47	58	53	52	53	45	62	55	53
Childcare	<1	1	<1	<1	<1	<1	<1	1	<1
Goods/Services	19	17	26	23	21	20	21	23	21
Personal Needs and Care	799	774	815	789	794	799	785	794	794
Education	124	137	49	131	110	109	115	109	110
Organizational Activities	3	5	5	3	4	2	6	6	4
Entertainment/Social	14	12	12	22	15	17	10	16	15
Recreation	221	243	282	211	239	230	241	249	239
Communication/ Passive Leisure	203	180	189	195	192	206	190	175	192
Don't know/Not coded	<1	2	3	<1	2	1	1	3	2
All Activities[b]	1,442	1,439	1,441	1,441	1,441	1,440	1,442	1,439	1,441
Sample Sizes (Unweighted)	318	204	407	271	1,200	224	263	713	1,200

[a] See Table 16-3 for a description of what is included in each activity category.
[b] The column totals may not be equal to 1,440 due to rounding.

Source: Wiley et al., 1991.

Table 16-10. Time (minutes/day) Children Under 12 Years of Age Spent in 6 Major Location Categories, for All Respondents and Doers

Location Category	Mean Duration (All)	% Doers[a]	Mean Duration (Doers)[a]	Median Duration (Doers)[a]	Maximum Duration (Doers)[a]	Detailed Location with Highest Average Time
Home	1,078	99	1,086	1,110	1,440	Home – Bedroom
School/Childcare	109	33	330	325	1,260	School or Daycare Facility
Friend's/Other's House	80	32	251	144	1,440	Friend's/Other's House – Bedroom
Stores, Restaurants, Shopping Places	24	35	69	50	475	Shopping Mall
In-transit	69	83	83	60	1,111	Traveling in Car
Other Locations	79	57	139	105	1,440	Park, Playground
Don't Know/Not Coded	<1	1	37	30	90	-
All Locations	1,440	-	-	-	-	-

[a] Doers indicate the respondents who reported participating in each activity category.

Source: Wiley et al., 1991.

Table 16-11. Mean Time (minutes/day) Children Under 12 Years of Age Spent in 6 Location Categories, Grouped by Age and Sex

Location Category	Boys									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Home	938	1,295	1,164	1,189	1,177	1,161	1,102	1,016	1,010	1,079
School/Childcare	0	1	26	53	73	86	79	110	99	89
Friend's/Other's House	418	40	127	63	54	69	89	110	111	95
Stores, Restaurants, Shopping Places	0	14	21	36	29	22	24	23	20	24
In-transit	77	51	69	63	56	61	67	64	72	65
Other Locations	7	40	33	36	52	41	78	116	127	88
Don't Know/Not Coded	0	0	0	0	0	0	0	0	0	0
Sample Sizes (Unweighted)	3	7	15	31	54	62	151	239	62	624
Location Category	**Girls**									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Home	1,285	1,341	1,151	1,192	1,162	1,065	1,118	1,012	862	1,058
School/Childcare	0	0	109	99	56	61	78	116	128	95
Friend's/Other's House	0	12	44	32	109	103	66	119	193	103
Stores, Restaurants, Shopping Places	0	13	20	15	21	40	32	25	24	27
In-transit	73	56	42	58	55	86	78	70	95	74
Other Locations	83	19	73	43	38	86	67	97	137	84
Don't Know/Not Coded	0	0	0	0	0	0	1	0	0	0
Sample Sizes (Unweighted)	4	10	11	23	43	50	151	225	59	576

[a] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.

Note: Column totals may not sum to 1,440 due to rounding.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-12. Mean Time (minutes/day) Children Under 12 Years of Age Spent in 6 Location Categories, Grouped by Season and Region

Location Category	Season					Region of California			
	Winter (Jan–Mar)	Spring (Apr–June)	Summer (July–Sept)	Fall (Oct–Dec)	All Seasons	Southern Coast	Bay Area	Rest of State	All Regions
Home	1,091	1,042	1,097	1,081	1,078	1,078	1,078	1,078	1,078
School/Childcare	119	141	52	124	109	113	103	108	109
Friend's/Other's House	69	75	108	69	80	73	86	86	80
Stores, Restaurants, Shopping Places	22	21	30	24	24	26	23	23	24
In transit	75	75	60	65	69	71	73	63	69
Other Locations	63	85	93	76	79	79	76	81	79
Don't Know/Not Coded	<1	<1	<1	<1	<1	<1	<1	<1	<1
All Locations[a]	1,439	1,439	1,440	1,439	1,439	1,439	1,440	1,440	1,439
Sample Sizes (Unweighted *N*'s)	318	204	407	271	1,200	224	263	713	1,200

[a] The column totals may not sum to 1,440 due to rounding.

Source: Wiley et al., 1991.

Table 16-13. Mean Time (minutes/day) Children Under 12 Years of Age Spent in Proximity to 2 Potential Sources of Exposure, Grouped by All Respondents, Age, and Sex

Potential Exposures	Boys									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Gasoline Fume	3	9	0	2	1	4	2	2	7	3
Gas Oven Fume	0	0	2	2	1	3	0	1	0	1
Sample Size (Unweighted *N*)	3	7	15	31	54	62	151	239	62	624
Potential Exposure	**Girls**									
	Birth to 1 Month	1 to <3 Months	3 to <6 Months	6 to <12 Months	1 to <2 Years	2 to <3 Years	3 to <6 Years	6 to <11 Years	11 Years[a]	Birth to 11 Years
Gasoline Fume	0	3	0	3	1	2	1	2	1	2
Gas Oven Fume	0	0	0	0	0	3	2	1	0	1
Sample Size (Unweighted *N*')	4	10	11	23	43	50	151	225	59	576

[a] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-14. Mean Time (minutes/day) Children Under 12 Years of Age Spent Indoors and Outdoors, Grouped by Age and Sex

	Boys			Girls		
Age Group	*N*	Indoor[a]	Outdoor[b]	*N*	Indoor[a]	Outdoor[b]
Birth to <1 Month	3	1,440	0	4	1,440	0
1 to <3 Months	7	1,432	8	10	1,431	9
3 to <6 Months	15	1,407	33	11	1,421	19
6 to <12 Months	31	1,322	118	23	1,280	160
1 to <2 Years	54	1,101	339	43	1,164	276
2 to <3 Years	62	1,121	319	50	1,102	338
3 to <6 Years	151	1,117	323	151	1,140	300
6 to <11 Years	239	1,145	295	225	1,183	255
11 Years[c]	62	1,166	274	59	1,215	225
All Ages	624	1,181	258	576	1,181	258

[a] Time indoors was estimating by adding the average times spent performing indoor activities (household work, child care, personal needs and care, education, and communication/passive leisure) and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., work-related, goods/services, organizational activities, entertainment/social, don't know/not coded).

[b] Time outdoors was estimated by adding the average time spent in recreation activities and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., work-related, goods/services, organizational activities, entertainment/social, don't know/not coded).

[c] The source data end at 11 years of age, so the 11 to <16 year category is truncated and the 16 to <21 year category is not included.

N = Sample size.

Note: Indoor and outdoor minutes/day may not sum to 1,440 minutes/day due to rounding.

Source: U.S. EPA analysis of source data used by Wiley et al., 1991.

Table 16-15. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined Whole Population and Doers Only, Children <21 years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Kitchen—Whole Population															
Birth to <1	63	36	0	0	0	0	0	0	10	70	109	125	134	158	195
1 to <2	118	56	0	0	0	0	0	0	40	90	132	195	232	242	392
2 to <3	118	48	0	0	0	0	0	0	30	75	120	146	173	188	215
3 to <6	357	47	0	0	0	0	0	0	30	75	105	150	180	222	362
6 to <11	497	42	0	0	0	0	0	0	30	60	105	135	150	196	690
11 to <16	466	37	0	0	0	0	0	0	24	55	90	130	180	249	450
16 to <21	481	34	0	0	0	0	0	0	15	50	90	130	170	195	545
Kitchen—Doers Only															
Birth to <1	33	69	10	10	10	13	15	30	70	90	124	133	157	176	195
1 to <4	76	87	10	10	13	19	30	45	70	110	173	214	240	281	392
2 to <3	80	70	10	10	11	15	15	30	60	105	136	155	184	195	215
3 to <6	252	67	2	5	10	15	15	30	60	90	133	165	210	232	362
6 to <11	342	61	1	2	5	10	15	30	50	79	120	145	172	229	690
11 to <16	323	54	1	2	4	5	10	20	40	65	114	150	218	281	450
16 to <21	305	54	1	2	3	5	10	20	35	65	120	159	194	209	545
Living Room/Family Room/Den—Whole Population															
Birth to <1	63	279	0	0	0	0	0	90	210	420	666	724	788	938	1,180
1 to <2	118	172	0	0	0	0	0	25	120	279	410	533	616	652	810
2 to <3	118	173	0	0	0	0	0	56	138	239	346	499	599	680	1,125
3 to <6	357	164	0	0	0	0	0	45	122	240	376	476	680	742	900
6 to <11	497	137	0	0	0	0	0	30	95	210	322	420	547	612	695
11 to <16	466	170	0	0	0	0	0	36	120	240	395	570	687	774	1,305
16 to <21	481	157	0	0	0	0	0	0	120	240	370	501	690	819	1,080
Living Room/Family Room/Den—Doers Only															
Birth to <1	54	326	25	28	31	57	90	136	268	450	686	744	789	973	1,180
1 to <2	93	219	10	15	19	25	60	90	180	310	444	540	642	667	810
2 to <3	105	195	1	5	10	22	34	90	150	255	377	527	603	691	1,125
3 to <6	290	202	5	8	19	30	50	90	153	270	415	498	705	778	900
6 to <11	403	169	5	10	10	20	30	60	130	240	349	449	579	655	695
11 to <16	380	209	2	10	16	30	45	85	165	275	436	594	705	776	1,305
16 to <21	352	214	5	10	15	24	40	85	165	285	440	547	720	909	1,080
Dining Room—Whole Population															
Birth to <1	63	9	0	0	0	0	0	0	0	0	30	70	86	96	105
1 to <2	118	19	0	0	0	0	0	0	0	17	60	90	176	260	315
2 to <3	118	19	0	0	0	0	0	0	0	30	80	105	118	146	150
3 to <6	357	17	0	0	0	0	0	0	0	10	60	96	133	150	300
6 to <11	497	13	0	0	0	0	0	0	0	5	57	70	120	135	225
11 to <16	466	11	0	0	0	0	0	0	0	0	33	65	119	164	390
16 to <21	481	7	0	0	0	0	0	0	0	0	30	45	90	112	330
Dining Room—Doers Only															
Birth to <1	9	60	15	-	-	-	-	-	-	-	-	-	-	-	105
1 to <2	32	72	10	12	13	16	30	34	53	66	110	237	287	301	315
2 to <3	34	65	15	15	15	18	29	30	60	90	105	134	150	150	150
3 to <6	93	65	10	10	10	15	16	30	55	85	120	150	209	286	300
6 to <11	126	53	5	5	5	6	15	30	45	60	98	135	150	196	225
11 to <16	90	59	5	5	5	10	15	30	38	69	122	166	202	283	390
16 to <21	67	50	5	5	7	15	15	20	35	60	90	124	135	201	330

Table 16-15. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined Whole Population and Doers Only, Children <21 years (continued)															
Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Bathroom—Whole Population															
Birth to <1	63	16	0	0	0	0	0	0	0	30	40	59	81	87	90
1 to <2	118	26	0	0	0	0	0	0	15	30	45	60	80	239	600
2 to <3	118	29	0	0	0	0	0	1	20	30	60	62	138	290	345
3 to <6	357	22	0	0	0	0	0	0	15	30	49	65	90	120	270
6 to <11	497	22	0	0	0	0	0	0	15	30	45	60	81	118	535
11 to <16	466	20	0	0	0	0	0	0	15	30	45	60	86	97	220
16 to <21	481	26	0	0	0	0	0	10	20	32	59	65	105	123	547
Bathroom—Doers Only															
Birth to <1	31	32	5	7	8	10	15	18	30	40	60	78	87	89	90
1 to <2	77	39	6	6	8	10	15	15	30	30	57	60	176	349	600
2 to <3	88	38	2	3	5	12	15	15	30	45	60	70	208	319	345
3 to <6	240	33	1	1	2	5	11	15	30	38	60	75	112	123	270
6 to <11	356	31	1	2	3	5	9	15	25	35	50	60	90	180	535
11 to <16	335	29	1	2	2	5	6	12	20	35	50	64	90	100	220
16 to <21	392	31	1	2	5	5	10	15	25	40	60	72	111	135	547
Bedroom—Whole Population															
Birth to <1	63	749	0	0	104	468	566	653	750	863	972	1,092	1,119	1,179	1,275
1 to <2	118	771	0	56	340	443	559	645	808	884	975	1,029	1,190	1,325	1,440
2 to <3	118	701	0	5	91	419	517	618	718	835	894	931	979	990	1,040
3 to <6	357	696	0	92	210	432	540	630	695	790	875	945	1,033	1,135	1,440
6 to <11	497	653	0	0	0	304	480	585	660	735	840	906	1,005	1,096	1,440
11 to <16	466	626	0	0	20	134	403	543	645	745	860	950	1,027	1,118	1,277
16 to <21	481	588	0	0	0	60	335	475	595	720	855	960	1,082	1,146	1,375
Bedroom—Doers Only															
Birth to <1	61	774	435	453	470	495	590	660	750	865	975	1,095	1,119	1,182	1,275
1 to <2	116	785	330	362	384	450	570	656	810	885	975	1,030	1,191	1,328	1,440
2 to <3	116	713	30	215	266	484	520	620	720	836	896	931	981	990	1,040
3 to <6	353	704	165	210	268	464	540	630	695	790	875	945	1,034	1,137	1,440
6 to <11	486	667	120	183	261	439	513	599	660	735	843	912	1,005	1,100	1,440
11 to <16	457	638	15	55	115	179	430	550	646	750	860	951	1,029	1,122	1,277
16 to <21	463	611	15	34	100	273	395	480	600	725	859	974	1,090	1,147	1,375
Garage—Whole Population															
Birth to <1	63	1	0	0	0	0	0	0	0	0	0	0	0	34	89
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 to <6	357	1	0	0	0	0	0	0	0	0	0	0	0	7	165
6 to <11	497	0	0	0	0	0	0	0	0	0	0	0	0	0	120
11 to <16	466	2	0	0	0	0	0	0	0	0	0	0	19	51	240
16 to <21	481	0	0	0	0	0	0	0	0	0	0	0	0	0	60
Garage—Doers Only															
Birth to <1	1	-	89	-	-	-	-	-	-	-	-	-	-	-	89
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 to <6	4	-	15	-	-	-	-	-	-	-	-	-	-	-	165
6 to <11	3	-	30	-	-	-	-	-	-	-	-	-	-	-	120
11 to <16	12	79	10	11	11	13	16	20	40	139	183	210	228	234	240
16 to <21	4	-	10	-	-	-	-	-	-	-	-	-	-	-	60

Table 16-15. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined Whole Population and Doers Only, Children <21 years (continued)

Age (years)	*N*	Mean	Min	Percentiles 1	2	5	10	25	50	75	90	95	98	99	Max
All Rooms Combined—Whole Population															
Birth to <1	63	1,091	0	391	631	742	786	943	1,105	1,258	1,440	1,440	1,440	1,440	1,440
1 to <2	118	1,047	0	63	377	651	705	915	1,050	1,239	1,440	1,440	1,440	1,440	1,440
2 to <3	118	971	0	66	342	640	727	852	995	1,120	1,232	1,295	1,354	1,369	1,440
3 to <6	357	951	0	284	402	621	716	810	930	1,110	1,245	1,354	1,440	1,440	1,440
6 to <11	497	873	0	0	0	420	631	758	880	1,005	1,175	1,275	1,374	1,440	1,440
11 to <16	466	876	0	0	117	370	575	751	871	1,043	1,215	1,314	1,440	1,440	1,440
16 to <21	481	819	0	0	165	375	510	645	810	995	1,170	1,287	1,419	1,440	1,440
All Rooms Combined—Doers Only															
Birth to <1	62	1,108	630	633	658	751	821	956	1,108	1,259	1,440	1,440	1,440	1,440	1,440
1 to <2	116	1,065	370	399	495	674	715	923	1,050	1,243	1,440	1,440	1,440	1,440	1,440
2 to <3	117	979	30	288	551	650	746	857	1,005	1,120	1,232	1,296	1,355	1,369	1,440
3 to <6	355	957	150	352	451	634	720	810	930	1,110	1,245	1,355	1,440	1,440	1,440
6 to <11	486	893	190	335	389	541	655	765	885	1,009	1,177	1,275	1,385	1,440	1,440
11 to <16	459	889	40	141	300	441	590	758	875	1,046	1,218	1,315	1,440	1,440	1,440
16 to <21	473	833	85	206	321	433	525	660	815	1,000	1,170	1,288	1,420	1,440	1,440

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only

Kitchen									Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		7,063	92.6	94.2	1.1	1	1,320	10	30	60	120	205	270	365	460
Sex	Male	2,988	75.0	80.8	1.5	1	840	10	30	55	90	155	215	300	392
Sex	Female	4,072	105.6	101.0	1.6	1	1,320	10	35	75	145	230	295	395	475
Sex	Refused	3	40.0	31.2	18.0	15	75	15	15	30	75	75	75	75	75
Age (years)	-	144	102.7	110.8	9.2	5	840	15	30	70	130	215	260	485	540
Age (years)	1 to 4	335	73.7	54.4	3.0	5	392	15	30	60	100	140	180	225	240
Age (years)	5 to 11	477	60.5	53.0	2.4	1	690	10	30	50	75	120	150	180	235
Age (years)	12 to 17	396	55.0	58.1	2.9	1	450	5	15	36	65	125	155	240	340
Age (years)	18 to 64	4,531	90.3	90.9	1.4	1	1,320	10	30	60	120	200	260	345	420
Age (years)	>64	1,180	131.4	119.6	3.5	3	825	15	49	100	172	275	360	490	620
Race	White	5,827	95.1	95.2	1.2	1	840	10	30	65	120	210	273	380	465
Race	Black	641	79.4	92.0	3.6	2	1,320	10	30	60	100	175	230	275	380
Race	Asian	113	89.4	95.5	9.0	5	690	10	30	75	115	150	220	265	650
Race	Some Others	119	69.1	60.8	5.6	2	315	7	30	55	90	150	195	210	315
Race	Hispanic	266	84.2	77.3	4.7	1	585	10	30	60	110	190	240	305	360
Race	Refused	97	90.3	113.6	11.5	5	880	7	30	60	90	190	275	480	880
Hispanic	No	6,458	93.4	94.8	1.2	1	1,320	10	30	60	120	210	270	370	460
Hispanic	Yes	497	83.9	82.9	3.7	1	675	10	30	60	110	180	240	315	415
Hispanic	DK	32	82.3	71.9	12.7	5	300	10	35	60	113	185	240	300	300
Hispanic	Refused	76	88.4	118.6	13.6	5	880	7	30	60	90	190	240	480	880
Employment	-	1,200	62.3	55.4	1.6	1	690	10	30	50	85	125	153	213	260
Employment	Full Time	2,965	77.7	77.5	1.4	1	840	10	30	60	100	165	225	300	376
Employment	Part Time	608	97.7	94.0	3.8	1	755	10	30	70	134	213	270	405	445
Employment	Not Employed	2,239	126.9	115.8	2.4	1	1,320	12	45	95	175	270	342	470	545
Employment	Refused	51	106.4	168.5	23.6	2	880	5	30	48	130	210	250	840	880
Education	-	1,346	63.9	62.3	1.7	1	880	10	30	50	85	130	165	235	285
Education	< High School	678	108.1	102.9	4.0	1	775	10	34	80	150	230	295	405	545
Education	High School Graduate	2,043	107.2	102.3	2.3	1	840	10	35	75	150	235	300	415	500
Education	< College	1,348	94.4	101.2	2.8	1	1,320	10	30	60	120	210	280	380	450
Education	College Graduate	933	91.9	92.1	3.0	2	840	10	30	60	120	200	261	330	410
Education	Post Graduate	715	88.2	87.7	3.3	1	770	10	30	60	113	190	260	380	405
Census Region	Northeast	1,645	99.6	99.7	2.5	1	840	10	30	70	130	210	300	390	465
Census Region	Midwest	1,601	96.1	93.6	2.3	1	833	10	30	65	125	213	270	355	450
Census Region	South	2,383	86.3	87.1	1.8	1	880	10	30	60	115	190	245	330	420
Census Region	West	1,434	91.4	99.1	2.6	1	1,320	10	30	60	119	195	255	380	480
Day Of Week	Weekday	4,849	90.1	92.2	1.3	1	1,320	10	30	60	119	195	255	360	450
Day Of Week	Weekend	2,214	98.3	98.2	2.1	1	840	10	30	66	135	220	280	390	480
Season	Winter	1,938	96.6	100.3	2.3	1	1,320	10	30	65	120	210	285	390	485
Season	Spring	1,780	89.0	90.2	2.1	1	840	10	30	60	120	195	255	350	420
Season	Summer	1,890	89.3	91.0	2.1	1	880	10	30	60	120	195	255	362	430
Season	Fall	1,455	96.2	94.5	2.5	1	770	10	30	65	125	210	275	375	470
Asthma	No	6,510	92.4	93.6	1.2	1	1,320	10	30	60	120	205	270	365	450
Asthma	Yes	503	94.0	96.0	4.3	1	785	10	30	60	120	210	270	345	450
Asthma	DK	50	104.4	143.7	20.3	7	880	10	30	60	120	195	240	713	880
Angina	No	6,798	91.6	93.0	1.1	1	1,320	10	30	60	120	200	265	360	450
Angina	Yes	207	122.5	111.4	7.7	4	657	10	45	100	155	255	360	415	620
Angina	DK	58	105.9	138.4	18.2	2	880	10	30	60	135	240	240	545	880
Bronchitis/Emphysema	No	6,671	91.8	92.6	1.1	1	1,320	10	30	60	120	200	265	360	445
Bronchitis/Emphysema	Yes	338	104.8	113.4	6.2	1	825	10	30	71	135	225	300	480	657
Bronchitis/Emphysema	DK	54	117.9	142.4	19.4	2	880	10	30	76	160	240	275	545	880

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Bathroom

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		6,661	35.0	48.8	0.6	1	870	5	15	25	40	60	90	137	255
Sex	Male	3,006	32.7	50.4	0.9	1	870	5	15	20.5	35	60	75	150	300
Sex	Female	3,653	36.9	47.4	0.8	1	665	5	15	30	45	70	90	135	240
Sex	Refused	2	27.5	3.5	2.5	25	30	25	25	27.5	30	30	30	30	30
Age (years)	-	122	43.9	67.0	6.1	2	530	5	15	30	45	85	120	300	360
Age (years)	1 to 4	328	35.9	46.5	2.6	1	600	10	15	30	40	60	75	125	270
Age (years)	5 to 11	490	31.0	38.6	1.7	1	535	5	15	27	35	52.5	60	100	200
Age (years)	12 to 17	445	29.1	32.9	1.6	1	547	5	15	20	35	60	65	90	100
Age (years)	18 to 64	4,486	34.5	46.1	0.7	1	665	5	15	25	40	60	90	135	250
Age (years)	>64	790	42.2	69.4	2.5	1	870	5	15	30	45	75	120	240	360
Race	White	5,338	34.3	48.6	0.7	1	870	5	15	25	40	60	85	135	255
Race	Black	711	36.9	39.6	1.5	1	460	5	15	30	45	70	98	135	186
Race	Asian	117	33.6	41.4	3.8	5	375	5	15	25	40	60	90	110	210
Race	Some Others	134	47.3	69.6	6.0	1	535	5	15	30	45	95	120	315	422
Race	Hispanic	283	38.6	61.5	3.7	1	546	5	15	24	45	60	80	270	425
Race	Refused	78	34.6	49.2	5.6	3	360	5	10	20	35	60	135	165	360
Hispanic	No	6,067	34.5	45.9	0.6	1	705	5	15	25	40	60	90	135	240
Hispanic	Yes	498	39.2	68.6	3.1	1	870	5	15	25	45	60	90	270	425
Hispanic	DK	33	44.4	72.3	12.6	5	422	10	15	30	45	60	120	422	422
Hispanic	Refused	63	44.1	95.2	12.0	3	665	5	10	20	35	60	150	360	665
Employment	-	1,240	32.0	39.7	1.1	1	600	5	15	30	35	60	70	100	180
Employment	Full Time	3,130	33.4	44.8	0.8	1	595	5	15	25	40	60	80	123	240
Employment	Part Time	583	35.5	43.9	1.8	1	430	5	15	29	45	60	90	140	270
Employment	Not Employed	1,661	40.2	61.6	1.5	1	870	5	15	30	45	75	110	210	340
Employment	Refused	47	34.7	54.8	8.0	3	360	5	15	25	30	55	75	360	360
Education	-	1,386	32.2	42.8	1.1	1	665	5	15	25	35	60	70	110	200
Education	< High School	522	40.9	64.5	2.8	1	870	5	15	30	45	70	100	240	350
Education	High School Graduate	1,857	35.8	50.2	1.2	1	600	5	15	25	40	63	90	135	270
Education	< College	1,305	36.1	44.1	1.2	1	540	5	15	25	45	70	95	150	225
Education	College Graduate	913	35.0	54.1	1.8	1	705	5	15	20	40	60	90	150	340
Education	Post Graduate	678	32.1	42.8	1.6	1	460	5	15	22	40	60	75	110	300
Census Region	Northeast	1,497	34.3	51.2	1.3	1	600	5	15	25	40	60	80	140	335
Census Region	Midwest	1,465	35.8	54.5	1.4	1	870	5	15	25	40	60	90	145	315
Census Region	South	2,340	35.1	42.0	0.9	1	510	5	15	30	40	60	90	135	214
Census Region	West	1,359	34.9	50.4	1.4	1	705	5	15	25	40	60	90	140	250
Day Of Week	Weekday	4,613	33.9	46.7	0.7	1	870	5	15	25	40	60	85	135	240
Day Of Week	Weekend	2,048	37.5	53.2	1.2	1	600	5	15	30	45	65	90	150	300
Season	Winter	1,853	37.0	50.7	1.2	1	665	5	15	30	42	65	90	150	270
Season	Spring	1,747	36.6	50.5	1.2	1	870	5	15	30	45	60	90	135	240
Season	Summer	1,772	32.8	44.5	1.1	1	570	5	15	25	38	60	80	135	210
Season	Fall	1,289	33.0	49.1	1.4	1	540	5	11	20	35	60	90	140	303
Asthma	No	6,132	34.9	48.8	0.6	1	870	5	15	25	40	60	90	135	255
Asthma	Yes	493	35.2	38.2	1.7	1	410	5	15	30	45	65	90	140	220
Asthma	DK	36	49.5	121.1	20.2	3	665	5	10	17.5	30	60	360	665	665
Angina	No	6,473	34.6	46.8	0.6	1	870	5	15	25	40	60	90	135	240
Angina	Yes	145	51.9	88.3	7.3	3	600	7	20	30	45	75	185	546	570
Angina	DK	43	44.9	111.2	17.0	3	665	5	10	15	30	50	110	665	665
Bronchitis/Emphysema	No	6,327	34.8	48.1	0.6	1	870	5	15	25	40	60	90	135	255
Bronchitis/Emphysema	Yes	296	36.8	47.5	2.8	1	600	5	15	30	43.5	60	90	180	250
Bronchitis/Emphysema	DK	38	54.6	122.7	19.9	3	665	5	10	17.5	30	110	360	665	665

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Bedroom

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		9,151	563.1	184.6	1.9	3	1,440	300	460	540	660	780	880	1,005	1,141
Sex	Male	4,157	549.6	183.0	2.8	3	1,440	285	450	540	640	780	860	980	1,095
Sex	Female	4,990	574.3	185.3	2.6	5	1,440	312	470	555	660	790	900	1,030	1,185
Sex	Refused	4	648.8	122.8	61.4	540	785	540	545	635	753	785	785	785	785
Age (years)	-	184	525.1	193.5	14.3	15	1,440	195	420	513	600	720	860	950	1,295
Age (years)	1 to 4	488	742.0	167.1	7.6	30	1,440	489	635	740	840	930	990	1,095	1,200
Age (years)	5 to 11	689	669.1	162.9	6.2	35	1,440	435	600	665	740	840	915	1,065	1,140
Age (years)	12 to 17	577	636.2	210.9	8.8	15	1,375	165	542	645	750	875	970	1,040	1,210
Age (years)	18 to 64	5,891	532.7	173.0	2.3	3	1,440	295	440	520	610	723	820	975	1,110
Age (years)	>64	1,322	550.8	172.0	4.7	15	1,440	315	475	540	610	735	840	1,000	1,140
Race	White	7,403	553.4	175.9	2.0	3	1,440	300	455	540	640	760	850	975	1,105
Race	Black	923	612.3	219.9	7.2	15	1,440	300	480	597	725	895	990	1,160	1,323
Race	Asian	153	612.3	187.4	15.2	25	1,285	345	510	600	705	830	950	1,005	1,245
Race	Some Others	174	590.7	200.2	15.2	15	1,405	300	464	580	700	830	960	1,050	1,152
Race	Hispanic	378	602.6	214.4	11.0	25	1,440	265	480	588	720	865	958	1,095	1,213
Race	Refused	120	555.8	198.6	18.1	30	1,405	285	440	534	630	763	875	1,290	1,295
Hispanic	No	8,326	560.9	182.6	2.0	3	1,440	300	460	540	650	780	870	1,000	1,140
Hispanic	Yes	684	597.4	206.3	7.9	15	1,440	300	480	585	713	840	958	1,095	1,200
Hispanic	DK	43	542.3	169.9	25.9	135	1,002	300	420	555	660	756	830	1,002	1,002
Hispanic	Refused	98	523.4	180.2	18.2	30	1,295	255	415	515	600	735	795	930	1,295
Employment	-	1,736	679.5	185.5	4.5	15	1,440	390	590	675	785	892	960	1,065	1,170
Employment	Full Time	3,992	513.5	157.6	2.5	3	1,440	283	435	510	585	680	765	890	1,000
Employment	Part Time	777	551.6	169.4	6.1	15	1,335	330	455	540	630	750	835	1,005	1,100
Employment	Not Employed	2,578	566.4	191.2	3.8	5	1,440	300	478	540	650	780	905	1,095	1,223
Employment	Refused	68	514.0	209.6	25.4	30	1,440	210	420	498	585	725	795	1,200	1,440
Education	-	1,925	668.3	188.8	4.3	15	1,440	360	575	663	780	885	960	1,060	1,170
Education	< High School	807	554.8	180.6	6.4	5	1,440	300	450	540	630	775	860	1,015	1,160
Education	High School Graduate	2,549	534.1	176.2	3.5	3	1,440	285	447	520	607	720	835	975	1,151
Education	< College	1,740	539.1	176.1	4.2	5	1,440	282	450	530	615	735	825	1,005	1,135
Education	College Graduate	1,223	526.0	164.9	4.7	15	1,404	300	445	515	600	713	785	965	1,070
Education	Post Graduate	907	525.2	160.6	5.3	3	1,355	315	445	510	600	690	780	950	1,095
Census Region	Northeast	2,037	561.5	185.3	4.1	5	1,440	300	457	540	655	781	885	1,020	1,139
Census Region	Midwest	2,045	552.4	179.2	4.0	3	1,440	280	450	540	643	765	860	965	1,035
Census Region	South	3,156	570.0	186.4	3.3	10	1,440	300	465	552	660	790	900	1,055	1,155
Census Region	West	1,913	564.9	186.4	4.3	5	1,440	305	460	540	660	793	875	995	1,152
Day Of Week	Weekday	6,169	552.6	174.5	2.2	3	1,440	325	450	539	635	760	855	975	1,130
Day Of Week	Weekend	2,982	584.9	202.4	3.7	3	1,440	223	480	570	690	825	920	1,055	1,170
Season	Winter	2,475	576.0	183.8	3.7	5	1,440	305	475	555	660	805	900	1,035	1,148
Season	Spring	2,365	559.0	176.7	3.6	15	1,440	315	455	540	655	770	855	960	1,095
Season	Summer	2,461	566.1	195.2	3.9	3	1,440	285	455	545	660	810	900	1,030	1,190
Season	Fall	1,850	547.2	179.9	4.2	3	1,440	270	450	538	630	750	850	960	1,100
Asthma	No	8,420	560.8	182.8	2.0	3	1,440	300	460	540	655	780	870	1,000	1,140
Asthma	Yes	671	593.8	201.5	7.8	30	1,440	300	475	580	690	835	946	1,060	1,327
Asthma	DK	60	543.1	218.4	28.2	30	1,295	223	423	540	605	760	983	1,275	1,295
Angina	No	8,836	564.2	183.9	2.0	3	1,440	300	460	540	660	785	880	1,005	1,140
Angina	Yes	244	535.5	203.9	13.1	20	1,440	215	450	523	613	770	840	1,135	1,230
Angina	DK	71	522.1	193.9	23.0	30	1,295	180	420	540	600	690	820	990	1,295
Bronchitis/Emphysema	No	8,660	563.1	184.2	2.0	3	1,440	300	460	540	660	780	880	1,005	1,141
Bronchitis/Emphysema	Yes	423	570.1	192.0	9.3	15	1,440	294	450	555	660	795	900	1,055	1,110
Bronchitis/Emphysema	DK	68	524.8	186.7	22.6	30	1,295	240	420	540	600	700	820	930	1,295

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Garage

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		193	117.8	144.5	10.4	1	790	5	20	60	150	296	480	665	690
Sex	Male	120	144.1	162.6	14.8	2	790	10	30	94	183	315	518	675	690
Sex	Female	73	74.6	94.3	11.0	1	530	5	15	30	120	180	240	450	530
Age (years)	-	1	20.0	-	-	20	20	20	20	20	20	20	20	20	20
Age (years)	1 to 4	4	83.5	47.5	23.7	15	120	15	52	100	115	120	120	120	120
Age (years)	5 to 11	6	63.3	63.4	25.9	10	165	10	25	30	120	165	165	165	165
Age (years)	12 to 17	12	80.8	78.4	22.6	10	240	10	20	51	148	185	240	240	240
Age (years)	18 to 64	130	134.5	165.1	14.5	1	790	5	20	68	180	360	526	675	690
Age (years)	>64	40	88.6	84.1	13.3	5	300	8	25	60	143	228	270	300	300
Race	White	165	109.5	127.5	9.9	1	690	5	20	60	135	240	315	526	675
Race	Black	12	205.0	219.5	63.4	5	570	5	38	90	405	530	570	570	570
Race	Asian	1	5.0	-	-	5	5	5	5	5	5	5	5	5	5
Race	Some Others	6	186.3	308.4	125.9	10	790	10	18	30	240	790	790	790	790
Race	Hispanic	8	120.0	164.9	58.3	15	510	15	23	60	135	510	510	510	510
Race	Refused	1	120.0	-	-	120	120	120	120	120	120	120	120	120	120
Hispanic	No	174	116.6	138.5	10.5	1	690	5	20	60	155	296	460	570	675
Hispanic	Yes	17	128.6	207.3	50.3	5	790	5	20	60	110	510	790	790	790
Hispanic	Refused	2	127.5	10.6	7.5	120	135	120	120	128	135	135	135	135	135
Employment	-	21	79.7	67.5	14.7	10	240	15	25	51	120	165	185	240	240
Employment	Full Time	85	145.3	175.2	19.0	1	790	5	20	65	180	405	530	675	790
Employment	Part Time	17	50.1	52.0	12.6	5	194	5	15	30	60	135	194	194	194
Employment	Not Employed	70	112.3	127.4	15.2	5	690	5	30	75	135	255	450	480	690
Education	-	22	76.5	67.6	14.4	10	240	10	20	51	120	165	185	240	240
Education	< High School	14	188.9	195.0	52.1	5	675	5	30	120	235	510	675	675	675
Education	High School Graduate	63	127.3	159.3	20.1	2	690	5	25	60	165	300	530	665	690
Education	< College	48	121.6	147.8	21.3	5	790	10	30	60	140	296	450	790	790
Education	College Graduate	25	118.2	145.8	29.2	5	480	5	20	60	120	405	460	480	480
Education	Post Graduate	21	75.9	88.1	19.2	1	300	2	10	30	120	195	260	300	300
Census Region	Northeast	23	137.2	159.5	33.2	5	510	15	30	60	195	460	510	510	510
Census Region	Midwest	42	131.4	166.4	25.7	10	690	20	40	88	120	260	665	690	690
Census Region	South	60	103.7	128.6	16.6	2	570	5	13	53	128	283	428	480	570
Census Region	West	68	115.3	139.7	16.9	1	790	5	20	73	153	300	315	530	790
Day Of Week	Weekday	116	128.7	159.0	14.8	1	790	5	25	60	165	315	510	665	690
Day Of Week	Weekend	77	101.4	118.4	13.5	2	675	10	20	60	120	240	300	526	675
Season	Winter	51	115.6	161.8	22.7	2	690	5	15	50	150	240	526	665	690
Season	Spring	59	136.8	163.3	21.3	5	790	10	30	90	165	315	570	675	790
Season	Summer	51	101.1	121.3	17.0	1	530	5	20	60	120	260	450	460	530
Season	Fall	32	112.9	110.2	19.5	5	480	10	25	85	158	240	315	480	480
Asthma	No	184	118.6	146.3	10.8	1	790	5	25	60	150	300	480	665	690
Asthma	Yes	9	101.1	102.6	34.2	5	270	5	15	60	180	270	270	270	270
Angina	No	187	118.2	146.2	10.7	1	790	5	20	60	150	300	480	665	690
Angina	Yes	6	104.2	78.6	32.1	10	220	10	25	110	150	220	220	220	220
Bronchitis/Emphysema	No	185	114.1	142.9	10.5	1	790	5	20	60	135	260	480	665	690
Bronchitis/Emphysema	Yes	8	201.9	163.6	57.9	15	450	15	60	178	338	450	450	450	450

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Basement

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		274	142.2	162.9	9.8	1	931	10	30	90	180	330	535	705	765
Sex	Male	132	160.4	180.7	15.7	1	931	10	40	90	203	490	565	720	765
Sex	Female	141	125.7	143.3	12.1	2	810	10	30	75	175	265	420	705	720
Sex	Refused	1	60.0	-	-	60	60	60	60	60	60	60	60	60	60
Age (years)	-	3	171.7	122.7	70.8	30	245	30	30	240	245	245	245	245	245
Age (years)	1 to 4	8	94.8	55.7	19.7	28	180	28	48	90	138	180	180	180	180
Age (years)	5 to 11	25	135.4	145.9	29.2	15	705	15	60	105	140	270	420	705	705
Age (years)	12 to 17	26	97.5	113.1	22.2	1	515	10	30	60	150	240	275	515	515
Age (years)	18 to 64	170	151.3	172.7	13.2	1	810	5	30	90	210	410	555	720	765
Age (years)	>64	42	143.8	173.5	26.8	5	931	10	40	90	170	330	455	931	931
Race	White	248	133.8	154.1	9.8	1	810	10	30	90	168	315	510	705	720
Race	Black	15	183.8	165.5	42.7	12	515	12	40	150	270	450	515	515	515
Race	Asian	2	135.0	106.1	75.0	60	210	60	60	135	210	210	210	210	210
Race	Some Others	3	468.7	455.7	263.1	20	931	20	20	455	931	931	931	931	931
Race	Hispanic	1	30.0	-	-	30	30	30	30	30	30	30	30	30	30
Race	Refused	5	263.2	173.1	77.4	60	540	60	231	240	245	540	540	540	540
Hispanic	No	263	139.0	161.7	10.0	1	931	10	30	90	180	330	510	705	765
Hispanic	Yes	6	185.0	197.3	80.6	15	555	15	30	150	210	555	555	555	555
Hispanic	DK	1	185.0	-	-	185	185	185	185	185	185	185	185	185	185
Hispanic	Refused	4	271.3	198.8	99.4	60	540	60	150	243	393	540	540	540	540
Employment	-	57	115.6	124.2	16.5	1	705	12	40	90	150	240	420	515	705
Employment	Full Time	107	149.1	178.6	17.3	1	810	5	30	75	210	450	540	720	765
Employment	Part Time	22	115.0	114.8	24.5	10	535	25	60	78	150	185	290	535	535
Employment	Not Employed	85	158.0	176.3	19.1	5	931	10	35	120	210	330	600	720	931
Employment	Refused	3	151.7	110.3	63.7	30	245	30	30	180	245	245	245	245	245
Education	-	65	129.5	133.4	16.6	1	705	15	45	90	160	270	420	535	705
Education	< High School	15	169.9	203.5	52.5	5	605	5	30	90	255	565	605	605	605
Education	High School Graduate	78	159.4	188.7	21.4	5	810	5	40	90	195	420	720	765	810
Education	< College	48	160.6	184.2	26.6	2	931	10	25	120	203	400	600	931	931
Education	College Graduate	39	146.7	150.8	24.1	10	555	10	30	70	210	450	510	555	555
Education	Post Graduate	29	73.1	66.3	12.3	1	245	10	30	60	100	210	210	245	245
Census Region	Northeast	90	115.6	118.7	12.5	5	555	10	40	73	150	250	400	540	555
Census Region	Midwest	123	129.0	146.9	13.2	2	765	10	30	90	180	270	510	605	630
Census Region	South	35	188.0	205.8	34.8	10	931	28	45	110	255	450	720	931	931
Census Region	West	26	234.4	247.7	48.6	1	810	1	30	165	325	705	720	810	810
Day Of Week	Weekday	178	135.3	159.4	11.9	1	810	10	30	83	180	315	535	720	765
Day Of Week	Weekend	96	154.8	169.3	17.3	5	931	10	50	98	190	450	540	600	931
Season	Winter	80	144.5	147.0	16.4	5	630	14	30	90	221	315	480	610	630
Season	Spring	65	174.2	196.8	24.4	1	931	5	60	105	210	490	555	810	931
Season	Summer	79	142.4	180.7	20.3	1	765	5	30	85	150	455	605	720	765
Season	Fall	50	96.4	83.1	11.7	5	332	10	30	60	145	240	255	301	332
Asthma	No	253	143.1	164.2	10.3	1	931	10	35	90	180	330	540	705	765
Asthma	Yes	20	124.7	151.0	33.8	1	510	6	16	73	178	383	510	510	510
Asthma	DK	1	245.0	-	-	245	245	245	245	245	245	245	245	245	245
Angina	No	269	141.4	163.7	10.0	1	931	10	30	90	180	330	535	705	765
Angina	Yes	3	201.7	122.1	70.5	65	300	65	65	240	300	300	300	300	300
Angina	DK	2	152.5	130.8	92.5	60	245	60	60	153	245	245	245	245	245
Bronchitis/Emphysema	No	265	139.0	161.0	9.9	1	931	10	30	90	180	330	515	705	765
Bronchitis/Emphysema	Yes	8	233.8	214.2	75.7	20	605	20	68	180	375	605	605	605	605
Bronchitis/Emphysema	DK	1	245.0	-	-	245	245	245	245	245	245	245	245	245	245

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Utility/Laundry Room

Group Name	Group Code	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		458	73.2	71.9	3.4	1	510	5	25	60	100	150	200	300	360
Sex	Male	70	78.4	95.7	11.4	1	510	5	20	60	90	168	345	360	510
Sex	Female	388	72.3	66.8	3.4	2	510	5	28	60	105	150	190	240	330
Age (years)	-	6	65.8	34.4	14.0	25	120	25	40	60	90	120	120	120	120
Age (years)	1 to 4	3	75.0	116.9	67.5	5	210	5	5	10	210	210	210	210	210
Age (years)	5 to 11	3	105.7	168.4	97.2	2	300	2	2	15	300	300	300	300	300
Age (years)	12 to 17	8	55.5	77.1	27.3	1	240	1	17	33	53	240	240	240	240
Age (years)	18 to 64	362	73.6	73.9	3.9	2	510	5	20	60	105	150	195	325	405
Age (years)	>64	76	72.6	58.1	6.7	2	345	10	30	60	90	150	180	245	345
Race	White	400	69.2	65.8	3.3	2	510	5	25	60	90	150	180	258	353
Race	Black	35	100.5	103.2	17.5	1	510	5	20	60	135	240	300	510	510
Race	Asian	4	82.5	37.7	18.9	30	120	30	60	90	105	120	120	120	120
Race	Some Others	6	86.7	27.9	11.4	60	120	60	65	78	120	120	120	120	120
Race	Hispanic	10	95.9	78.8	24.9	4	225	4	20	105	120	218	225	225	225
Race	Refused	3	170.0	264.2	152.5	15	475	15	15	20	475	475	475	475	475
Hispanic	No	435	72.1	69.9	3.4	1	510	5	25	60	90	150	190	300	360
Hispanic	Yes	20	81.7	63.0	14.1	4	225	5	40	60	120	183	218	225	225
Hispanic	DK	1	55.0	-	-	55	55	55	55	55	55	55	55	55	55
Hispanic	Refused	2	247.5	321.7	227.5	20	475	20	20	248	475	475	475	475	475
Employment	-	12	76.8	107.8	31.1	1	300	1	4	23	135	240	300	300	300
Employment	Full Time	206	69.2	78.4	5.5	2	510	5	20	60	90	135	203	360	405
Employment	Part Time	51	72.2	62.5	8.8	2	225	5	15	55	120	150	180	225	225
Employment	Not Employed	187	77.7	63.8	4.7	5	475	10	30	60	115	150	180	245	345
Employment	Refused	2	76.0	104.7	74.0	2	150	2	2	76	150	150	150	150	150
Education	-	17	72.0	90.9	22.0	1	300	1	10	35	90	240	300	300	300
Education	< High School	51	71.8	49.4	6.9	15	245	20	30	60	90	120	180	195	245
Education	High School Graduate	163	71.6	71.6	5.6	2	510	6	30	60	90	140	180	325	405
Education	< College	107	77.2	71.7	6.9	2	475	5	20	60	120	155	200	225	240
Education	College Graduate	60	74.0	77.3	10.0	5	510	10	27	60	98	154	190	203	510
Education	Post Graduate	60	71.3	79.9	10.3	5	360	5	18	60	90	155	263	360	360
Census Region	Northeast	105	80.9	84.6	8.3	2	510	5	25	60	120	180	225	345	360
Census Region	Midwest	116	64.9	63.3	5.9	2	475	5	15	60	90	135	155	215	240
Census Region	South	151	72.7	69.5	5.7	1	510	10	30	60	90	150	210	245	330
Census Region	West	86	75.9	69.9	7.5	4	405	5	30	60	115	150	180	360	405
Day Of Week	Weekday	322	68.6	66.7	3.7	1	510	5	23	60	90	140	180	240	345
Day Of Week	Weekend	136	84.1	82.1	7.0	5	510	10	30	60	120	180	240	360	405
Season	Winter	145	75.2	81.0	6.7	1	510	5	17	60	90	165	215	360	475
Season	Spring	89	81.9	83.0	8.8	5	510	10	30	60	100	180	240	405	510
Season	Summer	132	69.3	60.8	5.3	2	360	5	25	60	120	135	155	240	325
Season	Fall	92	67.3	58.6	6.1	3	345	10	22	60	90	125	180	245	345
Asthma	No	432	73.8	73.2	3.5	1	510	5	25	60	105	150	200	325	360
Asthma	Yes	26	64.2	44.8	8.8	10	200	10	25	60	90	120	130	200	200
Angina	No	440	72.1	70.2	3.3	1	510	5	25	60	100	150	185	270	360
Angina	Yes	16	103.1	109.9	27.5	5	360	5	30	60	138	345	360	360	360
Angina	DK	2	72.5	17.7	12.5	60	85	60	60	73	85	85	85	85	85
Bronchitis/emphysema	No	428	73.3	73.5	3.6	1	510	5	24	60	105	150	200	325	360
Bronchitis/emphysema	Yes	30	72.4	43.5	7.9	10	200	15	45	60	90	125	150	200	200

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

Indoors in a Residence (all rooms)																
								Percentiles								
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99	
All		9,343	1,001.4	275.1	2.8	8	1,440	575	795	985	1,235	1,395	1,440	1,440	1,440	
Sex	Male	4,269	945.9	273.5	4.2	8	1,440	540	750	900	1,160	1,350	1,430	1,440	1,440	
Sex	Female	5,070	1,048.1	267.9	3.8	30	1,440	620	840	1,050	1,280	1,420	1,440	1,440	1,440	
Sex	Refused	4	1,060.0	135.6	67.8	900	1,200	900	950	1,070	1,170	1,200	1,200	1,200	1,200	
Age (years)	-	187	1,001.1	279.9	20.5	265	1,440	565	799	955	1,230	1,440	1,440	1,440	1,440	
Age (years)	1 to 4	498	1,211.6	218.7	9.8	270	1,440	795	1,065	1,260	1,410	1,440	1,440	1,440	1,440	
Age (years)	5 to 11	700	1,005.1	222.3	8.4	190	1,440	686	845	975	1,165	1,334	1,412.5	1,440	1,440	
Age (years)	12 to 17	588	969.5	241.8	10.0	95	1,440	585	812	950	1,155	1,310	1,405	1,440	1,440	
Age (years)	18 to 64	6,022	947.9	273.0	3.5	8	1,440	540	750	900	1,165	1,350	1,428	1,440	1,440	
Age (years)	>64	1,348	1,174.6	229.3	6.2	60	1,440	760	1,030	1,210	1,375	1,440	1,440	1,440	1,440	
Race	White	7,556	999.4	275.7	3.2	8	1,440	570	795	980	1,235	1,395	1,440	1,440	1,440	
Race	Black	941	1,016.0	272.5	8.9	190	1,440	600	815	1,000	1,245	1,410	1,440	1,440	1,440	
Race	Asian	157	983.5	254.7	20.3	30	1,440	600	810	930	1,180	1,355	1,420	1,440	1,440	
Race	Some Others	181	996.1	268.3	19.9	10	1,440	604	805	975	1,198	1,380	1,440	1,440	1,440	
Race	Hispanic	382	1,009.4	281.8	14.4	55	1,440	555	810	1,005	1,250	1,410	1,440	1,440	1,440	
Race	Refused	126	1,019.7	276.6	24.6	270	1,440	575	840	975	1,255	1,440	1,440	1,440	1,440	
Hispanic	No	8,498	1,000.4	275.4	3.0	8	1,440	575	795	980	1,235	1,395	1,440	1,440	1,440	
Hispanic	Yes	696	1,009.8	270.8	10.3	55	1,440	585	810	1,000	1,230	1,405	1,440	1,440	1,440	
Hispanic	DK	46	1,097.9	286.7	42.3	401	1,440	645	835	1,173	1,355	1,440	1,440	1,440	1,440	
Hispanic	Refused	103	984.1	269.5	26.6	270	1,440	565	810	950	1,200	1,375	1,440	1,440	1,440	
Employment	-	1,768	1,053.3	248.5	5.9	95	1,440	675	870	1,030	1,255	1,413	1,440	1,440	1,440	
Employment	Full Time	4,068	881.0	259.2	4.1	8	1,440	515	715	835	1,046	1,290	1,385	1,440	1,440	
Employment	Part Time	797	982.4	243.1	8.6	255	1,440	600	820	970	1,170	1,320	1,380	1,440	1,440	
Employment	Not Employed	2,639	1,158.0	233.8	4.6	60	1,440	735	1,015	1,190	1,350	1,440	1,440	1,440	1,440	
Employment	Refused	71	995.1	268.1	31.8	445	1,440	575	810	940	1,255	1,440	1,440	1,440	1,440	
Education	-	1,963	1,044.5	251.9	5.7	95	1,440	660	855	1,020	1,254	1,410	1,440	1,440	1,440	
Education	< High School	829	1,093.4	278.6	9.7	150	1,440	630	870	1,130	1,345	1,440	1,440	1,440	1,440	
Education	High School Graduate	2,602	1,008.1	279.3	5.5	30	1,440	565	803	995	1,245	1,400	1,440	1,440	1,440	
Education	< College	1,788	974.3	272.6	6.4	10	1,,440	570	775	930	1,205	1,371	1,436	1,440	1,440	
Education	College Graduate	1,240	939.5	275.0	7.8	30	1,440	528	745	885	1,165	1,335	1,428	1,440	1,440	
Education	Post Graduate	921	943.7	274.3	9.0	8	1,440	540	750	900	1,155	1,350	1,410	1,440	1,440	
Census Region	Northeast	2,068	1,003.4	278.4	6.1	30	1,440	570	795	980	1,245	1,405	1,440	1,440	1,440	
Census Region	Midwest	2,087	1,001.7	280.6	6.1	8	1,440	565	790	989	1,250	1,390	1,440	1,440	1,440	
Census Region	South	3,230	999.0	270.2	4.8	10	1,440	585	800	970	1,228	1,400	1,440	1,440	1,440	
Census Region	West	1,958	1,002.8	274.0	6.2	30	1,440	575	800	1,000	1,230	1,390	1,440	1,440	1,440	
Day Of Week	Weekday	6,286	965.7	272.6	3.4	30	1,440	567	770	911	1,190	1,380	1,440	1,440	1,440	
Day Of Week	Weekend	3,057	1,074.8	265.7	4.8	8	1,440	615	895	1,105	1,290	1,420	1,440	1,440	1,440	
Season	Winter	2,513	1,034.9	278.2	5.6	30	1,440	590	825	1,015	1,285	1,432	1,440	1,440	1,440	
Season	Spring	2,424	977.9	267.2	5.4	10	1,440	580	780	955	1,185	1,370	1,435	1,440	1,440	
Season	Summer	2,522	980.5	274.0	5.5	8	1,440	555	785	960	1,201	1,365	1,440	1,440	1,440	
Season	Fall	1,884	1,014.8	277.5	6.4	30	1,440	589	805	997	1,260	1,405	1,440	1,440	1,440	
Asthma	No	8,591	999.1	274.4	3.0	8	1,440	576	795	980	1,230	1,393	1,440	1,440	1,440	
Asthma	Yes	689	1,027.4	284.4	10.8	190	1,440	555	825	1,025	1,260	1,430	1,440	1,440	1,440	
Asthma	DK	63	1,025.7	264.3	33.3	445	1,440	630	840	960	1,315	1,410	1,440	1,440	1,440	
Angina	No	9,019	997.8	274.1	2.9	8	1,440	575	795	975	1,230	1,391	1,440	1,440	1,440	
Angina	Yes	249	1,125.5	281.4	17.8	180	1,440	660	925	1,185	1,380	1,440	1,440	1,440	1,440	
Angina	DK	75	1,024.1	285.1	32.9	150	1,440	560	840	975	1,305	1,425	1,440	1,440	1,440	
Bronchitis/Emphysema	No	8,840	997.7	274.8	2.9	8	1,440	575	795	975	1,230	1,395	1,440	1,440	1,440	
Bronchitis/Emphysema	Yes	432	1,070.5	273.8	13.2	205	1,440	585	868	1,110	1,293	1,440	1,440	1,440	1,440	
Bronchitis/Emphysema	DK	71	1,045.5	273.0	32.4	445	1,440	565	845	975	1,320	1,440	1,440	1,440	1,440	

Table 16-16. Time Spent (minutes/day) in Various Rooms at Home and in All Rooms Combined, Doers Only (continued)

-	= Indicates missing data.
DK	= The respondent replied "don't know".
Refused	= Refused data.
N	= Doer sample size.
Mean	= Mean 24-hour cumulative number of minutes for doers.
SD	= Standard deviation.
SE	= Standard error.
Min	= Minimum number of minutes.
Max	= Maximum number of minutes. Percentiles are the percentage of doers below or equal to a given number of minutes.
Source:	U.S. EPA, 1996.

Table 16-17. Time Spent (minutes/day) at Selected Indoor Locations Whole Population and Doers Only, Children <21 years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Restaurants—Whole Population															
Birth to <1	63	13	0	0	0	0	0	0	0	0	45	69	105	194	330
1 to <2	118	7	0	0	0	0	0	0	0	0	30	62	88	102	120
2 to <3	118	9	0	0	0	0	0	0	0	0	45	62	92	111	120
3 to <6	357	7	0	0	0	0	0	0	0	0	21	52	90	120	130
6 to <11	497	6	0	0	0	0	0	0	0	0	15	45	85	110	180
11 to <16	466	10	0	0	0	0	0	0	0	0	35	60	90	137	315
16 to <21	481	35	0	0	0	0	0	0	0	20	105	240	380	466	645
Restaurants—Doers Only															
Birth to <1	10	85	10	-	-	-	-	-	-	-	-	-	-	-	330
1 to <2	15	58	5	6	8	12	21	33	55	83	99	110	116	118	120
2 to <3	17	63	20	21	22	24	28	45	60	80	102	116	118	119	120
3 to <6	43	57	4	7	9	10	16	30	45	90	120	120	122	126	130
6 to <11	57	54	5	5	6	10	15	30	45	60	107	124	140	158	180
11 to <16	78	59	2	3	7	10	18	30	45	65	102	141	223	283	315
16 to <21	135	126	1	4	5	10	17	30	60	170	334	437	537	546	645
School—Whole Population															
Birth to <1	63	4	0	0	0	0	0	0	0	0	0	0	46	100	165
1 to <2	118	13	0	0	0	0	0	0	0	0	0	22	156	453	665
2 to <3	118	23	0	0	0	0	0	0	0	0	0	193	414	503	545
3 to <6	357	75	0	0	0	0	0	0	0	0	416	540	569	589	630
6 to <11	497	187	0	0	0	0	0	0	0	397	444	480	552	601	665
11 to <16	466	201	0	0	0	0	0	0	0	420	459	495	578	630	855
16 to <21	481	131	0	0	0	0	0	0	0	308	430	495	566	629	855
School—Doers Only															
Birth to <1	2	-	60	-	-	-	-	-	-	-	-	-	-	-	165
1 to <2	8	-	5	-	-	-	-	-	-	-	-	-	-	-	665
2 to <3	11	251	10	10	10	10	10	83	269	388	510	528	538	542	545
3 to <6	71	379	5	23	34	110	160	228	418	540	570	590	615	627	630
6 to <11	235	396	5	64	129	195	305	370	400	435	480	540	612	643	665
11 to <16	229	409	15	38	96	132	290	395	420	450	495	559	631	696	855
16 to <21	171	367	15	22	31	90	185	270	388	440	525	576	726	801	855
Grocery/Convenience Stores, Other Stores, and Malls—Whole Population															
Birth to <1	63	39	0	0	0	0	0	0	0	30	98	178	224	241	250
1 to <2	118	16	0	0	0	0	0	0	0	0	62	87	146	202	255
2 to <3	118	18	0	0	0	0	0	0	0	0	60	86	133	250	360
3 to <6	357	17	0	0	0	0	0	0	0	0	62	111	189	223	420
6 to <11	497	14	0	0	0	0	0	0	0	0	49	101	167	225	320
11 to <16	466	18	0	0	0	0	0	0	0	0	54	122	204	300	413
16 to <21	481	36	0	0	0	0	0	0	0	15	120	230	402	484	960
Grocery/Convenience Stores, Other Stores, and Malls—Doers Only															
Birth to <1	21	88	5	5	5	5	24	30	55	130	190	235	244	247	250
1 to <2	23	81	5	7	9	17	30	55	65	93	152	205	235	245	255
2 to <3	27	80	10	11	13	20	33	45	60	82	120	234	313	337	360
3 to <6	64	96	5	5	5	16	23	50	73	116	204	236	339	382	420
6 to <11	91	76	3	3	5	5	14	20	60	110	170	230	255	262	320
11 to <16	104	82	1	2	5	10	10	20	45	120	199	300	359	383	413
16 to <21	146	120	2	4	5	5	10	22	60	149	330	456	517	562	960

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.
Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only

Restaurant																	
								Percentiles									
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,059	94.5	119.9	2.6	1	925	10	30	60	95	185	351	548	660
Sex	Male	986	87.5	114.2	3.6	1	900	10	30	60	90	160	305	550	660
Sex	Female	1,073	101.0	124.7	3.8	1	925	10	40	60	105	230	380	540	670
Age (years)	-	30	126.1	138.2	25.2	15	495	30	45	60	150	398	490	495	495
Age (years)	1 to 4	61	62.7	47.7	6.1	4	330	10	35	55	85	115	120	130	330
Age (years)	5 to 11	84	56.7	38.1	4.2	5	180	10	30	45	85	120	120	140	180
Age (years)	12 to 17	122	69.8	78.4	7.1	2	455	10	30	45	65	165	250	325	360
Age (years)	18 to 64	1,503	101.2	131.2	3.4	1	925	10	30	60	105	211	400	570	675
Age (years)	>64	259	83.6	83.5	5.2	3	750	19	45	60	90	150	215	315	520
Race	White	1,747	91.7	114.7	2.7	1	925	10	30	60	95	175	320	535	640
Race	Black	148	102.8	141.3	11.6	3	805	5	30	60	95	295	430	555	735
Race	Asian	37	81.3	78.9	13.0	15	480	18	30	60	90	135	200	480	480
Race	Some Others	30	145.2	194.8	35.6	5	765	10	45	83	120	433	750	765	765
Race	Hispanic	78	123.0	156.8	17.8	10	700	15	40	60	110	375	585	660	700
Race	Refused	19	123.8	127.6	29.3	20	480	20	30	70	210	330	480	480	480
Hispanic	No	1,911	92.9	117.6	2.7	1	925	10	30	60	95	180	330	542	645
Hispanic	Yes	129	116.7	148.0	13.0	1	765	15	40	60	115	360	435	660	700
Hispanic	DK	5	76.0	134.3	60.1	5	315	5	10	10	40	315	315	315	315
Hispanic	Refused	14	114.5	134.7	36.0	30	480	30	30	60	90	330	480	480	480
Employment	-	263	62.3	57.9	3.6	2	455	10	30	45	80	120	140	273	330
Employment	Full Time	1,063	105.5	142.4	4.4	1	925	10	35	60	105	235	485	630	735
Employment	Part Time	208	122.6	144.8	10.0	1	805	5	33	65	123	320	441	595	660
Employment	Not Employed	515	76.3	61.4	2.7	3	490	15	40	60	90	145	195	260	315
Employment	Refused	10	135.0	133.5	42.2	30	425	30	60	83	135	378	425	425	425
Education	-	299	72.2	79.6	4.6	1	548	10	30	50	85	130	250	360	480
Education	< High School	132	134.8	171.8	15.0	5	925	10	30	60	152	375	535	700	750
Education	High School Graduate	590	99.4	136.3	5.6	3	910	10	35	60	90	203	435	645	680
Education	< College	431	94.9	114.9	5.5	1	770	10	35	60	105	180	340	550	640
Education	College Graduate	359	89.5	104.1	5.5	1	765	10	35	60	100	165	295	490	570
Education	Post Graduate	248	95.0	109.4	6.9	3	765	15	40	60	115	180	260	560	675
Census Region	Northeast	409	94.4	113.6	5.6	2	765	15	35	60	100	210	330	507	585
Census Region	Midwest	504	96.9	120.9	5.4	1	805	10	30	60	105	190	340	560	675
Census Region	South	680	92.7	125.1	4.8	2	910	10	30	60	90	195	365	550	650
Census Region	West	466	94.9	116.9	5.4	1	925	10	30	60	110	175	375	535	640
Day Of Week	Weekday	1,291	97.3	128.8	3.6	1	925	10	30	60	93	210	377	555	700
Day Of Week	Weekend	768	89.8	103.2	3.7	1	770	10	36	60	105	155	280	510	620
Season	Winter	524	97.7	125.7	5.5	3	875	15	35	60	105	178	351	595	685
Season	Spring	559	91.6	109.7	4.6	2	925	10	35	60	95	180	360	505	555
Season	Summer	556	95.1	123.0	5.2	1	910	10	30	60	94	210	360	555	675
Season	Fall	420	93.6	121.7	5.9	1	900	10	30	60	95	185	325	540	653
Asthma	No	1,903	94.1	117.4	2.7	1	910	10	35	60	100	180	330	545	653
Asthma	Yes	150	96.3	143.6	11.7	4	925	10	30	46	90	238	485	590	670
Asthma	DK	6	196.3	220.9	90.2	30	480	30	30	79	480	480	480	480	480
Angina	No	1,998	94.9	120.7	2.7	1	925	10	30	60	100	190	355	550	660
Angina	Yes	50	69.0	53.6	7.6	3	340	15	45	60	90	105	120	286	340
Angina	DK	11	140.3	171.3	51.6	30	480	30	30	70	120	480	480	480	480
Bronchitis/Emphysema	No	1,945	93.7	117.7	2.7	1	910	10	30	60	97	180	335	548	653
Bronchitis/Emphysema	Yes	104	96.1	130.1	12.8	5	925	15	30	60	90	235	360	500	620
Bronchitis/Emphysema	DK	10	232.8	288.2	91.1	10	875	10	30	79	480	678	875	875	875

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)

Indoors at Bar/Nightclub/Bowling Alley

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		352	175.8	132.2	7.0	3	870	30	90	150	223	328	487	570	615
Sex	Male	213	174.3	133.2	9.1	5	870	30	90	140	220	340	479	568	615
Sex	Female	139	178.1	131.2	11.1	3	630	30	95	150	225	300	530	600	605
Age (years)	-	4	158.8	98.0	49.0	75	300	75	98	130	220	300	300	300	300
Age (years)	5 to 11	4	98.8	57.5	28.8	45	170	45	53	90	145	170	170	170	170
Age (years)	12 to 17	8	151.3	77.7	27.5	50	270	50	80	160	205	270	270	270	270
Age (years)	18 to 64	313	180.2	136.7	7.7	3	870	30	90	150	225	370	498	590	615
Age (years)	>64	23	141.2	85.2	17.8	5	328	30	75	135	180	240	325	328	328
Race	White	297	173.6	132.6	7.7	3	870	30	90	140	220	328	487	590	630
Race	Black	25	205.4	126.6	25.3	50	540	60	120	180	240	417	498	540	540
Race	Asian	8	169.9	153.3	54.2	5	479	5	38	175	225	479	479	479	479
Race	Some Others	7	197.3	187.6	70.9	70	615	70	110	135	185	615	615	615	615
Race	Hispanic	10	121.3	52.3	16.5	5	198	5	105	118	160	179	198	198	198
Race	Refused	5	246.6	127.2	56.9	73	410	73	180	270	300	410	410	410	410
Hispanic	No	327	177.1	134.5	7.4	3	870	30	90	150	225	340	489	590	615
Hispanic	Yes	20	144.9	85.1	19.0	5	440	38	110	120	160	222	343	440	440
Hispanic	DK	2	142.5	31.8	22.5	120	165	120	120	143	165	165	165	165	165
Hispanic	Refused	3	261.0	171.9	99.2	73	410	73	73	300	410	410	410	410	410
Employment	-	12	133.8	73.6	21.2	45	270	45	60	135	178	225	270	270	270
Employment	Full Time	223	182.4	138.3	9.3	5	870	30	90	150	228	340	525	600	630
Employment	Part Time	43	201.2	155.5	23.7	5	615	45	90	150	270	455	520	615	615
Employment	Not Employed	70	146.3	97.4	11.6	3	479	30	73	123	180	255	328	462	479
Employment	Refused	4	176.3	115.1	57.6	45	300	45	83	180	270	300	300	300	300
Education	-	13	146.5	84.2	23.3	45	300	45	60	150	185	270	300	300	300
Education	< High School	28	218.0	170.2	32.2	60	870	75	120	175	235	420	568	870	870
Education	High School Graduate	117	177.8	130.1	12.0	3	630	25	90	150	225	360	489	540	570
Education	< College	95	205.3	152.8	15.7	5	650	30	105	180	240	462	590	615	650
Education	College Graduate	55	141.8	92.8	12.5	10	417	20	75	120	205	265	340	410	417
Education	Post Graduate	44	131.4	90.2	13.6	30	400	30	60	110	178	265	290	400	400
Census Region	Northeast	83	179.3	137.0	15.0	5	650	45	89	140	240	328	489	630	650
Census Region	Midwest	88	169.8	126.2	13.5	5	615	30	90	148	212	299	487	568	615
Census Region	South	91	175.7	132.0	13.8	3	870	35	90	148	225	270	462	570	870
Census Region	West	90	178.5	135.5	14.3	5	605	30	85	153	225	407	479	590	605
Day Of Week	Weekday	192	167.5	133.5	9.6	5	650	30	80	120	210	340	520	590	605
Day Of Week	Weekend	160	185.9	130.4	10.3	3	870	45	108	165	228	322	475	568	630
Season	Winter	93	182.7	131.7	13.7	5	650	40	87	150	240	410	455	560	650
Season	Spring	83	186.1	147.6	16.2	5	870	30	90	140	230	380	498	570	870
Season	Summer	99	160.3	130.7	13.1	3	630	30	75	120	189	285	530	605	630
Season	Fall	77	176.4	117.2	13.4	15	615	30	100	165	220	299	410	600	615
Asthma	No	331	176.3	133.7	7.4	3	870	30	90	150	225	340	487	590	615
Asthma	Yes	18	169.4	109.0	25.7	60	530	60	105	135	210	270	530	530	530
Asthma	DK	3	160.0	124.9	72.1	60	300	60	60	120	300	300	300	300	300
Angina	No	345	177.0	132.8	7.1	3	870	30	90	150	225	340	487	590	615
Angina	Yes	5	82.0	47.2	21.1	5	120	5	75	90	120	120	120	120	120
Angina	DK	2	210.0	127.3	90.0	120	300	120	120	210	300	300	300	300	300
Bronchitis/Emphysema	No	333	177.3	133.3	7.3	3	870	30	90	150	225	340	487	590	615
Bronchitis/Emphysema	Yes	17	148.6	108.5	26.3	50	530	50	110	120	175	210	530	530	530
Bronchitis/Emphysema	DK	2	165.0	190.9	135.0	30	300	30	30	165	300	300	300	300	300

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)

Indoors at School

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		1,224	343.4	179.1	5.1	1	995	10	210	395	454	540	585	660	723
Sex	Male	581	358.6	167.7	7.0	1	995	30	255	400	450	540	600	690	778
Sex	Female	643	329.6	187.9	7.4	1	855	5	180	390	455	540	582	640	683
Age (years)	-	18	314.1	230.9	54.4	5	713	5	165	248	520	625	713	713	713
Age (years)	1 to 4	43	288.5	217.6	33.2	5	665	10	60	269	500	580	595	665	665
Age (years)	5 to 11	302	396.3	109.2	6.3	5	665	170	365	403	445	535	565	625	640
Age (years)	12 to 17	287	402.6	125.5	7.4	15	855	120	383	420	450	500	565	710	778
Age (years)	18 to 64	550	295.4	207.3	8.8	1	995	5	104	300	460	553	612	683	785
Age (years)	>64	24	187.7	187.0	38.2	2	585	3	45	120	328	480	510	585	585
Race	White	928	348.5	180.5	5.9	1	995	10	213	400	458	545	600	665	723
Race	Black	131	339.8	169.3	14.8	2	855	15	230	390	445	510	580	624	645
Race	Asian	39	332.4	179.9	28.8	5	840	20	190	365	450	560	580	840	840
Race	Some Others	36	363.6	155.6	25.9	10	820	105	273	366	458	502	598	820	820
Race	Hispanic	76	294.0	175.7	20.2	2	565	10	143	363	432	495	525	540	565
Race	Refused	14	279.7	221.3	59.1	5	681	5	60	260	440	625	681	681	681
Hispanic	No	1,082	344.9	179.6	5.5	1	995	10	210	395	455	540	598	665	730
Hispanic	Yes	127	333.0	173.8	15.4	2	820	15	200	390	445	500	565	600	630
Hispanic	DK	5	293.0	244.7	109.4	3	562	3	65	415	420	562	562	562	562
Hispanic	Refused	10	329.5	180.1	56.9	5	625	5	200	350	445	538	625	625	625
Employment	-	616	390.3	130.2	5.2	5	855	115	365	410	450	525	570	640	665
Employment	Full Time	275	331.3	222.0	13.4	1	995	5	115	405	510	575	625	690	755
Employment	Part Time	138	280.9	174.8	14.9	1	800	10	160	285	412	480	537	660	683
Employment	Not Employed	190	258.7	199.5	14.5	1	855	5	60	263	410	528	572	778	840
Employment	Refused	5	166.0	179.1	80.1	5	440	5	5	180	200	440	440	440	440
Education	-	679	388.9	132.8	5.1	5	855	100	360	410	450	525	580	640	710
Education	< High School	24	233.3	179.6	36.7	1	540	2	30	298	374	460	465	540	540
Education	High School Graduate	114	186.6	193.6	18.1	1	785	4	20	108	295	480	580	645	690
Education	< College	173	281.4	209.9	16.0	1	995	5	120	255	425	550	640	820	855
Education	College Graduate	93	300.4	208.7	21.6	1	755	5	115	320	470	540	580	730	755
Education	Post Graduate	141	373.5	193.4	16.3	1	683	15	250	442	510	575	615	655	680
Census Region	Northeast	261	345.7	181.5	11.2	1	995	11	210	385	455	535	620	710	855
Census Region	Midwest	290	334.4	176.7	10.4	1	730	10	180	390	440	530	585	645	683
Census Region	South	427	354.0	178.5	8.6	1	855	10	235	415	462	540	575	640	755
Census Region	West	246	332.8	180.3	11.5	1	820	15	195	378	440	555	595	681	713
Day Of Week	Weekday	1,179	346.8	177.5	5.2	1	995	10	222	395	455	540	585	655	723
Day Of Week	Weekend	45	252.0	198.5	29.6	20	820	40	105	180	360	555	632	820	820
Season	Winter	392	369.3	164.4	8.3	1	855	20	285	405	457	545	600	680	710
Season	Spring	353	355.1	165.5	8.8	1	855	12	250	400	455	535	575	636	713
Season	Summer	207	316.8	196.4	13.6	2	995	10	125	365	445	557	585	640	723
Season	Fall	272	311.0	195.3	11.8	1	855	5	120	365	445	540	595	660	778
Asthma	No	1,095	342.8	179.2	5.4	1	995	10	200	390	455	540	585	660	723
Asthma	Yes	124	350.7	178.8	16.1	1	855	10	250	402	445	535	605	645	800
Asthma	DK	5	287.0	190.7	85.3	5	445	5	180	365	440	445	445	445	445
Angina	No	1,209	344.6	178.9	5.1	1	995	10	210	395	455	540	595	660	723
Angina	Yes	9	205.8	169.5	56.5	15	510	15	90	180	275	510	510	510	510
Angina	DK	6	292.2	178.9	73.0	5	480	5	180	324	440	480	480	480	480
Bronchitis/Emphysema	No	1,175	344.8	178.8	5.2	1	995	10	212	395	455	540	595	660	730
Bronchitis/Emphysema	Yes	42	306.7	188.2	29.0	3	632	10	120	378	444	465	580	632	632
Bronchitis/Emphysema	DK	7	315.4	163.7	61.9	5	440	5	180	378	440	440	440	440	440

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)															
Office or Factory															
								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,975	394.0	230.8	5.2	1	1,440	9	180	485	550	630	675	765	818
Sex	Male	1,012	410.8	233.5	7.3	1	1,440	10	225	495	565	645	710	780	855
Sex	Female	963	376.3	226.7	7.3	1	855	5	120	480	540	600	645	710	750
Age (years)	-	49	438.9	232.6	33.2	10	900	20	299	500	555	675	780	900	900
Age (years)	1 to 4	12	31.6	25.6	7.4	5	90	5	13	25	45	60	90	90	90
Age (years)	5 to 11	14	100.9	155.1	41.5	2	580	2	10	33	178	195	580	580	580
Age (years)	12 to 17	19	145.4	181.1	41.6	1	625	1	10	50	240	510	625	625	625
Age (years)	18 to 64	1,749	419.0	218.4	5.2	1	1,440	10	273	500	555	630	680	765	818
Age (years)	>64	132	145.8	194.0	16.9	1	705	3	10	40	205	495	540	640	675
Race	White	1,612	387.6	232.0	5.8	1	1,440	6	150	480	550	628	675	750	800
Race	Black	191	413.9	218.0	15.8	1	1,037	10	268	485	540	635	720	803	900
Race	Asian	42	428.0	216.8	33.4	10	780	30	285	492	553	660	745	780	780
Race	Some Others	28	480.9	200.9	38.0	40	795	75	348	540	583	715	780	795	795
Race	Hispanic	74	394.5	237.8	27.6	1	840	5	230	493	560	645	720	765	840
Race	Refused	28	482.9	246.1	46.5	30	997	30	373	533	608	818	860	997	997
Hispanic	No	1,805	393.5	229.6	5.4	1	1,440	10	180	483	550	630	675	755	810
Hispanic	Yes	138	393.6	238.6	20.3	1	840	5	180	498	560	644	675	765	795
Hispanic	DK	7	262.6	242.1	91.5	1	610	1	12	245	540	610	610	610	610
Hispanic	Refused	25	470.0	258.8	51.8	17	860	30	311	525	615	810	818	860	860
Employment	-	43	121.3	178.0	27.1	1	685	2	10	40	178	307	580	685	685
Employment	Full Time	1,535	455.6	200.3	5.1	1	1,440	15	400	510	570	644	700	775	837
Employment	Part Time	164	293.0	197.0	15.4	1	750	10	95	343	480	525	555	585	615
Employment	Not Employed	213	77.6	123.0	8.4	1	705	3	10	30	90	215	305	570	640
Employment	Refused	20	449.2	184.8	41.3	30	675	60	334	523	550	645	675	675	675
Education	-	80	225.1	248.5	27.8	1	860	3	15	105	470	608	675	780	860
Education	< High School	104	329.5	264.4	25.9	2	930	5	51	389	553	640	705	765	855
Education	High School Graduate	631	396.9	228.1	9.1	1	997	10	210	492	550	615	675	760	800
Education	< College	462	393.1	228.8	10.6	1	1,440	5	210	480	540	615	660	770	820
Education	College Graduate	415	437.2	205.2	10.1	1	900	10	325	510	570	640	690	750	800
Education	Post Graduate	283	396.9	232.2	13.8	2	860	5	175	480	565	640	675	780	818
Census Region	Northeast	465	399.1	226.2	10.5	1	930	10	215	485	550	625	675	765	840
Census Region	Midwest	439	389.3	229.1	10.9	1	997	8	180	480	550	630	670	750	800
Census Region	South	666	408.6	228.2	8.8	1	1,440	10	225	498	555	630	675	760	840
Census Region	West	405	369.1	240.4	11.9	1	900	5	95	470	550	630	675	760	800
Day Of Week	Weekday	1,759	406.8	225.2	5.4	1	997	10	237	495	555	630	675	755	810
Day Of Week	Weekend	216	289.6	249.1	16.9	1	1,440	3	30	283	495	600	670	800	900
Season	Winter	531	390.7	231.7	10.1	1	997	10	180	480	550	625	675	755	835
Season	Spring	470	385.2	240.7	11.1	1	1,440	5	120	480	553	630	695	775	837
Season	Summer	550	393.5	224.5	9.6	1	1,037	9	200	483	540	614	675	753	810
Season	Fall	424	408.4	226.6	11.0	1	840	10	239	500	567	640	675	750	770
Asthma	No	1,845	395.0	230.4	5.4	1	1,440	8	185	490	550	630	675	760	810
Asthma	Yes	114	371.7	231.3	21.7	3	840	10	120	463	540	630	675	800	837
Asthma	DK	16	437.0	272.1	68.0	5	860	5	233	520	588	780	860	860	860
Angina	No	1,931	395.7	229.7	5.2	1	1,440	10	195	490	550	630	675	760	811
Angina	Yes	26	265.5	246.8	48.4	5	650	9	15	175	490	630	645	650	650
Angina	DK	18	392.3	282.6	66.6	5	860	5	30	490	550	780	860	860	860
Bronchitis/Emphysema	No	1,873	395.6	230.0	5.3	1	1,440	8	195	490	550	630	675	760	818
Bronchitis/Emphysema	Yes	86	356.4	236.1	25.5	5	800	10	75	428	540	620	660	720	800
Bronchitis/Emphysema	DK	16	403.9	289.5	72.4	5	860	5	30	490	583	780	860	860	860

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)

Schools, Churches, Hospitals, and Public Buildings

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,932	274.3	205.9	3.8	1	1,440	20	95	221	430	540	615	725	805
Sex	Male	1,234	285.1	206.7	5.9	1	1,440	30	110	255	425	540	620	745	840
Sex	Female	1,698	266.5	205.1	5.0	1	1,440	20	90	200	430	540	610	713	800
Age (years)	-	50	269.0	221.0	31.3	5	1,030	30	100	193	400	590	625	872	1,030
Age (years)	1 to 4	98	233.0	235.8	23.8	1	1,440	5	60	150	390	545	595	900	1,440
Age (years)	5 to 11	391	351.2	149.6	7.6	5	665	70	245	389	440	535	562	625	645
Age (years)	12 to 17	355	366.3	161.2	8.6	1	935	60	260	415	446	502	605	710	805
Age (years)	18 to 64	1,653	267.7	221.2	5.4	1	1,440	15	87	190	450	570	655	760	855
Age (years)	>64	385	151.1	128.6	6.6	5	710	21	60	115	195	340	435	525	615
Race	White	2,310	268.2	204.3	4.3	1	1,440	20	90	210	429	540	612	705	765
Race	Black	332	303.5	207.1	11.4	1	1,440	35	135	285	440	540	630	775	1,000
Race	Asian	61	295.0	199.4	25.5	5	900	30	135	240	425	535	565	840	900
Race	Some Others	57	314.7	203.5	27.0	10	967	30	135	360	455	525	598	820	967
Race	Hispanic	141	283.9	229.8	19.4	2	1,440	11	100	237	430	525	630	840	940
Race	Refused	31	257.8	192.5	34.6	5	681	5	120	240	430	495	625	681	681
Hispanic	No	2,654	271.3	203.6	4.0	1	1,440	20	94	215	425	540	612	712	800
Hispanic	Yes	240	306.4	230.8	14.9	1	1,440	20	110	288	445	568	695	840	940
Hispanic	DK	13	279.4	230.7	64.0	35	760	35	65	235	420	562	760	760	760
Hispanic	Refused	25	286.6	175.4	35.1	5	625	55	145	255	440	495	565	625	625
Employment	-	821	343.5	171.1	6.0	1	1,440	55	190	393	441	520	570	645	713
Employment	Full Time	1,029	300.3	239.8	7.5	1	1,440	15	90	215	510	610	685	775	900
Employment	Part Time	293	251.3	199.3	11.6	1	1,030	20	85	200	387	525	610	800	880
Employment	Not Employed	775	176.4	148.4	5.3	1	855	15	60	121	250	400	475	570	641
Employment	Refused	14	212.9	147.7	39.5	5	440	5	120	190	305	430	440	440	440
Education	-	917	340.3	172.6	5.7	1	1,440	45	190	390	440	525	580	645	713
Education	< High School	166	172.6	138.0	10.7	1	735	27	70	124	235	375	465	525	640
Education	High School Graduate	617	207.3	199.0	8.0	1	1,440	15	60	135	295	510	585	690	785
Education	< College	520	247.5	213.6	9.4	1	1,000	15	85	165	420	553	640	760	855
Education	College Graduate	351	261.6	214.3	11.4	1	1,005	15	85	180	450	560	625	750	800
Education	Post Graduate	361	319.1	236.2	12.4	1	1,440	30	110	290	510	615	683	765	900
Census Region	Northeast	645	272.7	211.6	8.3	1	1,440	25	90	215	420	545	630	735	855
Census Region	Midwest	686	275.4	207.2	7.9	1	1,440	30	88	239	425	540	615	745	850
Census Region	South	1,036	278.4	201.0	6.2	1	1,440	20	110	230	440	535	600	690	778
Census Region	West	565	267.4	207.2	8.7	1	1,440	15	100	200	420	555	620	712	820
Day Of Week	Weekday	2,091	309.8	212.6	4.6	1	1,440	15	115	340	460	565	632	750	855
Day Of Week	Weekend	841	186.0	156.9	5.4	1	1,440	40	85	140	230	385	525	640	735
Season	Winter	847	296.6	201.2	6.9	1	1,440	30	120	285	444	545	615	710	770
Season	Spring	805	276.8	204.6	7.2	1	1,440	30	110	220	420	535	600	725	840
Season	Summer	667	254.1	209.7	8.1	1	1,015	20	80	180	420	550	630	738	890
Season	Fall	613	262.4	207.3	8.4	1	1,005	14	75	210	425	540	615	712	778
Asthma	No	2,689	273.2	207.3	4.0	1	1,440	20	94	217	430	540	615	725	820
Asthma	Yes	229	288.0	191.6	12.7	1	855	25	120	275	435	533	605	645	800
Asthma	DK	14	270.0	171.2	45.8	5	565	5	145	280	430	445	565	565	565
Angina	No	2,836	277.1	206.4	3.9	1	1,440	20	100	230	430	540	615	725	805
Angina	Yes	78	176.4	172.8	19.6	5	890	28	60	120	195	480	575	625	890
Angina	DK	18	258.3	165.6	39.0	3	565	3	145	270	378	480	565	565	565
Bronchitis/Emphysema	No	2,794	277.0	207.3	3.9	1	1,440	20	95	228	430	540	615	726	840
Bronchitis/Emphysema	Yes	121	212.6	166.3	15.1	10	662	30	90	145	375	445	490	605	630
Bronchitis/Emphysema	DK	17	275.8	163.4	39.6	5	565	5	145	305	415	440	565	565	565

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)

Malls, Grocery Stores, or Other Stores

								Percentiles								
Group Name	Group Code	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,697	115.0	141.0	2.7	1	1,080	10	30	60	135	285	482	570	640
Sex	Male	1,020	120.2	157.1	4.9	1	840	5	30	60	130	375	530	609	658
Sex	Female	1,677	111.8	130.1	3.2	1	1,080	10	30	60	135	255	400	550	600
Age (years)	-	50	139.4	137.6	19.5	15	660	20	45	93	180	339	420	565	660
Age (years)	1 to 4	110	90.0	77.9	7.4	5	420	10	40	65	105	210	250	359	360
Age (years)	5 to 11	129	77.7	68.0	6.0	3	320	5	30	60	110	180	225	255	280
Age (years)	12 to 17	140	88.7	101.4	8.6	1	530	5	20	45	124	223	318	384	413
Age (years)	18 to 64	1,871	125.9	156.8	3.6	1	1,080	10	30	60	150	360	525	600	658
Age (years)	>64	397	88.6	88.5	4.4	1	655	10	30	60	120	180	255	400	470
Race	White	2,234	111.6	139.4	3.0	1	1,080	10	30	60	130	265	495	570	640
Race	Black	237	123.0	152.3	9.9	2	800	10	25	60	135	370	480	600	613
Race	Asian	37	158.9	151.7	24.9	2	600	14	50	105	220	410	480	600	600
Race	Some Others	52	150.2	146.7	20.3	5	660	14	65	103	180	280	588	600	660
Race	Hispanic	110	133.1	138.3	13.2	1	720	10	35	90	195	310	450	535	540
Race	Refused	27	124.7	131.1	25.2	10	515	10	30	60	207	300	380	515	515
Hispanic	No	2,476	114.4	141.8	2.9	1	1,080	10	30	60	132	285	495	570	640
Hispanic	Yes	188	126.1	133.2	9.7	1	720	10	30	90	173	270	450	540	610
Hispanic	DK	12	49.4	37.7	10.9	2	122	2	18	48	70	105	122	122	122
Hispanic	Refused	21	122.4	138.5	30.2	10	515	20	33	60	180	290	380	515	515
Employment	-	372	86.9	86.3	4.5	1	660	5	30	60	120	206	255	360	384
Employment	Full Time	1,170	136.8	176.7	5.2	1	1,080	10	30	60	150	480	562	640	690
Employment	Part Time	285	134.1	147.7	8.8	2	540	6	30	65	186	400	480	520	540
Employment	Not Employed	854	91.2	87.2	3.0	1	585	10	30	60	120	195	255	360	420
Employment	Refused	16	98.9	110.0	27.5	10	357	10	32	53	115	290	357	357	357
Education	-	420	88.3	91.9	4.5	1	660	5	29	60	120	210	263	384	420
Education	< High School	206	128.9	155.7	10.8	2	1,080	10	30	75	150	330	500	570	605
Education	High School Graduate	792	126.3	158.9	5.6	1	960	5	30	60	150	365	524	600	660
Education	< College	583	129.8	149.5	6.2	1	800	10	30	70	165	345	510	563	651
Education	College Graduate	411	117.9	144.1	7.1	1	720	10	30	60	135	290	515	600	640
Education	Post Graduate	285	78.2	95.7	5.7	1	630	10	25	50	90	160	250	450	555
Census Region	Northeast	622	110.2	134.9	5.4	1	755	5	30	60	130	280	465	563	600
Census Region	Midwest	601	108.2	133.1	5.4	2	840	10	30	60	130	250	440	560	645
Census Region	South	871	127.9	155.8	5.3	1	1,080	10	30	60	155	320	520	600	660
Census Region	West	603	107.9	130.7	5.3	1	840	10	30	60	120	255	430	550	600
Day Of Week	Weekday	1,721	117.5	148.9	3.6	1	1,080	10	30	60	135	320	510	586	650
Day Of Week	Weekend	976	110.6	125.7	4.0	1	840	5	30	65	135	255	380	560	608
Season	Winter	683	111.7	134.0	5.1	2	840	10	30	60	135	255	420	568	660
Season	Spring	679	115.8	142.2	5.5	1	720	10	30	60	130	300	500	588	645
Season	Summer	759	113.1	147.5	5.4	1	1,080	5	30	60	125	300	510	570	610
Season	Fall	576	120.2	138.9	5.8	1	840	10	30	60	160	295	480	550	640
Asthma	No	2,480	116.2	142.4	2.9	1	1,080	10	30	60	135	288	495	575	640
Asthma	Yes	208	101.1	125.0	8.7	1	600	5	30	60	120	245	420	545	550
Asthma	DK	9	85.1	79.6	26.5	33	290	33	55	58	60	290	290	290	290
Angina	No	2,607	116.0	142.1	2.8	1	1,080	10	30	60	135	290	495	570	640
Angina	Yes	74	90.8	103.9	12.1	2	630	15	37	64	105	150	190	510	630
Angina	DK	16	62.7	68.1	17.0	2	290	2	30	55	60	110	290	290	290
Bronchitis/Emphysema	No	2,553	115.7	141.7	2.8	1	1,080	10	30	60	135	285	481	570	640
Bronchitis/Emphysema	Yes	130	104.8	131.3	11.5	5	613	10	25	60	135	193	505	575	609
Bronchitis/Emphysema	DK	14	71.1	66.9	17.9	20	290	20	35	57	70	110	290	290	290

Table 16-18. Time Spent (minutes/day) at Selected Indoor Locations, Doers Only (continued)

Indoors at a Gym/Health Club

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		364	129.7	104.3	5.5	5	686	30	60	110	155	240	320	525	600
Sex	Male	176	147.2	115.6	8.7	5	686	30	78	120	175	285	360	533	660
Sex	Female	188	113.2	89.9	6.6	5	660	30	60	93	135	200	279	420	560
Age (years)	-	6	202.5	227.9	93.0	30	560	30	55	75	420	560	560	560	560
Age (years)	1 to 4	5	156.0	29.9	13.4	105	180	105	160	160	175	180	180	180	180
Age (years)	5 to 11	28	105.3	69.5	13.1	5	325	30	58	83	141	165	270	325	325
Age (years)	12 to 17	39	165.4	122.1	19.5	15	660	30	90	138	206	330	440	660	660
Age (years)	18 to 64	254	123.1	98.8	6.2	5	686	30	60	100	150	210	295	475	600
Age (years)	>64	32	141.4	114.2	20.2	10	533	30	60	103	173	292	340	533	533
Race	White	307	134.3	109.4	6.2	5	686	30	65	110	164	255	330	533	600
Race	Black	30	117.7	75.4	13.8	5	320	10	60	115	145	235	285	320	320
Race	Asian	10	75.2	36.5	11.5	30	145	30	54	60	95	133	145	145	145
Race	Some Others	11	112.9	69.1	20.8	25	270	25	65	90	153	179	270	270	270
Race	Hispanic	4	83.8	42.7	21.3	40	140	40	53	78	115	140	140	140	140
Race	Refused	2	57.5	3.5	2.5	55	60	55	55	58	60	60	60	60	60
Hispanic	No	345	132.0	105.9	5.7	5	686	30	65	110	160	240	325	533	600
Hispanic	Yes	17	90.1	58.8	14.3	5	255	5	60	90	115	140	255	255	255
Hispanic	Refused	2	57.5	3.5	2.5	55	60	55	55	58	60	60	60	60	60
Employment	-	72	139.6	103.3	12.2	5	660	30	76	120	165	265	330	440	660
Employment	Full Time	176	131.2	112.5	8.5	5	686	30	60	110	150	240	330	560	660
Employment	Part Time	40	129.3	92.8	14.7	25	420	35	60	95	168	285	325	420	420
Employment	Not Employed	75	117.9	91.3	10.5	5	533	25	60	90	145	230	285	475	533
Employment	Refused	1	40.0	-	-	40	40	40	40	40	40	40	40	40	40
Education	-	81	136.9	99.7	11.1	5	660	30	75	120	164	215	325	440	660
Education	< High School	9	110.6	97.7	32.6	10	300	10	30	80	165	300	300	300	300
Education	High School Graduate	61	128.5	110.0	14.1	5	660	25	75	105	145	210	310	525	660
Education	< College	71	145.6	129.1	15.3	5	600	35	65	110	170	285	533	560	600
Education	College Graduate	81	122.0	99.5	11.1	15	686	30	60	98	135	220	285	420	686
Education	Post Graduate	61	115.6	76.9	9.8	10	415	40	60	90	145	225	265	320	415
Census Region	Northeast	83	140.5	107.2	11.8	20	660	40	70	120	170	240	330	600	660
Census Region	Midwest	62	127.0	88.7	11.3	5	440	25	60	113	170	285	300	340	440
Census Region	South	118	125.7	107.0	9.9	5	660	15	60	105	150	240	330	533	540
Census Region	West	101	127.0	108.5	10.8	5	686	50	60	92	135	225	292	525	560
Day Of Week	Weekday	281	121.3	96.6	5.8	5	686	30	60	98	145	210	295	475	560
Day Of Week	Weekend	83	158.1	123.7	13.6	5	660	30	77	120	180	285	415	600	660
Season	Winter	127	139.8	108.3	9.6	5	686	25	75	120	177	240	330	533	660
Season	Spring	85	141.5	115.2	12.5	10	600	30	65	102	164	285	340	560	600
Season	Summer	81	109.9	87.4	9.7	5	525	30	60	90	130	160	310	440	525
Season	Fall	71	119.9	99.0	11.7	20	660	30	56	98	150	215	295	420	660
Asthma	No	333	132.4	106.8	5.9	5	686	30	62	110	160	255	325	533	600
Asthma	Yes	28	100.1	69.4	13.1	5	330	25	60	86	118	210	230	330	330
Asthma	DK	3	101.7	55.8	32.2	60	165	60	60	80	165	165	165	165	165
Angina	No	357	130.5	105.0	5.6	5	686	30	62	110	155	240	325	525	600
Angina	Yes	4	90.0	47.6	23.8	60	160	60	60	70	120	160	160	160	160
Angina	DK	3	81.7	65.3	37.7	30	155	30	30	60	155	155	155	155	155
Bronchitis/Emphysema	No	352	130.7	104.8	5.6	5	686	30	61	110	158	240	320	525	600
Bronchitis/Emphysema	Yes	10	97.3	92.8	29.4	10	330	10	45	77	120	245	330	330	330
Bronchitis/Emphysema	DK	2	107.5	67.2	47.5	60	155	60	60	108	155	155	155	155	155

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-19. Time Spent (minutes/day) in Selected Outdoor Locations Whole Population and Doers Only, Children <21 years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
School Grounds/Playground—Whole Population															
Birth to <1	63	2	0	0	0	0	0	0	0	0	0	0	0	53	140
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	4	0	0	0	0	0	0	0	0	0	0	50	131	175
3 to <6	357	5	0	0	0	0	0	0	0	0	0	0	64	127	625
6 to <11	497	8	0	0	0	0	0	0	0	0	10	60	121	170	315
11 to <16	466	10	0	0	0	0	0	0	0	0	20	80	120	160	570
16 to <21	481	8	0	0	0	0	0	0	0	0	0	50	135	180	510
School Grounds/Playground—Doers Only															
Birth to <1	1	-	140	-	-	-	-	-	-	-	-	-	-	-	140
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	5	-	10	-	-	-	-	-	-	-	-	-	-	-	175
3 to <6	12	138	20	22	24	31	42	59	118	138	150	364	521	573	625
6 to <11	52	80	10	10	10	10	15	30	59	106	169	217	280	298	315
11 to <16	62	72	3	4	5	5	5	21	53	95	149	178	217	360	570
16 to <21	34	116	10	10	10	13	18	46	95	161	201	305	418	464	510
Parks or Golf Courses—Whole Population															
Birth to <1	63	3	0	0	0	0	0	0	0	0	0	0	45	63	85
1 to <2	118	3	0	0	0	0	0	0	0	0	0	0	0	25	360
2 to <3	118	12	0	0	0	0	0	0	0	0	0	24	126	246	755
3 to <6	357	10	0	0	0	0	0	0	0	0	0	71	163	220	585
6 to <11	497	16	0	0	0	0	0	0	0	0	0	72	328	483	665
11 to <16	466	19	0	0	0	0	0	0	0	0	0	114	265	452	1,065
16 to <21	481	22	0	0	0	0	0	0	0	0	0	150	381	546	870
Parks or Golf Courses—Doers Only															
Birth to <1	3	-	30	-	-	-	-	-	-	-	-	-	-	-	85
1 to <2	2	-	30	-	-	-	-	-	-	-	-	-	-	-	360
2 to <3	7	-	21	-	-	-	-	-	-	-	-	-	-	-	755
3 to <6	26	144	25	26	28	31	44	63	113	165	273	388	505	545	585
6 to <11	34	236	25	30	35	43	52	73	123	394	568	644	662	663	665
11 to <16	38	237	15	15	15	15	27	86	164	266	470	851	954	1,010	1,065
16 to <21	47	225	1	7	14	15	24	60	160	308	557	633	677	773	870
Pool, River, or Lake—Whole Population															
Birth to <1	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 to <2	118	1	0	0	0	0	0	0	0	0	0	0	0	0	118
2 to <3	118	12	0	0	0	0	0	0	0	0	0	14	228	352	435
3 to <6	357	5	0	0	0	0	0	0	0	0	0	0	85	163	630
6 to <11	497	9	0	0	0	0	0	0	0	0	0	0	220	295	375
11 to <16	466	4	0	0	0	0	0	0	0	0	0	0	60	160	235
16 to <21	481	8	0	0	0	0	0	0	0	0	0	0	145	240	570
Pool, River, or Lake—Doers Only															
Birth to <1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	1	-	118	-	-	-	-	-	-	-	-	-	-	-	118
2 to <3	6	-	95	-	-	-	-	-	-	-	-	-	-	-	435
3 to <6	9	-	45	-	-	-	-	-	-	-	-	-	-	-	630
6 to <11	24	178	25	26	27	32	46	75	155	294	319	359	370	373	375
11 to <16	16	121	58	58	59	59	60	60	85	206	225	228	232	234	235
16 to <21	22	179	20	22	24	31	40	55	125	238	415	548	564	567	570

- = Indicates missing data.
N = Doer sample size.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only

Outdoors on School Grounds/Playground

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		259	98.4	110.1	6.8	1	690	5	30	70	120	208	300	540	570
Sex	Male	0.136	118.0	126.4	10.8	1	690	10	35	85	149	255	370	555	625
Sex	Female	123	76.7	83.9	7.6	1	570	5	20	51	120	180	225	270	440
Age (years)	-	2	275.0	374.8	265.0	10	540	10	10	275	540	540	540	540	540
Age (years)	1 to 4	9	85.0	61.1	20.4	10	175	10	30	65	140	175	175	175	175
Age (years)	5 to 11	64	88.0	95.6	12.0	5	625	10	30	60	120	170	220	315	625
Age (years)	12 to 17	76	78.7	88.2	10.1	3	570	5	25	55	105	165	225	370	570
Age (years)	18 to 64	101	119.8	127.6	12.7	1	690	5	30	85	165	240	360	540	555
Age (years)	>64	7	65.0	47.3	17.9	5	150	5	30	60	95	150	150	150	150
Race	White	208	98.2	106.5	7.4	1	690	9	30	70	125	190	281	510	555
Race	Black	23	128.4	157.5	32.9	5	570	5	25	67	170	300	540	570	570
Race	Asian	6	59.0	66.1	27.0	10	179	10	10	35	85	179	179	179	179
Race	Some Others	7	70.0	59.7	22.6	10	180	10	10	60	105	180	180	180	180
Race	Hispanic	15	83.7	103.0	26.6	1	370	1	10	30	120	228	370	370	370
Hispanic	No	225	102.6	113.7	7.6	3	690	9	30	70	125	210	300	540	570
Hispanic	Yes	32	71.2	79.9	14.1	1	370	1	13	33	110	150	228	370	370
Hispanic	DK	2	57.5	31.8	22.5	35	80	35	35	58	80	80	80	80	80
Employment	-	143	80.2	88.0	7.4	3	625	9	25	55	115	160	215	315	570
Employment	Full Time	48	130.3	127.2	18.4	1	555	10	40	85	180	300	360	555	555
Employment	Part Time	24	129.7	158.9	32.4	3	690	10	35	85	144	228	510	690	690
Employment	Not Employed	42	95.4	94.8	14.6	1	440	5	30	80	120	180	235	440	440
Employment	Refused	2	322.5	307.6	217.5	105	540	105	105	323	540	540	540	540	540
Education	-	162	86.6	94.6	7.4	3	625	10	27	60	120	170	220	370	570
Education	< High School	11	124.8	171.9	51.8	1	540	1	5	45	180	345	540	540	540
Education	High School Graduate	33	113.6	110.7	19.3	3	555	5	30	90	160	240	290	555	555
Education	< College	19	129.8	147.4	33.8	5	510	5	33	70	210	440	510	510	510
Education	College Graduate	19	122.1	149.9	34.4	5	690	5	50	85	125	235	690	690	690
Education	Post Graduate	15	102.9	98.1	25.3	1	360	1	30	75	125	235	360	360	360
Census Region	Northeast	66	106.0	115.2	14.2	5	690	10	30	85	150	190	281	540	690
Census Region	Midwest	53	86.1	109.2	15.0	3	540	5	20	50	115	190	290	510	540
Census Region	South	82	85.5	92.4	10.2	1	570	5	30	60	115	180	255	360	570
Census Region	West	58	119.3	125.6	16.5	1	625	10	30	85	160	235	440	555	625
Day Of Week	Weekday	205	87.0	105.5	7.4	1	625	5	25	55	115	180	240	540	555
Day Of Week	Weekend	54	141.5	117.1	15.9	10	690	25	67	113	180	290	345	440	690
Season	Winter	53	72.2	102.0	14.0	1	555	3	20	35	85	130	315	440	555
Season	Spring	88	108.6	96.5	10.3	5	540	10	45	85	148	215	255	510	540
Season	Summer	65	116.4	137.9	17.1	5	690	10	30	75	135	270	360	625	690
Season	Fall	53	85.5	96.2	13.2	5	540	5	20	55	120	180	235	345	540
Asthma	No	237	100.9	113.2	7.4	1	690	5	30	70	120	215	315	540	570
Asthma	Yes	22	70.9	62.0	13.2	5	179	10	15	45	145	160	165	179	179
Angina	No	254	99.1	110.8	7.0	1	690	5	30	69	120	208	300	540	570
Angina	Yes	5	61.2	53.4	23.9	1	130	1	15	70	90	130	130	130	130
Bronchitis/Emphysema	No	248	100.6	111.6	7.1	1	690	5	30	71	125	210	300	540	570
Bronchitis/Emphysema	Yes	10	52.7	45.4	14.4	9	160	9	22	44	60	125	160	160	160
Bronchitis/Emphysema	DK	1	15.0	0.0	0.0	15	15	15	15	15	15	15	15	15	15

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)																	
Outdoors at a Park/Golf Course																	
								Percentiles									
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		506	198.6	190.2	8.5	1	1,065	20	60	135	270	465	590	748	870
Sex	Male	291	205.8	183.1	10.7	1	1,015	25	60	150	285	510	590	730	755
Sex	Female	214	187.7	199.4	13.6	5	1,065	15	55	120	250	435	590	870	930
Sex	Refused	1	420.0	-	-	420	420	420	420	420	420	420	420	420	420
Age (years)	-	10	122.4	60.2	19.0	30	225	30	60	120	160	202	225	225	225
Age (years)	1 to 4	21	149.9	176.3	38.5	21	755	25	50	85	150	360	425	755	755
Age (years)	5 to 11	54	207.6	184.5	25.1	25	665	35	70	125	275	555	635	660	665
Age (years)	12 to 17	52	238.5	242.2	33.6	15	1,065	15	60	148	338	590	840	915	1,065
Age (years)	18 to 64	314	197.8	185.9	10.5	1	1,015	20	60	150	270	440	580	748	870
Age (years)	>64	55	189.0	182.9	24.7	10	735	20	30	120	300	510	570	590	735
Race	White	441	205.3	195.3	9.3	1	1,065	20	60	150	275	480	605	795	915
Race	Black	19	114.5	103.7	23.8	15	425	15	30	90	155	240	425	425	425
Race	Asian	8	185.6	233.4	82.5	30	665	30	33	48	315	665	665	665	665
Race	Some Others	16	171.3	154.2	38.6	30	560	30	58	120	235	405	560	560	560
Race	Hispanic	20	169.5	135.8	30.4	30	555	33	77	145	205	373	495	555	555
Race	Refused	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120
Hispanic	No	469	202.7	193.6	8.9	1	1,065	20	60	135	270	480	605	755	915
Hispanic	Yes	34	154.8	135.0	23.2	15	555	30	60	138	175	310	555	555	555
Hispanic	DK	1	10.0	-	-	10	10	10	10	10	10	10	10	10	10
Hispanic	Refused	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120
Employment	-	128	208.2	209.6	18.5	15	1,065	25	60	120	275	555	645	840	915
Employment	Full Time	201	195.8	189.0	13.3	8	1,015	25	60	135	270	450	570	748	930
Employment	Part Time	41	213.5	215.6	33.7	20	870	20	60	132	260	540	660	870	870
Employment	Not Employed	132	190.9	166.0	14.5	1	810	15	60	160	270	420	525	730	735
Employment	Refused	4	130.0	106.8	53.4	30	280	30	60	105	200	280	280	280	280
Education	-	140	202.7	204.7	17.3	15	1,065	21	60	120	270	499	640	840	915
Education	< High School	32	180.8	207.8	36.7	30	995	30	30	110	245	385	570	995	995
Education	High School Graduate	108	219.7	197.2	19.0	10	1,015	20	78	163	281	545	625	730	810
Education	<College	93	191.6	171.2	17.8	1	870	15	60	150	275	440	510	748	870
Education	College Graduate	83	203.5	183.1	20.1	5	930	23	60	145	270	450	590	795	930
Education	Post Graduate	50	157.8	166.6	23.6	10	735	20	45	75	255	338	555	703	735
Census Region	Northeast	106	184.9	177.4	17.2	1	1,065	20	60	124	240	450	574	635	660
Census Region	Midwest	124	194.6	188.7	16.9	10	1,015	30	60	135	255	420	590	735	995
Census Region	South	136	218.8	211.5	18.1	10	930	20	60	150	325	525	720	840	915
Census Region	West	140	192.9	179.4	15.2	5	870	18	58	131	273	430	575	755	810
Day Of Week	Weekday	276	196.0	189.3	11.4	5	1,015	20	60	145	253	510	625	748	840
Day Of Week	Weekend	230	201.7	191.8	12.6	1	1,065	20	60	130	280	455	580	810	915
Season	Winter	83	209.1	195.2	21.4	15	1,065	30	60	165	275	440	660	795	1,065
Season	Spring	163	168.5	159.1	12.5	8	930	20	50	120	235	360	510	570	755
Season	Summer	192	219.6	199.9	14.4	5	1,015	20	65	155	290	535	630	840	915
Season	Fall	68	198.7	217.9	26.4	1	995	20	60	118	280	555	735	810	995
Asthma	No	466	192.1	178.8	8.3	1	1,015	20	60	135	270	450	580	700	755
Asthma	Yes	38	284.5	288.7	46.8	30	1,065	35	90	170	390	870	995 1	65	1,065
Asthma	DK	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120
Angina	No	494	197.9	189.8	8.5	1	1,065	20	60	135	270	459	590	755	915
Angina	Yes	9	247.8	235.3	78.4	35	730	35	60	120	330	730	730	730	730
Angina	DK	3	170.0	170.6	98.5	30	360	30	30	120	360	360	360	360	360
Bronchitis/Emphysema	No	490	197.0	184.6	8.3	1	1,065	20	60	145	270	455	585	735	840
Bronchitis/Emphysema	Yes	14	273.1	339.1	90.6	20	995	20	75	100	280	930	995	995	995
Bronchitis/Emphysema	DK	2	75.0	63.6	45.0	30	120	30	30	75	120	120	120	120	120

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)

Outdoors at a Pool/River/Lake

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		283	209.6	185.7	11.0	5	1,440	25	60	150	296	480	570	670	690
Sex	Male	152	229.8	202.7	16.4	10	1,440	30	83	174	305	510	600	690	900
Sex	Female	131	186.0	161.3	14.1	5	645	20	60	135	280	440	550	630	630
Age (years)	-	6	175.0	157.0	64.1	60	480	60	85	115	195	480	480	480	480
Age (years)	1 to 4	14	250.6	177.5	47.4	90	630	90	130	168	370	560	630	630	630
Age (years)	5 to 11	29	175.4	117.9	21.9	25	390	30	60	145	293	365	375	390	390
Age (years)	12 to 17	22	128.3	94.4	20.1	40	420	58	60	83	210	225	235	420	420
Age (years)	18 to 64	187	224.5	203.8	14.9	5	1,440	20	60	150	320	511	615	690	900
Age (years)	>64	25	194.2	161.8	32.4	20	525	30	60	115	277	480	510	525	525
Race	White	246	201.6	182.3	11.6	5	1,440	25	60	145	285	440	560	670	690
Race	Black	12	380.6	231.9	66.9	20	690	20	178	450	563	615	690	690	690
Race	Asian	4	265.0	247.1	123.5	30	505	30	53	263	478	505	505	505	505
Race	Some Others	5	237.0	129.9	58.1	70	435	70	220	225	235	435	435	435	435
Race	Hispanic	12	161.0	131.7	38.0	20	390	20	53	113	265	375	390	390	390
Race	Refused	4	243.8	208.6	104.3	90	550	90	115	168	373	550	550	550	550
Hispanic	No	259	208.9	187.8	11.7	5	1,440	25	60	150	295	480	585	670	690
Hispanic	Yes	20	210.9	160.1	35.8	20	540	29	88	155	338	451	526	540	540
Hispanic	Refused	4	243.8	208.6	104.3	90	550	90	115	168	373	550	550	550	550
Employment	-	66	176.9	131.3	16.2	25	630	40	70	143	235	370	420	560	630
Employment	Full Time	119	210.7	176.1	16.1	10	900	20	65	150	298	510	600	645	670
Employment	Part Time	26	217.0	199.9	39.2	20	670	30	60	120	320	570	580	670	670
Employment	Not Employed	69	238.9	236.2	28.4	5	1,440	20	65	145	370	510	630	690	1,440
Employment	Refused	3	141.7	52.5	30.3	90	195	90	90	140	195	195	195	195	195
Education	-	73	172.9	130.0	15.2	20	630	30	70	140	225	370	420	560	630
Education	< High School	18	267.6	159.4	37.6	40	600	40	145	248	375	525	600	600	600
Education	High School Graduate	69	213.2	224.1	27.0	10	1,440	20	60	145	285	511	670	690	1,440
Education	< College	62	233.3	192.4	24.4	5	690	30	65	150	360	550	580	615	690
Education	College Graduate	37	230.9	187.3	30.8	14	645	20	70	173	400	505	630	645	645
Education	Post Graduate	24	172.7	197.0	40.2	20	900	25	45	113	240	370	480	900	900
Census Region	Northeast	61	220.7	172.4	22.1	30	900	30	60	180	325	390	510	670	900
Census Region	Midwest	41	219.2	257.2	40.2	10	1,440	20	60	120	280	480	600	1,440	1,440
Census Region	South	111	182.2	161.3	15.3	5	670	20	60	118	280	420	525	630	645
Census Region	West	70	237.6	181.8	21.7	25	690	40	90	180	300	548	615	690	690
Day Of Week	Weekday	165	188.8	179.9	14.0	10	1,440	30	60	125	255	420	511	615	670
Day Of Week	Weekend	118	238.6	190.4	17.5	5	900	20	75	188	350	555	630	690	690
Season	Winter	30	173.2	181.7	33.2	20	630	20	40	103	270	493	585	630	630
Season	Spring	77	206.5	163.6	18.6	15	690	30	80	180	288	480	555	670	690
Season	Summer	151	219.7	196.8	16.0	5	1,440	26	65	155	300	445	580	630	900
Season	Fall	25	201.4	189.7	37.9	20	670	45	70	105	310	510	510	670	670
Asthma	No	262	209.0	188.2	11.6	5	1,440	25	60	150	295	480	580	670	690
Asthma	Yes	17	238.8	162.0	39.3	15	570	15	105	225	350	525	570	570	570
Asthma	DK	4	121.3	59.2	29.6	60	195	60	75	115	168	195	195	195	195
Angina	No	272	205.9	185.2	11.2	5	1,440	25	60	145	291	480	570	645	690
Angina	Yes	8	359.4	178.8	63.2	60	690	60	288	340	435	690	690	690	690
Angina	DK	3	141.7	52.5	30.3	90	195	90	90	140	195	195	195	195	195
Bronchitis/Emphysema	No	266	211.0	189.1	11.6	5	1,440	25	60	150	296	480	580	670	690
Bronchitis/Emphysema	Yes	14	197.1	131.5	35.2	15	440	15	90	173	300	370	440	440	440
Bronchitis/Emphysema	DK	3	141.7	52.5	30.3	90	195	90	90	140	195	195	195	195	195

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)

Outdoors on a Sidewalk, Street, or in the Neighborhood

								Percentiles								
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		896	85.8	133.8	4.5	1	1,440	2	15	40	90	223	405	565	615
Sex	Male	409	108.8	168.1	8.3	1	1,440	3	20	45	120	330	525	615	710
Sex	Female	487	66.5	91.9	4.2	1	580	1	15	35	75	152	255	435	465
Age (years)	-	15	72.5	69.4	17.9	1	290	1	40	55	90	120	290	290	290
Age (years)	1 to 4	30	54.8	52.7	9.6	1	235	2	10	43	78	125	158	235	235
Age (years)	5 to 11	75	110.8	116.8	13.5	1	540	5	20	65	178	240	410	465	540
Age (years)	12 to 17	74	52.6	74.8	8.7	1	435	2	15	30	60	125	200	338	435
Age (years)	18 to 64	580	94.3	153.9	6.4	1	1,440	2	15	40	83	278	480	600	690
Age (years)	>64	122	59.4	61.5	5.6	1	380	2	20	40	75	120	190	235	270
Race	White	727	85.7	136.5	5.1	1	1,440	2	15	41	90	215	405	570	675
Race	Black	87	89.2	132.7	14.2	1	565	2	10	35	120	324	426	540	565
Race	Asian	11	88.7	114.0	34.4	2	405	2	30	45	120	149	405	405	405
Race	Some Others	18	80.6	106.0	25.0	10	420	10	20	40	75	240	420	420	420
Race	Hispanic	42	71.4	110.8	17.1	1	525	1	20	40	75	135	290	525	525
Race	Refused	11	122.9	117.7	35.5	2	310	2	40	60	290	300	310	310	310
Hispanic	No	807	87.5	136.1	4.8	1	1,440	2	15	45	90	225	410	565	600
Hispanic	Yes	79	67.8	110.3	12.4	1	615	1	15	30	62	140	300	525	615
Hispanic	DK	1	2.0	-	-	2	2	2	2	2	2	2	2	2	2
Hispanic	Refused	9	100.8	115.9	38.6	2	310	2	40	60	90	310	310	310	310
Employment	-	176	79.2	96.3	7.3	1	540	2	15	45	110	200	260	435	465
Employment	Full Time	384	102.2	169.5	8.7	1	1,440	3	15	41	75	330	525	600	710
Employment	Part Time	74	74.4	113.9	13.2	1	795	1	15	43	86	180	255	390	795
Employment	Not Employed	255	70.0	94.0	5.9	1	615	1	15	40	85	152	270	380	485
Employment	Refused	7	45.1	36.6	13.8	2	90	2	4	40	90	90	90	90	90
Education	-	198	74.9	92.3	6.6	1	540	2	15	41	90	185	240	435	465
Education	< High School	56	131.2	247.3	33.0	1	1,440	1	15	40	118	465	710	735	1,440
Education	High School Graduate	223	100.2	146.9	9.8	1	795	5	20	45	95	275	480	600	680
Education	< College	172	77.2	128.8	9.8	1	675	1	10	30	75	180	435	570	600
Education	College Graduate	138	76.3	106.6	9.1	1	600	3	20	45	70	205	310	485	565
Education	Post Graduate	109	78.2	121.3	11.6	1	710	5	20	45	60	200	330	560	570
Census Region	Northeast	202	89.1	132.3	9.3	1	735	3	15	45	90	235	410	530	570
Census Region	Midwest	193	87.9	153.3	11.0	1	1,440	2	15	30	85	240	355	565	600
Census Region	South	298	79.9	125.5	7.3	1	710	2	15	35	75	185	420	532	680
Census Region	West	203	89.1	127.9	9.0	1	795	1	20	45	105	210	300	570	615
Day Of Week	Weekday	642	86.7	143.9	5.7	1	1,440	2	15	40	80	223	426	585	680
Day Of Week	Weekend	254	83.5	104.2	6.5	1	565	2	25	45	90	220	310	440	480
Season	Winter	210	73.5	144.3	10.0	1	1,440	1	15	33	60	160	270	560	710
Season	Spring	242	97.9	137.2	8.8	1	795	4	25	45	120	240	435	570	675
Season	Summer	276	84.0	123.1	7.4	1	690	4	15	45	90	200	420	525	580
Season	Fall	168	86.6	131.9	10.2	1	710	2	15	40	90	240	405	600	615
Asthma	No	832	86.1	129.5	4.5	1	795	2	15	40	90	225	418	565	600
Asthma	Yes	57	85.6	193.1	25.6	1	1,440	1	15	35	90	180	235	260	1,440
Asthma	DK	7	48.9	28.0	10.6	2	90	2	30	60	60	90	90	90	90
Angina	No	857	86.2	134.9	4.6	1	1,440	2	15	40	90	223	410	565	615
Angina	Yes	33	81.7	117.4	20.4	1	465	1	17	45	60	250	380	465	465
Angina	DK	6	52.0	29.3	11.9	2	90	2	40	60	60	90	90	90	90
Bronchitis/Emphysema	No	855	84.8	132.3	4.5	1	1,440	2	15	40	85	225	405	560	600
Bronchitis/Emphysema	Yes	34	117.7	176.4	30.3	3	735	8	30	45	120	215	690	735	735
Bronchitis/Emphysema	DK	7	46.3	27.5	10.4	2	90	2	32	40	60	90	90	90	90

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)																
At Home in the Yard or Other Areas Outside the House																
								Percentiles								
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		2,308	137.6	144.1	3.0	1	1,290	10	40	90	180	320	420	570	660
Sex	Male	1,198	158.4	160.0	4.6	1	1,290	10	60	120	198	360	500	627	730
Sex	Female	1,107	114.9	120.9	3.6	1	1,065	5	30	75	150	285	360	450	560
Sex	Refused	3	183.3	60.3	34.8	120	240	120	120	190	240	240	240	240	240
Age (years)	-	27	167.4	164.5	31.7	2	600	5	60	120	230	395	600	600	600
Age (years)	1 to 4	151	135.3	111.5	9.1	5	630	25	60	90	180	305	345	450	480
Age (years)	5 to 11	271	150.6	135.1	8.2	2	1,250	20	60	120	190	310	405	553	570
Age (years)	12 to 17	157	113.2	117.7	9.4	2	660	5	30	80	150	240	405	462	610
Age (years)	18 to 64	1,301	136.4	147.9	4.1	1	1,080	5	30	90	180	330	435	570	715
Age (years)	>64	401	141.1	155.2	7.8	1	1,290	10	45	90	180	302	465	598	660
Race	White	1,966	139.0	145.5	3.3	1	1,290	10	40	90	180	330	435	570	670
Race	Black	173	128.4	144.6	11.0	1	1,250	5	30	95	180	270	390	462	745
Race	Asian	21	101.2	88.5	19.3	12	360	15	35	90	125	210	240	360	360
Race	Some Others	37	183.5	161.9	26.6	2	750	3	84	120	270	380	553	750	750
Race	Hispanic	83	106.1	96.8	10.6	2	610	5	35	75	145	240	270	330	610
Race	Refused	28	152.3	151.0	28.5	5	600	5	60	98	210	360	510	600	600
Hispanic	No	2,122	137.7	144.3	3.1	1	1,290	10	40	90	180	320	420	570	670
Hispanic	Yes	153	125.0	134.3	10.9	1	750	5	30	85	150	270	435	575	630
Hispanic	DK	10	213.8	192.2	60.8	3	585	3	60	145	380	503	585	585	585
Hispanic	Refused	23	176.7	156.6	32.6	5	600	5	60	160	240	360	510	600	600
Employment	-	581	137.5	125.6	5.2	2	1,250	15	60	110	180	300	370	480	570
Employment	Full Time	807	131.1	150.7	5.3	1	1,080	5	30	80	175	307	450	600	745
Employment	Part Time	166	126.1	134.1	10.4	1	1,080	10	30	78	180	300	360	450	485
Employment	Not Employed	739	146.1	149.7	5.5	1	1,290	10	45	100	185	360	465	585	655
Employment	Refused	15	198.0	239.0	61.7	5	660	5	30	120	465	600	660	660	660
Education	-	615	136.3	125.7	5.1	2	1,250	15	60	105	180	300	370	480	570
Education	< High School	236	161.0	186.5	12.1	2	1,290	10	45	105	195	390	510	765	915
Education	High School Graduate	618	144.7	144.9	5.8	1	840	5	40	100	195	360	479	555	660
Education	< College	381	128.8	141.2	7.2	1	1,080	5	35	85	175	300	400	585	720
Education	College Graduate	251	123.0	135.8	8.6	1	750	10	30	75	160	300	390	575	690
Education	Post Graduate	207	127.1	150.0	10.4	1	1,065	5	30	78	150	320	435	570	630
Census Region	Northeast	473	137.7	132.8	6.1	1	750	10	45	90	185	317	420	532	600
Census Region	Midwest	456	138.9	155.7	7.3	2	1,290	10	45	90	180	300	440	575	690
Census Region	South	832	136.5	146.7	5.1	1	1,080	10	35	90	180	310	420	570	730
Census Region	West	547	138.2	139.9	6.0	1	750	5	36	90	180	330	460	570	630
Day Of Week	Weekday	1,453	126.9	131.6	3.5	1	1,250	5	35	90	165	300	395	553	610
Day Of Week	Weekend	855	155.7	161.7	5.5	1	1,290	10	45	110	210	360	475	630	745
Season	Winter	399	112.2	136.0	6.8	1	1,080	5	30	60	140	300	380	540	690
Season	Spring	787	149.7	139.2	5.0	1	915	10	60	120	195	338	430	555	660
Season	Summer	796	143.7	155.9	5.5	1	1,290	10	45	99	180	330	450	610	715
Season	Fall	326	124.5	130.5	7.2	1	720	10	35	88	160	300	380	510	655
Asthma	No	2,129	137.7	144.4	3.1	1	1,290	10	40	90	180	315	420	570	690
Asthma	Yes	166	131.6	136.0	10.6	1	670	10	30	90	165	345	450	553	610
Asthma	DK	13	188.5	192.1	53.3	5	600	5	60	90	300	480	600	600	600
Angina	No	2,228	136.5	141.1	3.0	1	1,290	10	41	90	180	315	420	570	660
Angina	Yes	63	158.7	216.3	27.3	2	1,080	5	30	75	180	420	485	1,065	1,080
Angina	DK	17	199.1	191.3	46.4	5	600	5	35	120	325	480	600	600	600
Bronchitis/Emphysema	No	2,191	138.8	145.0	3.1	1	1,290	10	45	90	180	320	430	570	690
Bronchitis/Emphysema	Yes	105	104.4	111.3	10.9	1	553	5	30	60	145	270	360	415	475
Bronchitis/Emphysema	DK	12	207.5	192.2	55.5	5	600	5	60	140	330	480	600	600	600

Table 16-20. Time Spent (minutes/day) in Selected Outdoor Locations, Doers Only (continued)																	
Cumulative Outdoors (outside the residence)																	
								Percentiles									
Group Name	Group Code	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		3,124	154.0	158.3	2.8	1	1,290	5	40	105	210	362	480	610	715
Sex	Male	1,533	174.9	173.7	4.4	1	1,290	10	60	120	240	420	540	680	745
Sex	Female	1,588	133.5	138.8	3.5	1	1,065	5	30	90	190	325	415	525	610
Sex	Refused	3	340.0	140.0	80.8	240	500	240	240	280	500	500	500	500	500
Age (years)	-	40	164.0	179.6	28.4	2	720	4	40	108	213	430	600	720	720
Age (years)	1 to 4	201	195.7	163.7	11.5	3	715	30	75	135	270	430	535	625	699
Age (years)	5 to 11	353	187.6	158.6	8.4	4	1,250	20	80	150	265	365	479	600	720
Age (years)	12 to 17	219	135.3	137.0	9.3	1	720	5	35	100	190	300	452	545	610
Age (years)	18 to 64	1,809	144.2	155.1	3.6	1	1,080	5	30	90	199	360	470	600	715
Age (years)	>64	502	156.4	168.3	7.5	1	1,290	5	36	110	210	375	485	645	735
Race	White	2,622	156.8	160.2	3.1	1	1,290	5	45	105	215	375	485	625	720
Race	Black	255	141.6	153.2	9.6	1	1,250	5	30	95	195	330	420	535	645
Race	Asian	34	115.8	135.6	23.2	1	480	5	20	60	150	360	450	480	480
Race	Some Others	53	167.0	149.0	20.5	3	750	5	60	130	238	320	475	553	750
Race	Hispanic	125	117.3	128.9	11.5	1	720	5	30	70	150	270	355	590	610
Race	Refused	35	187.1	163.8	27.7	5	600	5	60	170	240	450	510	600	600
Hispanic	No	2,857	153.8	158.4	3.0	1	1,290	5	40	105	210	362	480	610	720
Hispanic	Yes	222	146.4	154.1	10.3	1	750	5	30	113	200	345	480	640	690
Hispanic	DK	15	191.5	178.3	46.0	15	585	15	40	140	380	420	585	585	585
Hispanic	Refused	30	212.5	165.3	30.2	5	600	5	60	180	345	458	510	600	600
Employment	-	774	175.8	156.1	5.6	1	1,250	15	60	125	245	380	480	610	705
Employment	Full Time	1,110	141.3	159.9	4.8	1	1,080	5	30	85	195	359	490	660	745
Employment	Part Time	240	134.7	140.8	9.1	1	1,080	5	30	90	183	333	423	485	525
Employment	Not Employed	978	156.1	159.2	5.1	1	1,290	5	40	115	220	375	480	610	701
Employment	Refused	22	152.7	209.8	44.7	5	660	5	15	60	125	555	600	660	660
Education	-	825	174.1	156.2	5.4	1	1,250	15	60	125	240	380	480	610	699
Education	< High School	306	171.9	188.4	10.8	1	1,290	7	45	120	240	405	510	765	855
Education	High School Graduate	837	153.6	154.8	5.4	1	840	5	35	105	215	380	480	598	701
Education	< College	527	143.4	157.1	6.8	1	1,080	5	30	90	195	360	465	615	720
Education	College Graduate	355	126.9	142.6	7.6	1	750	5	30	80	170	300	415	615	690
Education	Post Graduate	274	130.5	151.0	9.1	1	1,065	5	30	75	180	325	465	570	660
Census Region	Northeast	635	148.0	143.7	5.7	1	750	5	35	105	215	345	450	575	610
Census Region	Midwest	639	156.0	169.2	6.7	1	1,290	5	45	102	210	360	500	655	750
Census Region	South	1,120	158.6	165.2	4.9	1	1,080	5	40	110	210	390	495	640	745
Census Region	West	730	150.6	149.6	5.5	1	855	5	36	105	213	360	465	575	660
Day Of Week	Weekday	1,933	141.2	149.0	3.4	1	1,250	5	31	90	190	345	452	598	698
Day Of Week	Weekend	1,191	174.9	170.4	4.9	1	1,290	10	50	120	260	400	500	660	745
Season	Winter	548	114.0	138.1	5.9	1	1,080	5	25	60	150	280	380	540	690
Season	Spring	1,034	171.9	159.4	5.0	1	990	10	60	120	240	390	495	645	730
Season	Summer	1,098	168.3	168.2	5.1	1	1,290	5	50	120	235	400	510	630	715
Season	Fall	444	126.5	140.7	6.7	1	960	5	30	75	163	313	420	575	655
Asthma	No	2,869	154.5	159.2	3.0	1	1,290	5	40	105	210	365	480	615	720
Asthma	Yes	236	145.8	145.5	9.5	1	885	5	45	105	190	360	450	575	610
Asthma	DK	19	182.4	181.0	41.5	1	600	1	60	120	300	480	600	600	600
Angina	No	3,023	153.2	156.3	2.8	1	1,290	5	40	105	210	360	479	610	707
Angina	Yes	76	172.9	222.3	25.5	2	1,080	5	30	69	253	465	660	1,065	1,080
Angina	DK	25	195.0	170.4	34.1	5	600	5	60	150	300	465	480	600	600
Bronchitis/Emphysema	No	2,968	154.9	158.8	2.9	1	1,290	5	40	105	210	367	480	615	715
Bronchitis/Emphysema	Yes	139	129.4	142.5	12.1	1	855	5	30	75	175	327	415	553	735
Bronchitis/Emphysema	DK	17	206.8	179.8	43.6	5	600	5	60	170	300	480	600	600	600

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-21. Mean Time Spent (minutes/day) Inside and Outside, by Age Category, Children <21 years

Age (years)	*N*	Average Indoor Minutes[a]	Average Outdoor Minutes[b]	Average Unclassified Minutes[c]
Birth to <1	25	1,353	44	43
1 to <2	90	1,353	36	51
2 to <3	131	1,316	76	48
3 to <6	360	1,278	107	54
6 to <11	511	1,244	132	64
11 to <16	449	1,260	100	80
16 to <21	493	1,248	102	90

[a] Time indoors was estimating by adding the average times spent indoors at the respondents' home (kitchen, living room, bathroom, etc.), at other houses, and inside other locations such as school, restaurants, etc.

[b] Time outdoors was estimated by adding the average time spent outdoors at the respondents' pool and yard, others' pool and yard, and outside other locations such as sidewalk, street, neighborhood, parking lot, service station/gas station, school grounds, park/golf course, pool, river, lake, farm, etc.

[c] Includes time spent in vehicles or in activities that could not be assigned an indoor or outdoor location.

N = Sample size.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-22. Mean Time Spent (minutes/day) Outside and Inside, Adults 18 Years and Older, Doers Only

Time Outdoors						
Age (years)	Time Outdoors away from Residence[a]		Time Outdoors at Residence[a]		Total Time Outdoors[b]	
	Mean	95th Percentile	Mean	95th Percentile	Mean	95th Percentile
18 to 64	144.2	470	136.4	435	281	-
>64	156.5	485	141.1	465	298	-

Time Indoors			
Age (years)	Total Minutes/24 hours	Total Time Outdoors	Total Time Indoors[c]
		Mean	Mean
18 to 64	1,440	281	1,159
>64	1,440	298	1,142

[a] For additional statistics see Table 16-26.

[b] Total Time Outdoors was calculated by summing the time spent outdoors away from the residence and the time outdoors at the residence.

Source: U.S. EPA, 1996.

Table 16-23. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined Whole Population and Doers Only, Children <21 Years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Car—Whole Population															
Birth to <1	63	36	0	0	0	0	0	0	10	49	107	171	208	220	235
1 to <2	118	41	0	0	0	0	0	0	20	60	98	151	246	336	390
2 to <3	118	33	0	0	0	0	0	0	20	50	90	126	163	187	215
3 to <6	357	43	0	0	0	0	0	0	20	60	117	155	221	272	620
6 to <11	497	37	0	0	0	0	0	0	15	55	102	146	185	212	630
11 to <16	466	39	0	0	0	0	0	0	15	55	99	150	254	302	900
16 to <21	481	61	0	0	0	0	0	8	40	90	155	195	249	321	380
Car—Doers Only															
Birth to <1	35	65	2	5	7	10	14	20	40	73	159	203	218	227	235
1 to <2	68	72	5	8	10	10	15	30	58	85	147	186	323	363	390
2 to <3	73	54	4	4	4	8	10	24	42	65	118	141	181	197	215
3 to <6	227	67	4	4	5	7	10	25	45	88	150	180	267	327	620
6 to <11	317	58	1	2	2	5	10	20	40	82	127	163	202	300	630
11 to <16	286	64	1	3	5	5	10	20	40	75	122	193	279	338	900
16 to <21	364	81	2	9	10	10	17	30	60	105	180	210	275	334	380
Truck (Pickup or Van)—Whole Population															
Birth to <1	63	2	0	0	0	0	0	0	0	0	0	0	0	42	110
1 to <2	118	2	0	0	0	0	0	0	0	0	0	0	52	81	90
2 to <3	118	14	0	0	0	0	0	0	0	0	14	31	124	201	955
3 to <6	357	5	0	0	0	0	0	0	0	0	0	30	60	114	245
6 to <11	497	7	0	0	0	0	0	0	0	0	15	45	95	110	240
11 to <16	466	9	0	0	0	0	0	0	0	0	15	59	153	181	352
16 to <21	481	11	0	0	0	0	0	0	0	0	25	90	150	190	445
Truck (Pickup or Van)—Doers Only															
Birth to <1	1	-	110	-	-	-	-	-	-	-	-	-	-	-	110
1 to <2	5	-	20	-	-	-	-	-	-	-	-	-	-	-	90
2 to <3	15	109	10	10	10	10	11	15	30	53	188	434	746	851	955
3 to <6	34	53	1	2	4	8	10	16	30	59	117	207	222	233	245
6 to <11	69	48	1	4	6	10	10	15	30	65	110	124	151	186	240
11 to <16	62	67	5	5	5	5	7	15	35	89	180	185	258	299	352
16 to <21	70	78	5	5	5	10	11	22	54	115	170	213	238	304	445
Bus—Whole Population															
Birth to <1	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	1	0	0	0	0	0	0	0	0	0	0	0	25	120
3 to <6	357	2	0	0	0	0	0	0	0	0	0	0	30	47	80
6 to <11	497	11	0	0	0	0	0	0	0	0	50	70	90	110	140
11 to <16	466	16	0	0	0	0	0	0	0	15	60	89	119	148	370
16 to <21	481	6	0	0	0	0	0	0	0	0	0	45	108	135	225
Bus—Doers Only															
Birth to <1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	2	-	30	-	-	-	-	-	-	-	-	-	-	-	120
3 to <6	14	40	15	16	16	18	21	30	33	49	67	74	77	79	80
6 to <11	115	49	5	5	6	14	17	25	43	67	90	107	120	122	140
11 to <16	130	58	7	10	10	10	15	30	54	71	101	131	159	175	370
16 to <21	41	75	10	12	14	20	25	30	60	100	135	175	193	209	225

Table 16-23. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined Whole Population and Doers Only, Children <21 Years (continued)

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
All Vehicles—Whole Population															
Birth to <1	63	39	0	0	0	0	0	0	20	60	113	171	208	220	235
1 to <2	118	44	0	0	0	0	0	0	28	60	98	151	246	336	390
2 to <3	118	50	0	0	0	0	0	0	30	60	120	151	203	214	955
3 to <6	357	50	0	0	0	0	0	0	30	65	122	167	238	272	620
6 to <11	497	57	0	0	0	0	0	15	40	85	124	155	212	289	630
11 to <16	466	67	0	0	0	0	0	15	45	85	155	206	291	383	900
16 to <21	481	84	0	0	0	0	0	25	62	120	180	239	328	382	675
All Vehicles—Doers Only															
Birth to <1	37	66	2	5	8	10	16	20	46	75	151	202	217	226	235
1 to <2	72	72	5	9	10	10	20	30	60	85	143	178	316	362	390
2 to <3	86	69	4	4	5	10	10	26	45	83	128	166	212	326	955
3 to <6	261	68	1	4	6	10	13	30	46	85	150	190	261	309	620
6 to <11	417	68	1	2	4	10	14	25	55	90	130	161	240	306	630
11 to <16	383	82	1	5	5	10	16	30	60	99	177	235	314	392	900
16 to <21	428	94	5	8	10	15	20	40	75	120	190	240	345	386	675

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only

								Car								
								Percentiles								
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		6,560	87.4	88.2	1.1	1	1,280	10	34	63	110	175	240	345	450
Sex	Male	2,852	90.7	97.3	1.8	1	1,280	10	30	63	115	185	254	360	526
Sex	Female	3,706	84.9	80.4	1.3	1	878	10	35	64	110	165	220	335	420
Sex	Refused	2	30.0	14.1	10.0	20	40	20	20	30	40	40	40	40	40
Age (years)	-	120	94.0	90.2	8.2	7	593	10	38	72	120	180	223	435	450
Age (years)	1 to 4	297	63.0	56.8	3.3	2	390	10	25	45	80	135	180	235	270
Age (years)	5 to 11	449	64.6	81.1	3.8	1	900	5	20	40	85	145	175	310	345
Age (years)	12 to 17	393	64.8	71.0	3.6	1	630	9	20	41	80	136	185	300	380
Age (years)	18 to 64	4,489	93.8	92.3	1.4	1	1,280	13	40	70	120	184	250	360	495
Age (years)	>64	812	83.5	79.4	2.8	4	780	10	30	60	110	165	225	315	405
Race	White	5,337	87.6	89.7	1.2	1	1,280	10	31	64	110	175	240	360	460
Race	Black	640	86.8	74.3	2.9	1	690	10	35	65	115	180	240	305	330
Race	Asian	117	78.8	66.3	6.1	5	360	20	35	60	95	135	225	320	330
Race	Some Others	121	87.7	84.5	7.7	3	540	10	30	60	120	180	250	330	345
Race	Hispanic	265	90.1	101.5	6.2	2	825	15	35	65	100	165	235	465	620
Race	Refused	80	82.4	73.3	8.2	5	420	12	30	60	120	168	230	315	420
Hispanic	No	5,987	87.5	87.6	1.1	1	1,280	10	35	65	110	175	240	345	440
Hispanic	Yes	477	88.5	97.2	4.5	2	825	10	30	60	103	180	240	388	595
Hispanic	DK	29	63.9	73.1	13.6	5	325	6	20	40	60	187	200	325	325
Hispanic	Refused	67	86.1	78.4	9.6	5	420	14	30	60	120	180	239	315	420
Employment	-	1,124	64.2	72.3	2.2	1	900	5	20	45	81	136	180	270	345
Employment	Full Time	3,134	93.6	92.2	1.6	2	1,280	15	40	70	120	180	242	360	490
Employment	Part Time	632	90.1	82.0	3.3	2	878	10	40	70	117	175	230	330	384
Employment	Not Employed	1,629	90.4	90.2	2.2	1	780	10	35	60	115	195	250	365	465
Employment	Refused	41	97.2	84.0	13.1	10	330	15	30	75	120	220	290	330	330
Education	-	1,260	66.5	72.3	2.0	1	900	6	21	45	85	145	187	270	350
Education	< High School	434	86.0	82.1	3.9	5	620	10	35	60	115	165	210	360	455
Education	High School Graduate	1,805	91.8	91.1	2.1	1	870	10	38	65	115	190	255	385	465
Education	< College	1,335	93.2	94.3	2.6	2	1,280	10	36	70	120	180	250	380	460
Education	College Graduate	992	95.7	95.5	3.0	4	840	14	40	73	120	185	250	370	580
Education	Post Graduate	734	91.5	82.0	3.0	4	905	20	40	75	115	175	235	330	380
Census Region	Northeast	1,412	85.8	83.8	2.2	1	780	10	33	60	110	170	240	330	410
Census Region	Midwest	1,492	89.1	86.6	2.2	4	825	10	35	65	113	180	250	360	465
Census Region	South	2,251	88.3	89.3	1.9	1	900	10	34	65	115	175	235	338	490
Census Region	West	1,405	85.9	92.2	2.5	2	1,280	10	30	60	110	175	235	345	435
Day Of Week	Weekday	4,427	83.9	85.0	1.3	1	905	10	30	60	105	165	225	330	440
Day Of Week	Weekend	2,133	94.7	94.0	2.0	1	1,280	10	35	70	120	190	265	360	455
Season	Winter	1,703	83.5	82.1	2.0	1	870	10	30	60	105	165	230	350	425
Season	Spring	1,735	88.6	91.5	2.2	1	905	10	30	60	110	180	250	380	480
Season	Summer	1,767	88.0	86.5	2.1	1	900	10	35	65	115	170	235	330	450
Season	Fall	1,355	90.1	93.2	2.5	1	1,280	10	35	70	115	170	240	335	545
Asthma	No	6,063	87.4	88.0	1.1	1	1,280	10	34	63	110	175	240	350	450
Asthma	Yes	463	88.2	92.1	4.3	4	870	15	34	64	110	165	245	345	505
Asthma	DK	34	78.4	57.4	9.8	10	239	10	30	71	100	160	220	239	239
Angina	No	6,368	87.5	88.7	1.1	1	1,280	10	34	64	110	175	240	350	450
Angina	Yes	154	82.2	68.6	5.5	8	365	10	30	60	115	162	214	285	320
Angina	DK	38	89.6	72.9	11.8	10	360	10	35	74	120	180	239	360	360
Bronchitis/Emphysema	No	6,224	87.6	88.9	1.1	1	1,280	10	34	62	110	175	240	350	450
Bronchitis/Emphysema	Yes	300	85.6	76.2	4.4	1	505	10	35	69	109	185	238	305	435
Bronchitis/Emphysema	DK	36	81.1	63.1	10.5	5	239	10	30	71	120	175	220	239	239

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only (continued)

Truck (Pick-up/Van)

Group Name	Group Code	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		1,172	85.3	95.9	2.8	1	955	10	30	60	110	180	240	395	478
Sex	Male	760	91.1	105.4	3.8	1	955	10	30	60	115	190	265	450	620
Sex	Female	412	74.6	74.2	3.7	1	510	10	25	55	95	165	220	300	355
Age (years)	-	13	110.8	129.2	35.8	10	450	10	35	60	90	300	450	450	450
Age (years)	1 to 4	41	80.8	154.3	24.1	1	955	10	15	35	70	206	210	955	955
Age (years)	5 to 11	89	47.6	44.2	4.7	1	240	7	15	30	65	110	130	180	240
Age (years)	12 to 17	80	66.8	71.1	7.9	5	352	6	15	37	94	180	223	265	352
Age (years)	18 to 64	859	91.4	98.0	3.3	2	750	10	30	60	115	189	260	440	555
Age (years)	>64	90	79.0	82.4	8.7	10	453	12	30	49	105	185	265	390	453
Race	White	1,022	84.7	96.2	3.0	1	955	10	30	60	110	180	235	390	510
Race	Black	68	91.3	98.5	11.9	6	453	14	28	63	106	220	295	450	453
Race	Asian	3	138.3	63.3	36.6	90	210	90	90	115	210	210	210	210	210
Race	Some Others	20	67.2	48.5	10.8	5	165	8	25	63	103	137	155	165	165
Race	Hispanic	48	92.8	99.3	14.3	5	440	10	28	60	120	224	330	440	440
Race	Refused	11	88.2	110.8	33.4	10	390	10	30	60	65	190	390	390	390
Hispanic	No	1,069	85.1	95.6	2.9	1	955	10	30	60	110	180	240	390	478
Hispanic	Yes	87	89.1	100.8	10.8	5	630	5	29	60	115	210	230	440	630
Hispanic	DK	5	58.0	36.2	16.2	20	97	20	20	68	85	97	97	97	97
Hispanic	Refused	11	85.9	111.6	33.7	10	390	10	30	35	65	190	390	390	390
Employment	-	205	60.2	86.4	6.0	1	955	7	15	30	75	146	185	240	265
Employment	Full Time	642	93.3	101.4	4.0	4	750	10	30	60	120	192	270	450	555
Employment	Part Time	97	89.4	89.0	9.0	2	460	6	30	60	120	190	270	450	460
Employment	Not Employed	217	83.0	85.8	5.8	5	655	10	30	60	110	180	235	300	355
Employment	Refused	11	96.4	114.3	34.5	10	390	10	30	35	170	190	390	390	390
Education	-	230	64.0	86.9	5.7	1	955	7	15	35	85	160	206	245	352
Education	< High School	119	90.5	81.7	7.5	5	453	14	35	60	120	195	280	295	450
Education	High School Graduate	392	87.6	94.7	4.8	2	675	10	30	60	115	185	255	450	510
Education	< College	238	92.0	111.8	7.2	4	750	10	30	60	110	190	290	555	655
Education	College Graduate	127	85.2	74.6	6.6	5	370	15	30	60	110	180	230	345	355
Education	Post Graduate	66	112.4	118.0	14.5	10	650	10	35	80	135	220	412	445	650
Census Region	Northeast	170	85.4	104.2	8.0	2	695	10	20	50	110	186	260	445	630
Census Region	Midwest	268	91.2	94.4	5.8	1	750	10	30	60	119	205	245	390	460
Census Region	South	491	87.3	100.1	4.5	4	955	10	30	60	111	180	235	445	595
Census Region	West	243	74.7	81.3	5.2	5	478	10	23	52	90	160	235	395	440
Day Of Week	Weekday	796	80.1	90.6	3.2	1	750	10	30	55	101	170	230	375	510
Day Of Week	Weekend	376	96.3	105.5	5.4	2	955	12	30	61	120	192	280	430	460
Season	Winter	322	78.5	91.6	5.1	1	955	10	29	51	95	170	220	355	445
Season	Spring	300	92.5	100.2	5.8	1	695	10	30	60	120	208	268	443	549
Season	Summer	323	86.1	99.3	5.5	2	750	10	30	60	110	180	233	430	595
Season	Fall	227	84.2	90.9	6.0	5	675	10	30	60	105	165	265	395	465
Asthma	No	1,092	85.3	93.5	2.8	1	750	10	30	60	110	184	240	412	478
Asthma	Yes	72	83.6	125.3	14.8	5	955	10	20	46	115	170	235	395	955
Asthma	DK	8	101.9	129.7	45.8	10	390	10	20	60	128	390	390	390	390
Angina	No	1,142	84.9	95.2	2.8	1	955	10	30	60	110	180	235	395	475
Angina	Yes	20	93.4	116.0	25.9	5	555	8	38	70	103	141	351	555	555
Angina	DK	10	118.5	128.6	40.7	10	390	10	30	60	190	340	390	390	390
Bronchitis/Emphysema	No	1,128	85.5	96.6	2.9	1	955	10	30	60	110	180	240	412	478
Bronchitis/Emphysema	Yes	35	77.8	60.5	10.2	5	240	5	30	60	120	165	220	240	240
Bronchitis/Emphysema	DK	9	93.3	123.9	41.3	10	390	10	20	60	65	390	390	390	390

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only (continued)

Bus															
								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		469	74.6	93.5	4.3	2	945	10	30	55	90	125	180	435	570
Sex	Male	219	77.3	104.1	7.0	5	945	10	30	55	90	135	180	460	570
Sex	Female	250	72.4	83.3	5.3	2	640	15	30	55	90	120	175	420	501
Age (years)	-	14	145.0	167.2	44.7	10	605	10	60	100	140	435	605	605	605
Age (years)	1 to 4	5	56.0	40.2	18.0	15	120	15	30	55	60	120	120	120	120
Age (years)	5 to 11	133	48.4	29.4	2.6	5	140	10	25	43	67	90	110	120	122
Age (years)	12 to 17	143	59.4	46.3	3.9	7	370	10	30	54	75	110	135	179	225
Age (years)	18 to 64	147	96.6	128.4	10.6	2	945	10	30	60	110	180	405	640	690
Age (years)	>64	27	132.0	144.6	27.8	10	570	20	45	73	130	435	460	570	570
Race	White	311	70.1	89.5	5.1	2	945	10	30	54	80	120	147	405	501
Race	Black	101	85.2	92.4	9.2	5	570	15	35	60	110	140	185	460	468
Race	Asian	15	58.0	58.5	15.1	5	175	5	20	20	120	155	175	175	175
Race	Some Others	14	107.1	176.5	47.2	20	690	20	30	43	100	225	690	690	690
Race	Hispanic	24	65.5	71.5	14.6	15	370	20	30	43	87	90	120	370	370
Race	Refused	4	168.0	196.2	98.1	10	435	10	21	114	315	435	435	435	435
Hispanic	No	415	72.8	86.1	4.2	2	945	10	30	55	90	125	165	420	468
Hispanic	Yes	46	83.9	138.9	20.5	7	690	15	30	38	85	145	370	690	690
Hispanic	DK	2	47.5	10.6	7.5	40	55	40	40	48	55	55	55	55	55
Hispanic	Refused	6	137.8	159.6	65.2	10	435	10	32	78	195	435	435	435	435
Employment	-	274	54.0	39.4	2.4	5	370	10	29	50	70	100	120	150	179
Employment	Full Time	95	122.6	168.8	17.3	5	945	10	30	60	120	405	570	690	945
Employment	Part Time	34	83.3	79.3	13.6	2	468	10	40	60	100	135	185	468	468
Employment	Not Employed	61	80.3	69.2	8.9	5	460	10	30	65	120	135	165	205	460
Employment	Refused	5	167.4	169.9	76.0	10	435	10	32	165	195	435	435	435	435
Education	-	295	55.3	45.0	2.6	5	435	10	29	49	70	100	120	155	225
Education	< High School	25	120.4	124.3	24.9	10	570	30	45	90	135	195	405	570	570
Education	High School Graduate	57	111.6	116.7	15.5	10	501	20	45	73	120	225	435	468	501
Education	< College	38	108.8	133.4	21.6	10	640	20	40	75	120	195	605	640	640
Education	College Graduate	30	84.6	128.1	23.4	2	690	5	30	60	90	130	300	690	690
Education	Post Graduate	24	110.5	199.2	40.7	5	945	10	29	60	102	125	460	945	945
Census Region	Northeast	145	77.1	75.4	6.3	7	435	15	30	60	95	135	180	435	435
Census Region	Midwest	102	69.7	103.3	10.2	2	945	10	30	55	85	120	125	175	468
Census Region	South	142	71.7	82.8	7.0	5	570	10	30	50	80	135	180	460	501
Census Region	West	80	81.8	124.3	13.9	5	690	13	30	42	90	128	298	640	690
Day Of Week	Weekday	426	70.6	84.6	4.1	2	690	10	30	50	85	120	165	435	501
Day Of Week	Weekend	43	114.7	152.2	23.2	10	945	20	45	90	120	180	300	945	945
Season	Winter	158	78.3	98.1	7.8	5	690	10	30	58	90	125	180	435	605
Season	Spring	140	61.6	53.5	4.5	2	460	10	30	50	75	120	138	205	225
Season	Summer	94	86.6	116.7	12.0	5	945	10	30	60	95	155	225	435	945
Season	Fall	77	76.2	107.5	12.3	5	640	10	30	50	80	125	175	570	640
Asthma	No	413	76.4	96.8	4.8	2	945	10	30	55	90	125	180	435	570
Asthma	Yes	50	55.4	39.3	5.6	5	195	10	30	48	71	115	135	165	195
Asthma	DK	6	111.5	161.5	65.9	10	435	10	32	46	100	435	435	435	435
Angina	No	459	73.4	91.3	4.3	2	945	10	30	55	90	125	179	420	570
Angina	Yes	4	168.8	182.7	91.3	20	435	20	60	110	278	435	435	435	435
Angina	DK	6	109.5	162.4	66.3	10	435	10	30	41	100	435	435	435	435
Bronchitis/Emphysema	No	442	74.8	94.3	4.5	2	945	10	30	55	90	125	180	435	570
Bronchitis/Emphysema	Yes	19	58.2	39.9	9.1	10	155	10	30	55	65	125	155	155	155
Bronchitis/Emphysema	DK	8	104.6	137.9	48.8	10	435	10	29	68	100	435	435	435	435

Table 16-24. Time Spent (minutes/day) in Selected Vehicles and All Vehicles Combined, Doers Only (continued)

All Vehicles Combined

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		7,743	97.3	104.9	1.2	1	1,440	12	40	70	120	190	270	425	570
Sex	Male	3,603	103.7	119.7	2.0	1	1,440	10	40	70	120	205	295	478	655
Sex	Female	4,138	91.7	89.8	1.4	1	995	12	40	70	115	180	240	385	465
Sex	Refused	2	30.0	14.1	10.0	20	40	20	20	30	40	40	40	40	40
Age (years)	-	144	117.0	129.1	10.8	5	810	20	40	80	143	210	435	593	660
Age (years)	1 to 4	335	68.1	75.5	4.1	1	955	10	30	47	85	150	200	245	270
Age (years)	5 to 11	571	71.0	77.6	3.2	1	900	10	25	51	90	140	171	275	360
Age (years)	12 to 17	500	81.5	79.8	3.6	1	790	10	30	60	100	166	233	345	405
Age (years)	18 to 64	5,286	104.0	111.1	1.5	1	1,440	15	43	75	120	200	285	450	620
Age (years)	>64	907	90.9	93.9	3.1	4	900	10	35	60	120	190	258	400	460
Race	White	6,288	97.2	107.2	1.4	1	1,440	10	40	70	120	190	270	425	595
Race	Black	766	98.7	91.3	3.3	2	810	15	45	75	120	195	265	390	485
Race	Asian	133	83.4	74.9	6.5	5	540	20	35	70	105	150	210	330	360
Race	Some Others	144	96.2	94.0	7.8	3	690	10	40	70	128	180	250	345	540
Race	Hispanic	319	101.7	110.4	6.2	2	825	20	41	70	120	190	335	465	620
Race	Refused	93	93.6	90.1	9.3	10	480	15	30	65	120	205	255	420	480
Hispanic	No	7,050	97.1	104.8	1.2	1	1,440	10	40	70	120	190	270	420	566
Hispanic	Yes	578	100.0	109.0	4.5	2	825	15	40	70	120	190	285	480	630
Hispanic	DK	34	73.0	68.3	11.7	5	325	6	25	60	97	175	200	325	325
Hispanic	Refused	81	98.9	95.3	10.6	10	480	15	30	65	130	220	255	420	480
Employment	-	1,388	73.6	77.8	2.1	1	955	10	30	55	90	150	195	275	382
Employment	Full Time	3,732	105.8	116.2	1.9	4	1,440	16	45	75	124	198	290	475	660
Employment	Part Time	720	98.8	95.0	3.5	2	960	10	45	75	120	195	260	380	470
Employment	Not Employed	1,849	96.6	99.5	2.3	1	995	10	37	65	120	200	275	420	526
Employment	Refused	54	120.3	108.6	14.8	10	480	20	35	88	190	290	330	390	480
Education	-	1,550	76.4	78.9	2.0	1	955	10	30	60	95	155	201	303	385
Education	< High School	561	100.8	120.2	5.1	5	1,440	15	40	70	120	180	265	460	620
Education	High School Graduate	2,166	101.6	107.6	2.3	1	1,210	12	40	70	120	210	286	445	570
Education	< College	1,556	103.2	110.1	2.8	2	1,280	15	40	75	120	195	285	460	630
Education	College Graduate	1,108	104.5	109.5	3.3	4	1,215	15	45	75	125	200	280	450	675
Education	Post Graduate	802	101.9	108.7	3.8	4	1,357	20	45	76	120	195	270	365	480
Census Region	Northeast	1,662	98.6	106.6	2.6	1	1,215	15	40	70	120	190	275	425	570
Census Region	Midwest	1,759	101.2	114.6	2.7	1	1,440	10	40	70	120	205	290	435	595
Census Region	South	2,704	96.1	97.7	1.9	1	955	13	40	70	120	190	250	420	558
Census Region	West	1,618	93.7	103.7	2.6	2	1,280	10	35	65	115	180	260	420	540
Day Of Week	Weekday	5,289	94.4	101.4	1.4	1	1,215	10	40	66	115	180	260	435	575
Day Of Week	Weekend	2,454	103.4	111.9	2.3	1	1,440	13	40	75	125	205	280	420	540
Season	Winter	2,037	94.3	101.4	2.2	1	1,080	10	35	65	116	190	270	425	544
Season	Spring	2,032	99.6	110.5	2.5	1	1,440	12	40	70	120	200	275	440	546
Season	Summer	2,090	97.8	103.8	2.3	1	1,357	10	40	70	120	190	260	415	558
Season	Fall	1,584	97.4	103.7	2.6	1	1,280	14	40	70	120	180	265	420	620
Asthma	No	7,152	97.3	104.6	1.2	1	1,440	10	40	70	120	190	270	425	570
Asthma	Yes	544	97.2	110.8	4.8	4	955	17	40	65	117	180	255	460	705
Asthma	DK	47	100.0	95.2	13.9	10	480	10	30	75	120	220	239	480	480
Angina	No	7,516	97.3	105.2	1.2	1	1,440	11	40	70	120	190	270	425	570
Angina	Yes	172	93.1	93.1	7.1	8	615	15	30	65	120	185	280	420	540
Angina	DK	55	108.9	99.7	13.4	10	480	20	35	75	150	235	360	390	480
Bronchitis/Emphysema	No	7,349	97.6	106.1	1.2	1	1,440	10	40	70	120	190	270	425	580
Bronchitis/Emphysema	Yes	342	91.0	79.3	4.3	2	505	15	40	70	115	195	240	325	460
Bronchitis/Emphysema	DK	52	98.9	93.8	13.0	5	480	10	30	74	145	195	239	390	480

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-25. Time Spent (minutes/day) in Selected Activities Whole Population and Doers Only, Children <21 Years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Sleeping/Napping—Whole Population															
Birth to <1	63	782	485	519	546	579	613	668	762	873	1,011	1,080	1,121	1,144	1,175
1 to <2	118	779	360	483	510	579	627	700	780	855	925	962	987	1,098	1,320
2 to <3	118	716	270	365	470	523	594	635	708	805	870	917	937	944	990
3 to <6	357	681	0	480	510	539	573	630	675	735	795	840	893	916	1,110
6 to <11	497	613	120	295	390	458	510	570	625	660	720	750	831	868	945
11 to <16	466	569	0	320	376	415	450	510	558	630	705	762	809	907	1,015
16 to <21	481	537	0	239	295	360	390	450	525	615	690	750	840	906	1,317
Sleeping/Napping—Doers Only															
Birth to <1	63	782	485	519	546	579	613	668	762	873	1,011	1,080	1,121	1,144	1,175
1 to <2	118	779	360	483	510	579	627	700	780	855	925	962	987	1,098	1,320
2 to <3	118	716	270	365	470	523	594	635	708	805	870	917	937	944	990
3 to <6	356	683	420	491	510	540	578	630	675	738	795	840	893	916	1,110
6 to <11	497	613	120	295	390	458	510	570	625	660	720	750	831	868	945
11 to <16	465	571	150	341	379	415	450	510	560	630	705	762	809	907	1,015
16 to <21	480	538	85	252	299	360	390	450	525	615	690	751	840	906	1,317
Eating—Whole Population															
Birth to <1	63	117	0	6	12	36	45	73	110	145	194	224	334	345	345
1 to <2	118	98	0	10	10	29	40	60	90	120	167	206	233	244	270
2 to <3	118	92	15	15	15	20	30	60	89	120	157	176	198	208	270
3 to <6	357	78	0	0	0	15	28	45	75	105	135	150	180	217	265
6 to <11	497	65	0	0	0	10	20	35	60	88	115	139	155	176	255
11 to <16	466	52	0	0	0	0	10	30	45	74	100	120	146	162	205
16 to <21	481	52	0	0	0	0	0	20	40	65	105	135	192	210	630
Eating—Doers Only															
Birth to <1	62	118	10	16	23	40	46	77	110	148	195	224	335	345	345
1 to <2	117	99	10	10	12	30	40	60	90	120	167	206	234	244	270
2 to <3	118	92	15	15	15	20	30	60	89	120	157	176	198	208	270
3 to <6	349	80	2	10	15	20	30	45	75	105	135	150	180	218	265
6 to <11	480	67	5	10	10	15	20	40	60	90	115	140	157	179	255
11 to <16	432	56	2	5	7	10	20	30	50	75	100	125	148	163	205
16 to <21	426	59	2	5	9	10	15	30	45	75	105	144	197	210	630
Attending School Full-Time—Whole Population															
Birth to <1	63	11	0	0	0	0	0	0	0	0	0	0	83	265	550
1 to <2	118	28	0	0	0	0	0	0	0	0	0	204	546	594	665
2 to <3	118	65	0	0	0	0	0	0	0	0	334	502	564	618	710
3 to <6	357	73	0	0	0	0	0	0	0	0	392	510	558	581	630
6 to <11	497	183	0	0	0	0	0	0	0	390	435	460	525	570	645
11 to <16	466	187	0	0	0	0	0	0	0	409	445	464	487	500	595
16 to <21	481	117	0	0	0	0	0	0	0	270	408	445	489	551	825
Attending School Full-Time—Doers Only															
Birth to <1	3	-	60	-	-	-	-	-	-	-	-	-	-	-	550
1 to <2	9	-	20	-	-	-	-	-	-	-	-	-	-	-	665
2 to <3	20	385	20	37	53	103	119	226	458	520	576	632	679	694	710
3 to <6	71	366	30	37	66	128	165	203	395	510	558	583	615	627	630
6 to <11	234	389	60	125	164	211	311	370	390	425	460	497	570	600	645
11 to <16	217	401	10	86	108	270	343	385	415	440	467	485	505	548	595
16 to <21	162	347	20	46	78	126	195	270	370	420	459	519	567	609	825

Table 16-25. Time Spent (minutes/day) in Selected Activities Whole Population and Doers Only, Children <21 Years (continued)

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Outdoor Recreation—Whole Population															
Birth to <1	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 to <2	118	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	118	4	0	0	0	0	0	0	0	0	0	0	15	28	370
3 to <6	357	6	0	0	0	0	0	0	0	0	0	0	60	172	630
6 to <11	497	7	0	0	0	0	0	0	0	0	0	0	142	226	574
11 to <16	466	6	0	0	0	0	0	0	0	0	0	0	142	191	465
16 to <21	481	6	0	0	0	0	0	0	0	0	0	0	103	189	570
Outdoor Recreation—Doers Only															
Birth to <1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	4	-	15	-	-	-	-	-	-	-	-	-	-	-	370
3 to <6	11	207	30	30	30	30	30	60	150	240	585	608	621	626	630
6 to <11	17	204	60	60	60	60	66	120	165	245	351	403	506	540	574
11 to <16	22	138	5	5	5	5	11	60	126	180	234	411	446	456	465
16 to <21	13	228	30	35	41	57	77	130	180	300	420	480	534	552	570
Active Sports—Whole Population															
Birth to <1	63	15	0	0	0	0	0	0	0	0	60	90	131	143	155
1 to <2	118	20	0	0	0	0	0	0	0	0	68	131	180	201	270
2 to <3	118	27	0	0	0	0	0	0	0	0	110	180	257	319	390
3 to <6	357	40	0	0	0	0	0	0	0	30	135	242	330	408	630
6 to <11	497	51	0	0	0	0	0	0	0	60	172	272	371	435	975
11 to <16	466	53	0	0	0	0	0	0	0	74	168	245	309	425	1,065
16 to <21	481	35	0	0	0	0	0	0	0	0	145	180	285	386	565
Active Sports—Doers Only															
Birth to <1	13	75	25	26	26	28	31	40	60	90	132	143	150	153	155
1 to <2	24	96	10	15	19	30	33	60	73	131	180	201	240	255	270
2 to <3	26	124	15	18	20	26	30	41	98	179	253	314	360	375	390
3 to <6	97	149	15	20	29	30	30	60	120	180	315	354	559	625	630
6 to <11	175	146	2	12	15	20	30	60	110	193	312	393	450	522	975
11 to <16	179	137	5	5	15	15	30	60	115	180	261	314	442	533	1,065
16 to <21	117	143	5	15	15	20	30	60	120	180	272	371	501	519	565
Exercise—Whole Population															
Birth to <1	63	13	0	0	0	0	0	0	0	0	0	0	122	354	670
1 to <2	118	2	0	0	0	0	0	0	0	0	0	0	25	30	150
2 to <3	118	1	0	0	0	0	0	0	0	0	0	0	0	0	60
3 to <6	357	3	0	0	0	0	0	0	0	0	0	0	0	54	525
6 to <11	497	5	0	0	0	0	0	0	0	0	0	0	100	137	450
11 to <16	466	5	0	0	0	0	0	0	0	0	0	30	70	114	245
16 to <21	481	8	0	0	0	0	0	0	0	0	0	60	151	176	300
Exercise—Doers Only															
Birth to <1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to <2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 to <3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 to <6	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 to <11	20	124	15	17	19	25	30	60	100	146	226	284	384	417	450
11 to <16	28	75	20	21	23	27	30	42	60	101	128	148	194	219	245
16 to <21	41	99	15	15	15	25	30	40	90	145	180	240	260	280	300

Table 16-25. Time Spent (minutes/day) in Selected Activities Whole Population and Doers Only, Children <21 Years (continued)

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Walking—Whole Population															
Birth to <1	63	6	0	0	0	0	0	0	0	0	9.2	29	64	104	160
1 to <2	118	2	0	0	0	0	0	0	0	0	0	10	40	58	60
2 to <3	118	3	0	0	0	0	0	0	0	0	10	17	45	54	60
3 to <6	357	3	0	0	0	0	0	0	0	0	4	20	35	60	60
6 to <11	497	4	0	0	0	0	0	0	0	0	14	30	40	55	170
11 to <16	466	10	0	0	0	0	0	0	0	0	30	55	79	130	190
16 to <21	481	8	0	0	0	0	0	0	0	0	20	45	90	127	410
Walking—Doers Only															
Birth to <1	9	-	4	-	-	-	-	-	-	-	-	-	-	-	160
1 to <2	9	-	4	-	-	-	-	-	-	-	-	-	-	-	60
2 to <3	19	19	1	1	1	2	2	7	10	28	51	56	58	59	60
3 to <6	44	20	1	1	1	1	2	5	15	30	56	60	60	60	60
6 to <11	118	18	1	1	1	2	2	5	10	25	40	51	65	94	170
11 to <16	190	25	1	1	1	2	3	5	14	30	60	78	134	154	190
16 to <21	128	30	1	1	2	2	3	5	18	32	62	120	148	175	410

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes less than 10.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only															
Sleeping/Napping															
								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		9,362	526.3	134.4	1.4	30	1,430	345	445	510	600	690	760	850	925
Sex	Male	4,283	523.3	135.2	2.1	30	1,295	330	435	510	600	690	765	860	925
Sex	Female	5,075	528.7	133.7	1.8	30	1,430	350	450	510	600	690	750	840	925
Sex	Refused	4	645.0	123.7	61.8	540	780	540	540	630	750	780	780	780	780
Age (years)	-	185	502.3	125.4	9.2	195	908	330	420	480	555	655	745	865	900
Age (years)	1 to 4	499	732.4	124.3	5.6	270	1,320	540	655	720	810	900	930	1,005	1,110
Age (years)	5 to 11	702	625.1	100.7	3.8	120	1,110	480	570	630	680	725	780	840	875
Age (years)	12 to 17	588	563.7	110.8	4.6	150	1,015	395	484	550	630	705	750	810	900
Age (years)	18 to 64	6,041	496.9	123.0	1.6	30	1,420	330	420	480	555	630	705	780	868
Age (years)	>64	1,347	517.1	117.5	3.2	30	1,430	345	450	510	570	660	720	780	860
Race	White	7,576	523.6	129.5	1.5	30	1,430	350	445	510	600	690	750	840	900
Race	Black	940	541.3	162.7	5.3	60	1,415	315	424	530	630	738	823	940	1,020
Race	Asian	156	537.1	118.1	9.5	300	920	345	468	540	600	690	735	840	870
Race	Some Others	181	528.8	142.3	10.6	60	905	300	420	525	630	720	769	810	842
Race	Hispanic	383	538.0	148.9	7.6	60	1,125	315	450	540	630	720	765	870	930
Race	Refused	126	523.4	143.7	12.8	180	1,140	330	420	510	600	720	780	870	930
Hispanic	No	8,514	525.2	133.2	1.4	30	1,430	345	445	510	600	690	750	855	925
Hispanic	Yes	700	540.1	147.1	5.6	60	1,125	320	450	540	630	720	778	843	915
Hispanic	DK	45	527.5	139.3	20.8	195	842	345	420	515	659	690	710	842	842
Hispanic	Refused	103	521.6	138.9	13.7	240	930	330	420	510	590	720	780	865	870
Employment	-	1,771	636.6	128.5	3.1	120	1,320	440	555	630	705	802	860	930	975
Employment	Full Time	4,085	487.2	118.9	1.9	30	1,420	325	420	480	540	628	685	770	840
Employment	Part Time	798	502.8	117.4	4.2	60	1,005	330	435	495	570	645	720	780	860
Employment	Not Employed	2,638	520.3	125.5	2.4	30	1,430	345	450	510	590	660	720	800	885
Employment	Refused	70	513.7	136.5	16.3	210	930	320	420	490	570	697	780	900	930
Education	-	1,966	625.6	134.0	3.0	120	1,420	420	540	628	699	790	855	926	975
Education	< High School	832	515.4	135.7	4.7	30	1,317	300	435	510	585	670	750	860	900
Education	High School Graduate	2,604	505.4	123.0	2.4	30	1,430	330	420	495	570	659	720	780	840
Education	< College	1,791	496.6	119.9	2.8	60	1,350	315	420	480	565	630	690	779	845
Education	College Graduate	1,245	492.5	117.6	3.3	75	1,404	330	420	480	540	629	690	775	900
Education	Post Graduate	924	486.7	110.4	3.6	105	1,295	345	420	480	540	615	660	725	800
Census Region	Northeast	2,068	523.1	133.7	2.9	55	1,420	345	435	510	600	690	760	860	930
Census Region	Midwest	2,096	520.8	127.6	2.8	30	1,215	330	440	510	598	690	745	840	870
Census Region	South	3,234	529.0	135.7	2.4	30	1,430	345	450	510	600	699	765	855	925
Census Region	West	1,964	530.9	140.0	3.2	60	1,404	345	450	510	600	690	769	862	940
Day Of Week	Weekday	6,303	511.1	131.8	1.7	30	1,430	330	420	495	570	670	745	840	920
Day Of Week	Weekend	3,059	557.5	134.4	2.4	30	1,420	360	480	540	630	720	780	870	925
Season	Winter	2,514	534.9	134.7	2.7	55	1,404	355	450	520	600	700	780	870	930
Season	Spring	2,431	526.8	130.5	2.6	30	1,175	345	445	510	600	690	750	840	900
Season	Summer	2,533	527.7	139.5	2.8	30	1,430	330	435	510	600	699	765	840	930
Season	Fall	1,884	512.2	131.1	3.0	60	1,420	330	430	505	570	660	735	840	900
Asthma	No	8,608	525.1	133.6	1.4	30	1,430	345	445	510	600	690	750	840	915
Asthma	Yes	692	540.1	143.6	5.5	30	1,404	330	450	538	618	715	780	900	945
Asthma	DK	62	544.2	141.0	17.9	300	1,035	330	465	535	600	720	780	930	1,035
Angina	No	9,039	526.8	134.2	1.4	30	1,420	345	445	510	600	690	760	855	925
Angina	Yes	249	513.7	137.7	8.7	60	1,430	300	445	510	595	660	735	795	845
Angina	DK	74	511.4	146.3	17.0	30	930	300	420	510	600	720	780	840	930
Bronchitis/Emphysema	No	8,860	526.5	134.3	1.4	30	1,430	345	445	510	600	690	760	850	924
Bronchitis/Emphysema	Yes	432	521.7	138.5	6.7	80	1,110	300	420	510	600	705	765	840	930
Bronchitis/Emphysema	DK	70	521.2	131.9	15.8	210	930	300	450	510	600	690	745	840	930

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Eating or Drinking

								Percentiles									
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		8,627	74.9	54.8	0.6	1	900	15	35	60	96	140	175	215	270
Sex	Male	3,979	75.8	56.2	0.9	1	900	15	39	60	96	140	180	210	270
Sex	Female	4,644	74.1	53.6	0.8	2	640	15	34	60	98	140	170	225	270
Sex	Refused	4	60.0	21.2	10.6	30	75	30	45	68	75	75	75	75	75
Age (years)	-	157	75.3	50.1	4.0	10	315	15	30	65	100	145	150	195	285
Age (years)	1 to 4	492	93.5	52.9	2.4	2	345	20	60	90	120	160	190	225	270
Age (years)	5 to 11	680	68.5	39.0	1.5	5	255	15	40	65	90	120	143	165	195
Age (years)	12 to 17	538	55.9	35.0	1.5	2	210	10	30	50	75	105	125	150	170
Age (years)	18 to 64	5,464	71.9	55.1	0.7	1	900	15	30	60	90	135	170	220	270
Age (years)	>64	1,296	91.7	62.7	1.7	5	750	20	50	80	120	165	200	270	295
Race	White	7,049	77.0	55.7	0.7	1	900	15	40	64	100	145	180	225	270
Race	Black	808	59.9	46.6	1.6	2	505	15	30	50	75	119	140	200	225
Race	Asian	148	80.4	47.8	3.9	2	305	15	45	73	107	150	160	200	200
Race	Some Others	168	66.0	52.1	4.0	7	525	15	30	60	83	120	135	190	200
Race	Hispanic	345	68.7	51.9	2.8	2	435	12	30	60	90	125	165	195	225
Race	Refused	109	74.2	60.8	5.8	8	410	20	30	60	90	130	180	290	315
Hispanic	No	7,861	75.6	55.2	0.6	1	900	15	35	60	100	140	175	220	270
Hispanic	Yes	639	68.3	50.2	2.0	2	435	15	30	60	90	120	155	195	225
Hispanic	DK	41	60.4	37.1	5.8	5	150	15	30	55	90	120	130	150	150
Hispanic	Refused	86	68.9	55.5	6.0	8	410	15	30	60	90	115	155	210	410
Employment	-	1,695	72.2	44.9	1.1	2	345	15	40	65	90	133	150	195	210
Employment	Full Time	3,684	70.6	55.1	0.9	1	900	15	30	60	90	135	165	225	270
Employment	Part Time	715	72.2	55.4	2.1	2	509	15	30	60	90	135	170	230	260
Employment	Not Employed	2,472	83.9	59.1	1.2	2	750	15	45	75	110	150	185	235	285
Employment	Refused	61	71.0	61.0	7.8	8	385	15	30	55	90	120	145	235	385
Education	-	1,867	70.9	45.4	1.1	2	375	15	38	60	90	130	150	190	210
Education	< High School	758	72.3	57.4	2.1	2	460	15	30	60	90	135	180	230	315
Education	High School Graduate	2,363	74.9	57.1	1.2	1	900	15	35	60	96	140	175	220	270
Education	< College	1,612	73.9	56.5	1.4	2	525	15	30	60	90	145	175	230	275
Education	College Graduate	1,160	78.5	55.4	1.6	1	640	15	40	65	105	145	180	220	265
Education	Post Graduate	867	82.8	59.7	2.0	2	750	15	40	70	110	150	185	240	270
Census Region	Northeast	1,916	78.3	59.2	1.4	1	750	15	37	65	103	145	180	240	285
Census Region	Midwest	1,928	75.8	51.4	1.2	1	435	15	40	64	100	140	175	210	255
Census Region	South	2,960	71.4	55.1	1.0	2	900	15	30	60	90	135	165	210	270
Census Region	West	1,823	76.0	53.0	1.2	2	500	15	35	60	100	150	180	210	240
Day Of Week	Weekday	5,813	71.2	52.0	0.7	1	900	15	33	60	90	130	165	210	250
Day Of Week	Weekend	2,814	82.5	59.5	1.1	2	630	15	40	70	110	150	190	240	297
Season	Winter	2,332	76.1	56.4	1.2	2	640	15	39	65	96	140	175	240	275
Season	Spring	2,222	76.3	55.2	1.2	1	630	15	35	60	100	145	178	220	275
Season	Summer	2,352	73.5	53.3	1.1	1	750	15	35	60	95	135	170	210	260
Season	Fall	1,721	73.3	54.3	1.3	2	900	15	30	60	95	140	175	210	232
Asthma	No	7,937	75.2	54.8	0.6	1	900	15	35	60	100	140	175	215	270
Asthma	Yes	635	71.4	55.0	2.2	2	460	15	30	60	90	133	170	225	285
Asthma	DK	55	69.3	56.6	7.6	8	335	15	30	60	90	120	210	215	335
Angina	No	8,318	74.6	54.4	0.6	1	900	15	35	60	95	140	175	210	265
Angina	Yes	243	85.0	63.5	4.1	2	500	15	45	75	115	160	180	285	330
Angina	DK	66	75.7	67.3	8.3	5	435	15	30	60	90	150	195	215	435
Bronchitis/Emphysema	No	8,169	74.7	54.3	0.6	1	900	15	35	60	95	140	170	210	260
Bronchitis/Emphysema	Yes	397	80.7	65.2	3.3	2	460	15	30	60	110	150	180	285	360
Bronchitis/Emphysema	DK	61	67.0	47.7	6.1	8	230	15	30	60	90	120	155	215	230

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Working in a Main Job

Category	Population Group	N	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		3,259	475.9	179.1	3.1	1	1,440	120	395	500	570	660	740	840	930
Sex	Male	1,733	492.3	187.0	4.5	1	1,440	120	417	510	595	690	770	890	955
Sex	Female	1,526	457.3	167.7	4.3	2	1,440	120	390	485	543	620	690	785	850
Age (years)	-	80	472.4	183.3	20.5	5	940	118	378	483	560	673	850	900	940
Age (years)	1 to 4	3	16.7	11.5	6.7	10	30	10	10	10	30	30	30	30	30
Age (years)	5 to 11	10	150.4	185.8	58.8	2	550	2	10	68	264	448	550	550	550
Age (years)	12 to 17	38	293.2	180.7	29.3	5	840	15	185	269	390	510	675	840	840
Age (years)	18 to 64	2,993	484.8	173.1	3.2	1	1,440	140	420	505	570	660	745	840	930
Age (years)	>64	135	366.1	208.7	18.0	5	990	30	185	395	500	600	660	840	940
Race	White	2,630	477.5	179.0	3.5	1	1,440	120	400	500	570	660	735	845	933
Race	Black	343	466.6	176.0	9.5	5	1,037	105	390	490	550	655	735	880	990
Race	Asian	57	464.1	177.3	23.5	5	870	45	390	493	553	660	750	780	870
Race	Some Others	56	477.4	181.7	24.3	45	855	75	415	510	570	680	765	780	855
Race	Hispanic	125	465.9	185.3	16.6	2	840	95	360	485	580	720	750	825	840
Race	Refused	48	492.1	191.6	27.7	50	957	120	410	508	575	810	840	957	957
Hispanic	No	2,980	475.4	179.2	3.3	1	1,440	120	395	500	570	660	740	850	940
Hispanic	Yes	221	481.5	174.3	11.7	2	1,106	150	405	505	580	670	740	825	840
Hispanic	DK	12	529.6	146.2	42.2	295	757	295	425	554	610	710	757	757	757
Hispanic	Refused	46	468.5	201.3	29.7	10	860	115	350	498	585	780	818	860	860
Employment	-	47	257.9	202.8	29.6	2	840	5	65	245	390	540	625	840	840
Employment	Full Time	2,679	504.4	164.8	3.2	1	1,440	180	450	510	582	675	750	855	950
Employment	Part Time	395	364.6	159.4	8.0	5	945	80	250	365	480	540	600	675	795
Employment	Not Employed	112	270.9	216.0	20.4	4	990	9	83	245	378	600	675	795	870
Employment	Refused	26	513.6	155.5	30.5	170	840	225	440	510	570	778	790	840	840
Education	-	108	343.0	211.9	20.4	2	860	10	177	343	510	610	675	840	840
Education	< High School	217	473.5	216.7	14.7	4	1,440	85	360	485	568	710	795	940	1,080
Education	High School Graduate	1,045	482.0	180.6	5.6	1	1,440	120	405	500	565	670	765	890	979
Education	< College	795	475.6	174.0	6.2	2	1,440	140	409	495	563	648	750	825	905
Education	College Graduate	627	484.5	159.8	6.4	5	1,005	120	424	510	570	645	720	765	815
Education	Post Graduate	467	483.0	169.6	7.8	1	945	125	400	510	590	660	730	810	860
Census Region	Northeast	721	476.0	180.8	6.7	1	1,440	120	405	495	570	669	740	890	950
Census Region	Midwest	755	477.0	182.2	6.6	2	1,440	120	395	495	570	660	750	825	940
Census Region	South	1,142	478.2	176.7	5.2	1	1,440	105	405	505	570	660	735	840	900
Census Region	West	641	470.4	177.8	7.0	5	1,080	120	390	500	570	657	730	850	880
Day Of Week	Weekday	2,788	487.9	166.2	3.1	1	1,440	155	425	505	570	660	740	840	930
Day Of Week	Weekend	471	405.2	229.5	10.6	2	1,440	30	245	415	555	670	770	870	960
Season	Winter	864	475.8	172.8	5.9	5	1,440	150	390	495	570	660	735	835	900
Season	Spring	791	473.0	195.4	6.9	1	1,440	75	390	495	570	670	765	850	915
Season	Summer	910	477.2	179.9	6.0	1	1,215	120	400	500	565	670	750	890	979
Season	Fall	694	477.7	166.0	6.3	2	1,005	130	405	510	570	645	720	780	840
Asthma	No	3,042	477.0	177.0	3.2	1	1,440	120	400	500	570	660	740	840	930
Asthma	Yes	195	453.4	204.2	14.6	5	1,440	45	345	480	550	668	793	855	979
Asthma	DK	22	523.2	217.0	46.3	170	1,215	225	430	500	565	780	860	1,215	1,215
Angina	No	3,192	475.7	178.4	3.2	1	1,440	120	395	500	570	660	740	840	930
Angina	Yes	44	472.1	200.7	30.3	10	990	60	386	500	573	679	730	990	990
Angina	DK	23	507.4	230.3	48.0	80	1,215	170	430	500	565	780	860	1,215	1,215
Bronchitis/Emphysema	No	3,120	476.5	178.2	3.2	1	1,440	120	400	500	570	660	740	840	930
Bronchitis/Emphysema	Yes	116	447.0	189.4	17.6	5	985	30	368	480	558	644	720	800	855
Bronchitis/Emphysema	DK	23	535.2	226.3	47.2	170	1,215	225	430	500	600	860	875	1,215	1,215

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Attending Full Time School

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		884	358.5	130.3	4.4	1	840	95	300	390	435	483	550	600	640
Sex	Male	468	369.3	123.2	5.7	20	840	120	320	390	435	485	555	595	645
Sex	Female	416	346.4	137.1	6.7	1	710	75	263	385	430	480	535	600	628
Age (years)	-	7	232.1	148.1	56.0	10	495	10	180	210	320	495	495	495	495
Age (years)	1 to 4	56	365.0	199.2	26.6	20	710	30	173	428	530	595	628	665	710
Age (years)	5 to 11	297	387.8	98.0	5.7	60	645	170	360	390	435	485	555	600	630
Age (years)	12 to 17	271	392.3	85.0	5.2	10	605	200	375	405	435	460	485	510	555
Age (years)	18 to 64	247	292.2	154.6	9.8	1	840	60	180	289	400	480	535	645	785
Age (years)	>64	6	203.3	147.4	60.2	75	480	75	120	153	240	480	480	480	480
Race	White	665	362.9	128.5	5.0	1	825	107	310	392	435	485	550	600	630
Race	Black	92	351.8	129.6	13.5	40	710	70	287	388	433	465	526	645	710
Race	Asian	33	346.3	156.0	24.2	90	840	120	225	365	435	500	565	840	840
Race	Some Others	29	337.8	148.1	27.5	58	553	70	212	360	445	502	540	553	553
Race	Hispanic	58	345.3	124.0	16.3	30	565	85	260	378	430	480	510	510	565
Race	Refused	7	285.0	157.0	59.4	60	440	60	150	290	440	440	440	440	440
Hispanic	No	771	359.6	130.8	4.7	1	840	100	300	390	435	483	550	600	645
Hispanic	Yes	103	353.1	126.4	12.5	30	630	85	269	385	425	483	510	595	600
Hispanic	DK	4	315.5	167.8	83.9	65	416	65	221	391	410	415	415	415	415
Hispanic	Refused	6	348.3	140.6	57.4	150	445	150	185	435	440	445	445	445	445
Employment	-	608	386.5	107.3	4.4	10	710	165	361	400	440	485	550	595	625
Employment	Full Time	49	206.6	133.6	19.1	5	502	15	115	180	305	430	461	502	502
Employment	Part Time	89	304.7	134.8	14.3	25	695	90	210	295	395	480	500	585	695
Employment	Not Employed	135	325.3	161.0	13.9	1	840	60	215	340	420	500	605	785	825
Employment	Refused	3	270.0	147.2	85.0	185	440	185	185	440	440	440	440	440	440
Education	-	666	385.0	107.9	4.2	10	710	160	360	400	440	485	550	595	625
Education	< High School	14	267.1	129.3	34.6	5	415	5	175	310	357	385	415	415	415
Education	High School Graduate	54	238.5	141.1	19.2	58	785	60	125	212	330	400	480	480	785
Education	< College	100	303.4	170.6	17.1	1	840	60	185	273	415	526	614	760	833
Education	College Graduate	24	238.4	145.9	29.8	25	565	30	135	200	360	430	460	565	565
Education	Post Graduate	26	302.8	144.1	28.3	10	535	95	210	300	461	500	502	535	535
Census Region	Northeast	186	351.6	127.0	9.3	60	825	120	268	375	420	483	520	600	785
Census Region	Midwest	200	358.1	123.9	8.8	5	645	88	308	393	425	470	528	578	602
Census Region	South	322	373.9	139.7	7.8	10	840	60	330	405	450	500	565	625	645
Census Region	West	176	338.3	120.5	9.1	1	630	120	263	375	410	465	540	555	600
Day Of Week	Weekday	858	363.7	126.0	4.3	1	840	120	310	390	435	485	550	600	640
Day Of Week	Weekend	26	189.5	158.4	31.1	15	465	20	60	120	300	460	465	465	465
Season	Winter	302	375.1	118.5	6.8	5	695	150	330	395	440	495	550	612	640
Season	Spring	287	353.4	133.7	7.9	10	840	90	290	390	430	475	500	570	710
Season	Summer	125	332.4	142.1	12.7	40	630	70	217	375	425	470	550	600	600
Season	Fall	170	357.0	132.8	10.2	1	785	120	285	380	430	510	565	605	645
Asthma	No	784	358.0	130.7	4.7	1	840	95	295	390	435	485	550	595	630
Asthma	Yes	96	363.0	127.9	13.1	20	695	95	334	390	428	475	540	645	695
Asthma	DK	4	363.8	162.6	81.3	120	450	120	280	443	448	450	450	450	450
Angina	No	875	358.6	130.5	4.4	1	840	95	300	390	435	483	550	600	640
Angina	Yes	4	382.5	87.7	43.9	255	455	255	330	410	435	455	455	455	455
Angina	DK	5	333.6	140.5	62.8	120	460	120	270	378	440	460	460	460	460
Bronchitis/Emphysema	No	851	359.1	130.4	4.5	1	840	95	300	390	435	485	550	600	640
Bronchitis/Emphysema	Yes	27	340.1	132.7	25.5	30	605	60	305	365	435	450	460	605	605
Bronchitis/Emphysema	DK	6	357.2	121.5	49.6	120	440	120	350	397	440	440	440	440	440

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Outdoor Recreation

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		253	211.2	185.5	11.7	5	1,440	20	60	165	300	480	574	670	690
Sex	Male	140	231.8	207.4	17.5	5	1,440	18	68	177	330	503	600	690	735
Sex	Female	112	183.7	150.2	14.2	5	645	20	60	150	255	380	525	585	630
Sex	Refused	1	420.0	-	-	420	420	420	420	420	420	420	420	420	420
Age (years)	-	2	337.5	201.5	142.5	195	480	195	195	338	480	480	480	480	480
Age (years)	1 to 4	13	166.5	177.1	49.1	15	630	15	30	130	180	370	630	630	630
Age (years)	5 to 11	21	206.1	156.2	34.1	30	585	60	90	165	245	360	574	585	585
Age (years)	12 to 17	27	155.1	128.3	24.7	5	465	5	60	135	225	420	420	465	465
Age (years)	18 to 64	158	223.6	193.0	15.4	5	1,440	30	80	173	310	505	585	690	690
Age (years)	>64	32	211.1	206.6	36.5	5	735	5	30	171	375	495	600	735	735
Race	White	225	209.8	182.7	12.2	5	1,440	20	60	165	300	460	570	670	690
Race	Black	16	233.9	231.3	57.8	5	690	5	43	150	450	585	690	690	690
Race	Asian	3	203.3	262.2	151.4	30	505	30	30	75	505	505	505	505	505
Race	Some Others	2	327.5	130.8	92.5	235	420	235	235	328	420	420	420	420	420
Race	Hispanic	4	77.5	53.9	27.0	20	150	20	43	70	113	150	150	150	150
Race	Refused	3	308.3	209.4	120.9	180	550	180	180	195	550	550	550	550	550
Hispanic	No	238	211.8	187.1	12.1	5	1,440	20	60	165	300	480	585	690	690
Hispanic	Yes	12	175.5	149.1	43.0	15	511	15	70	150	255	340	511	511	511
Hispanic	Refused	3	308.3	209.4	120.9	180	550	180	180	195	550	550	550	550	550
Employment	-	60	177.1	150.0	19.4	5	630	13	60	148	230	395	520	585	630
Employment	Full Time	104	210.7	153.4	15.0	5	670	30	83	180	294	419	511	600	645
Employment	Part Time	19	205.3	204.0	46.8	30	690	30	60	150	180	570	690	690	690
Employment	Not Employed	68	244.4	245.0	29.7	5	1,440	15	60	180	375	525	690	735	1,440
Employment	Refused	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195
Education	-	64	176.7	145.3	18.2	5	630	15	60	153	225	370	465	585	630
Education	< High School	22	259.4	178.0	37.9	5	600	30	105	248	380	525	600	600	600
Education	High School Graduate	59	238.2	229.0	29.8	15	1,440	20	90	175	310	511	670	690	1,440
Education	< College	54	218.1	172.2	23.4	5	690	25	65	173	345	460	550	570	690
Education	College Graduate	31	224.7	193.1	34.7	20	690	30	60	150	325	505	645	690	690
Education	Post Graduate	23	157.6	178.2	37.2	5	735	10	50	80	200	370	480	735	735
Census Region	Northeast	52	189.6	160.9	22.3	5	690	30	60	163	232	370	574	670	690
Census Region	Midwest	54	212.1	228.4	31.1	5	1,440	20	60	178	280	419	600	735	1,440
Census Region	South	84	217.3	175.3	19.1	5	645	15	63	150	348	495	525	600	645
Census Region	West	63	220.3	179.7	22.6	10	690	30	75	165	280	545	585	690	690
Day Of Week	Weekday	129	197.2	195.3	17.2	5	1,440	15	60	150	275	465	525	670	735
Day Of Week	Weekend	124	225.8	174.3	15.6	5	690	20	85	180	310	480	600	690	690
Season	Winter	31	196.6	165.5	29.7	5	585	5	60	165	280	440	550	585	585
Season	Spring	75	198.9	161.7	18.7	5	690	25	75	180	270	465	545	670	690
Season	Summer	102	228.2	204.2	20.2	5	1,440	30	75	180	325	459	585	690	690
Season	Fall	45	203.5	193.8	28.9	5	735	20	60	120	330	505	574	735	735
Asthma	No	232	208.2	187.7	12.3	5	1,440	20	60	159	294	480	585	690	690
Asthma	Yes	19	250.2	166.6	38.2	15	570	15	80	255	350	525	570	570	570
Asthma	DK	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195
Angina	No	245	206.8	184.9	11.8	5	1,440	20	60	160	288	480	570	670	690
Angina	Yes	6	399.2	151.2	61.7	285	690	285	310	345	420	690	690	690	690
Angina	DK	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195
Bronchitis/Emphysema	No	238	212.2	189.2	12.3	5	1,440	20	60	165	300	495	585	690	690
Bronchitis/Emphysema	Yes	13	196.3	122.2	33.9	5	370	5	117	160	310	340	370	370	370
Bronchitis/Emphysema	DK	2	187.5	10.6	7.5	180	195	180	180	188	195	195	195	195	195

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Active Sport

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,384	124.0	112.8	3.0	1	1,130	15	50	90	165	267	330	435	525
Sex	Male	753	136.8	120.8	4.4	1	1,130	20	60	105	180	285	375	500	558
Sex	Female	629	108.6	100.6	4.0	1	1,065	15	38	75	150	240	300	370	435
Sex	Refused	2	142.5	38.9	27.5	115	170	115	115	143	170	170	170	170	170
Age (years)	-	23	108.7	78.6	16.4	5	290	30	40	90	155	220	225	290	290
Age (years)	1 to 4	105	115.8	98.9	9.6	10	630	30	45	90	159	250	330	345	390
Age (years)	5 to 11	247	148.9	126.6	8.1	2	975	20	60	120	188	320	390	510	558
Age (years)	12 to 17	215	137.5	124.5	8.5	5	1,065	15	60	110	180	265	375	470	520
Age (years)	18 to 64	642	120.3	110.4	4.4	1	1,130	15	45	90	160	250	330	450	525
Age (years)	>64	152	88.0	80.2	6.5	1	380	15	30	60	120	220	285	315	330
Race	White	1,139	126.0	116.2	3.4	1	1,130	15	50	90	165	270	340	452	530
Race	Black	109	113.4	96.8	9.3	5	440	10	45	86	150	240	332	430	435
Race	Asian	30	89.9	79.2	14.5	5	310	10	30	60	145	215	235	310	310
Race	Some Others	35	135.4	112.2	19.0	15	553	20	60	105	195	270	330	553	553
Race	Hispanic	59	116.3	91.3	11.9	1	520	15	45	115	145	240	305	345	520
Race	Refused	12	120.0	86.6	25.0	40	300	40	60	95	130	290	300	300	300
Hispanic	No	1,250	124.5	113.5	3.2	1	1,130	15	45	90	165	270	330	435	515
Hispanic	Yes	120	121.2	110.8	10.1	1	630	15	50	90	148	240	335	520	553
Hispanic	DK	4	113.8	57.5	28.8	60	185	60	68	105	160	185	185	185	185
Hispanic	Refused	10	102.0	72.1	22.8	40	290	40	60	83	105	215	290	290	290
Employment	-	561	137.1	120.8	5.1	2	1,065	20	60	110	180	285	370	452	558
Employment	Full Time	375	117.6	107.3	5.5	5	1,130	20	45	90	155	240	305	380	525
Employment	Part Time	87	116.2	87.6	9.4	1	450	15	60	95	160	235	285	355	450
Employment	Not Employed	352	112.5	110.0	5.9	1	600	10	30	70	150	270	330	475	520
Employment	Refused	9	99.4	77.2	25.7	30	280	30	45	90	120	280	280	280	280
Education	-	610	137.7	121.2	4.9	2	1,065	20	60	110	180	285	370	470	558
Education	< High School	86	101.0	99.7	10.8	10	570	15	30	60	135	225	270	510	570
Education	High School Graduate	233	116.8	116.8	7.7	1	1,130	20	45	85	150	240	300	420	530
Education	< College	178	115.8	100.3	7.5	1	525	15	45	90	160	270	340	418	475
Education	College Graduate	165	116.2	97.9	7.6	1	600	15	50	90	150	250	310	380	450
Education	Post Graduate	112	106.4	97.9	9.2	5	375	10	40	60	143	270	330	360	375
Census Region	Northeast	333	132.0	129.1	7.1	1	1,130	15	60	100	170	275	345	485	558
Census Region	Midwest	254	116.9	101.9	6.4	5	570	18	45	90	150	255	315	430	440
Census Region	South	479	119.5	108.7	5.0	1	975	15	45	90	160	265	330	410	462
Census Region	West	318	128.1	108.8	6.1	1	625	25	55	93	175	295	330	500	525
Day Of Week	Weekday	902	115.5	97.8	3.3	1	650	15	45	90	150	240	300	395	485
Day Of Week	Weekend	482	139.9	135.2	6.2	1	1,130	20	59	100	180	300	380	500	565
Season	Winter	316	115.6	115.2	6.5	1	1,065	15	45	85	155	240	305	370	475
Season	Spring	423	130.8	105.0	5.1	5	650	30	60	105	175	270	330	435	515
Season	Summer	425	129.5	115.1	5.6	1	625	15	45	95	178	290	375	462	530
Season	Fall	220	112.3	118.3	8.0	1	1,130	15	43	78	144	240	290	460	565
Asthma	No	1,266	122.5	109.6	3.1	1	1,130	15	45	90	162	266	330	430	515
Asthma	Yes	105	144.8	145.8	14.2	1	1,065	15	60	110	180	300	390	553	565
Asthma	DK	13	105.0	110.4	30.6	30	450	30	60	60	90	165	450	450	450
Angina	No	1,343	125.5	113.6	3.1	1	1,130	15	50	90	165	270	332	440	525
Angina	Yes	33	72.1	74.0	12.9	5	330	5	30	50	60	180	275	330	330
Angina	DK	8	86.9	41.1	14.5	40	155	40	60	75	115	155	155	155	155
Bronchitis/Emphysema	No	1,331	124.1	113.2	3.1	1	1,130	15	50	90	165	267	330	435	520
Bronchitis/Emphysema	Yes	43	130.0	112.7	17.2	10	553	30	45	110	165	270	340	553	553
Bronchitis/Emphysema	DK	10	84.0	39.8	12.6	40	155	40	60	75	105	148	155	155	155

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Exercise

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		564	77.4	70.4	3.0	4	670	15	30	60	100	150	195	275	420
Sex	Male	262	84.7	75.8	4.7	5	670	20	30	60	117	165	205	285	450
Sex	Female	302	71.1	64.9	3.7	4	525	15	30	60	90	125	175	265	360
Age (years)	-	10	76.5	74.0	23.4	15	270	15	30	60	90	188	270	270	270
Age (years)	1 to 4	11	127.3	187.2	56.4	15	670	15	30	60	150	160	670	670	670
Age (years)	5 to 11	26	132.5	126.3	24.8	15	525	25	60	90	180	275	450	525	525
Age (years)	12 to 17	35	67.8	41.6	7.0	15	180	20	30	60	100	120	150	180	180
Age (years)	18 to 64	407	77.6	63.6	3.2	4	480	20	30	60	100	145	185	265	300
Age (years)	>64	75	54.9	44.5	5.1	6	195	10	25	40	70	120	150	193	195
Race	White	480	78.0	71.5	3.3	4	670	15	30	60	100	150	194	285	450
Race	Black	34	74.7	44.7	7.7	15	250	15	45	60	105	120	130	250	250
Race	Asian	10	46.3	25.0	7.9	15	95	15	30	42	60	83	95	95	95
Race	Some Others	14	80.2	73.9	19.8	30	275	30	30	48	90	179	275	275	275
Race	Hispanic	19	63.0	60.7	13.9	15	265	15	30	45	60	160	265	265	265
Race	Refused	7	128.6	130.5	49.3	30	360	30	55	60	270	360	360	360	360
Hispanic	No	516	76.9	70.1	3.1	4	670	15	30	60	99	145	193	275	420
Hispanic	Yes	38	76.6	59.5	9.7	15	265	20	30	60	110	160	250	265	265
Hispanic	DK	3	65.0	69.5	40.1	20	145	20	20	30	145	145	145	145	145
Hispanic	Refused	7	128.6	130.5	49.3	30	360	30	55	60	270	360	360	360	360
Employment	-	72	99.0	111.6	13.2	15	670	20	30	60	120	180	275	525	670
Employment	Full Time	300	72.7	55.6	3.2	5	460	20	30	60	90	130	180	240	291
Employment	Part Time	50	86.0	83.6	11.8	10	420	20	30	60	92	168	300	390	420
Employment	Not Employed	139	72.7	63.4	5.4	4	480	10	30	60	90	135	195	240	265
Employment	Refused	3	113.3	135.8	78.4	30	270	30	30	40	270	270	270	270	270
Education	-	83	102.0	111.0	12.2	15	670	25	30	60	120	205	275	525	670
Education	< High School	21	58.2	66.1	14.4	10	300	10	28	30	60	90	165	300	300
Education	High School Graduate	124	81.0	63.0	5.7	4	298	15	30	60	115	179	205	250	265
Education	< College	104	80.9	70.2	6.9	15	480	20	30	60	113	150	170	240	420
Education	College Graduate	110	73.6	62.5	6.0	5	460	20	30	60	98	130	180	285	297
Education	Post Graduate	122	60.9	38.4	3.5	5	240	15	30	60	80	110	127	165	185
Census Region	Northeast	130	88.4	77.6	6.8	10	450	15	30	60	120	200	240	297	420
Census Region	Midwest	101	63.6	44.3	4.4	10	300	15	30	60	89	115	120	170	215
Census Region	South	177	75.3	71.6	5.4	5	525	15	30	60	90	150	185	298	480
Census Region	West	156	79.6	75.3	6.0	4	670	20	30	60	104	130	183	270	460
Day Of Week	Weekday	426	73.1	63.9	3.1	4	670	15	30	60	90	130	180	240	298
Day Of Week	Weekend	138	90.8	86.6	7.4	6	525	15	30	60	120	200	265	420	460
Season	Winter	150	67.4	49.9	4.1	8	285	15	30	60	90	128	175	213	240
Season	Spring	140	74.9	55.4	4.7	10	360	18	30	60	90	148	181	220	298
Season	Summer	192	93.2	91.3	6.6	5	670	20	30	63	120	180	250	450	525
Season	Fall	82	63.3	63.3	7.0	4	460	15	30	45	75	120	135	300	460
Asthma	No	523	76.6	70.2	3.1	4	670	15	30	60	100	150	185	265	420
Asthma	Yes	37	78.2	51.5	8.5	20	275	20	45	65	100	120	200	275	275
Asthma	DK	4	175.0	167.0	83.5	10	360	10	35	165	315	360	360	360	360
Angina	No	553	77.3	69.4	2.9	4	670	15	30	60	100	145	193	265	420
Angina	Yes	7	27.3	19.6	7.4	6	60	6	10	25	45	60	60	60	60
Angina	DK	4	188.8	150.4	75.2	60	360	60	63	168	315	360	360	360	360
Bronchitis/Emphysema	No	542	77.1	69.5	3.0	4	670	15	30	60	100	145	185	265	420
Bronchitis/Emphysema	Yes	17	64.6	60.6	14.7	10	275	10	30	50	63	120	275	275	275
Bronchitis/Emphysema	DK	5	157.0	149.6	66.9	15	360	15	60	80	270	360	360	360	360

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Walking

								Percentiles							
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,639	29.7	41.6	1.0	1	540	2	6	16	39	65	95	151	190
Sex	Male	755	32.5	48.3	1.8	1	540	2	7	20	40	70	100	170	270
Sex	Female	883	27.3	34.8	1.2	1	360	2	6	15	35	60	94	140	171
Sex	Refused	1	20.0	-	-	20	20	20	20	20	20	20	20	20	20
Age (years)	-	38	29.5	23.7	3.9	1	100	2	10	25	40	60	80	100	100
Age (years)	1 to 4	58	24.3	26.3	3.5	1	160	2	10	15	35	60	60	70	160
Age (years)	5 to 11	155	18.2	21.0	1.7	1	170	1	5	10	25	40	60	65	100
Age (years)	12 to 17	223	25.8	32.4	2.2	1	190	2	6	15	30	60	100	135	151
Age (years)	18 to 64	944	31.8	45.0	1.5	1	410	2	6	19	40	70	110	171	250
Age (years)	>64	221	33.8	49.3	3.3	1	540	2	10	20	45	73	95	155	180
Race	White	1,289	29.6	43.7	1.2	1	540	2	6	15	35	65	100	160	225
Race	Black	175	34.8	39.7	3.0	1	250	2	10	20	50	75	125	160	194
Race	Asian	36	26.6	24.7	4.1	1	100	1	10	20	30	60	78	100	100
Race	Some Others	30	23.8	21.2	3.9	1	60	1	6	17	43	60	60	60	60
Race	Hispanic	88	23.1	21.1	2.2	1	100	2	6	15	37	50	60	92	100
Race	Refused	21	33.2	33.0	7.2	4	150	8	15	20	40	65	65	150	150
Hispanic	No	1,467	29.9	41.0	1.1	1	410	2	6	16	40	65	100	155	194
Hispanic	Yes	144	26.8	48.7	4.1	1	540	2	6	15	35	60	70	100	135
Hispanic	DK	10	30.2	28.8	9.1	2	80	2	10	18	55	78	80	80	80
Hispanic	Refused	18	35.7	34.8	8.2	8	150	8	15	25	55	65	150	150	150
Employment	-	431	22.8	28.0	1.3	1	190	2	5	13	30	55	65	131	151
Employment	Full Time	561	31.0	43.8	1.8	1	365	2	7	16	40	70	100	180	250
Employment	Part Time	153	26.9	37.1	3.0	1	295	2	5	15	35	60	92	135	165
Employment	Not Employed	482	35.5	49.4	2.3	1	540	2	10	20	50	75	120	150	250
Employment	Refused	12	18.4	13.5	3.9	5	55	5	10	17	20	30	55	55	55
Education	-	472	22.7	27.6	1.3	1	190	2	5	13	30	55	65	130	151
Education	< High School	138	42.7	71.9	6.1	1	540	3	7	20	50	115	145	360	365
Education	High School Graduate	366	29.3	41.6	2.2	1	410	2	5	18	35	65	100	150	240
Education	< College	288	32.5	39.3	2.3	1	295	2	10	20	45	75	100	160	180
Education	College Graduate	210	29.8	38.8	2.7	1	300	2	8	19	40	60	90	140	225
Education	Post Graduate	165	34.6	44.6	3.5	1	360	2	10	20	45	80	95	180	200
Census Region	Northeast	507	34.9	45.3	2.0	1	365	2	10	20	45	75	107	170	250
Census Region	Midwest	321	29.3	46.9	2.6	1	540	2	6	15	31	60	105	160	180
Census Region	South	423	25.0	37.7	1.8	1	410	2	5	10	30	60	80	135	171
Census Region	West	388	28.2	35.0	1.8	1	285	2	8	15	40	60	90	140	180
Day Of Week	Weekday	1,182	29.3	39.2	1.1	1	540	2	7	18	40	65	92	145	180
Day Of Week	Weekend	457	30.7	47.4	2.2	1	410	2	5	15	35	60	120	171	200
Season	Winter	412	32.3	47.7	2.4	1	365	2	6	20	39	75	120	180	250
Season	Spring	459	28.9	41.5	1.9	1	540	2	6	16	35	60	90	146	180
Season	Summer	475	26.6	31.3	1.4	1	270	2	6	15	35	60	85	123	160
Season	Fall	293	32.2	46.7	2.7	1	410	2	8	20	45	61	105	155	295
Asthma	No	1,504	29.6	42.0	1.1	1	540	2	6	16	36	65	95	152	190
Asthma	Yes	120	29.7	38.3	3.5	1	250	2	5	15	40	70	118	135	150
Asthma	DK	15	36.2	27.8	7.2	5	90	5	10	30	60	75	90	90	90
Angina	No	1,578	29.5	41.5	1.0	1	540	2	6	16	38	65	95	151	190
Angina	Yes	44	29.0	36.1	5.4	2	150	4	6	15	36	60	115	150	150
Angina	DK	17	46.6	63.1	15.3	5	270	5	10	30	60	90	270	270	270
Bronchitis/Emphysema	No	1,553	29.7	42.1	1.1	1	540	2	6	16	38	65	95	151	194
Bronchitis/Emphysema	Yes	67	27.0	31.9	3.9	1	165	2	5	16	40	60	90	130	165
Bronchitis/Emphysema	DK	19	35.4	31.4	7.2	3	110	3	10	30	60	90	110	110	110

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

Housekeeping[a]

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		1,943	118.8	113.4	2.6	1	810	10	40	90	165	270	345	465	540
Sex	Male	370	109.4	116.5	6.1	1	810	10	30	60	150	270	360	425	560
Sex	Female	1,573	121.0	112.5	2.8	1	790	15	45	90	165	270	345	465	540
Age (years)	-	47	146.0	121.3	17.7	10	480	10	45	115	240	300	375	480	480
Age (years)	1 to 4	11	74.1	69.4	20.9	10	270	10	40	60	90	90	270	270	270
Age (years)	5 to 11	54	42.9	34.1	4.6	1	180	5	20	30	53	80	120	150	180
Age (years)	12 to 17	72	78.1	75.5	8.9	1	300	5	28	60	105	210	240	285	300
Age (years)	18 to 64	1,316	120.4	113.7	3.1	1	810	15	40	90	165	270	360	465	525
Age (years)	>64	443	128.2	118.9	5.7	3	790	10	55	90	180	270	345	540	570
Race	White	1,649	119.1	112.2	2.8	1	790	10	40	90	165	265	340	465	540
Race	Black	137	116.6	109.4	9.3	1	490	5	30	90	150	300	358	480	484
Race	Asian	32	98.8	100.5	17.8	15	425	15	30	60	128	265	345	425	425
Race	Some Others	26	82.4	56.4	11.1	5	210	15	40	60	115	185	190	210	210
Race	Hispanic	71	112.6	129.3	15.3	5	660	8	30	60	135	270	465	518	660
Race	Refused	28	189.3	176.2	33.3	10	810	20	53	148	248	420	465	810	810
Hispanic	No	1,771	117.4	110.6	2.6	1	790	10	40	90	165	265	335	425	525
Hispanic	Yes	134	121.7	129.6	11.2	5	660	10	35	85	135	270	470	540	658
Hispanic	DK	15	146.9	127.9	33.0	10	510	10	30	120	210	240	510	510	510
Hispanic	Refused	23	191.1	180.3	37.6	10	810	20	45	150	255	390	420	810	810
Employment	-	138	65.6	68.8	5.9	1	375	5	25	45	80	180	240	285	300
Employment	Full Time	673	106.6	102.4	3.9	1	655	10	30	70	145	240	325	413	490
Employment	Part Time	193	124.7	117.5	8.5	1	660	15	45	90	180	270	390	480	540
Employment	Not Employed	925	132.7	119.4	3.9	3	790	15	55	105	180	295	370	484	600
Employment	Refused	14	236.8	208.2	55.6	10	810	10	120	183	300	430	810	810	810
Education	-	171	82.2	96.9	7.4	1	810	5	30	45	105	220	270	300	375
Education	< High School	246	140.7	125.4	8.0	3	715	10	60	120	180	300	400	540	660
Education	High School Graduate	677	125.1	120.5	4.6	2	790	15	45	90	175	270	375	490	610
Education	< College	433	112.9	100.1	4.8	1	570	10	40	90	150	240	320	420	470
Education	College Graduate	245	107.3	102.2	6.5	1	585	15	30	60	150	240	328	405	465
Education	Post Graduate	171	130.8	118.0	9.0	5	655	15	60	90	180	280	390	495	540
Census Region	Northeast	464	119.2	116.4	5.4	2	790	10	35	90	165	245	330	480	655
Census Region	Midwest	413	117.9	112.6	5.5	1	715	10	34	88	165	255	345	480	525
Census Region	South	648	119.9	116.2	4.6	1	810	10	40	90	165	285	370	435	540
Census Region	West	418	117.7	106.6	5.2	5	720	15	40	90	165	255	340	420	470
Day Of Week	Weekday	1,316	113.2	111.9	3.1	1	790	10	30	75	150	255	330	470	550
Day Of Week	Weekend	627	130.6	115.6	4.6	1	810	15	55	90	180	290	370	435	525
Season	Winter	470	111.4	100.6	4.6	1	810	10	45	85	160	240	290	390	480
Season	Spring	451	122.6	114.0	5.4	3	720	15	40	90	180	270	360	465	540
Season	Summer	563	111.8	114.5	4.8	1	690	10	30	75	135	255	365	465	610
Season	Fall	459	131.3	122.4	5.7	1	790	15	45	90	180	300	390	480	560
Asthma	No	1,789	118.5	112.1	2.6	1	790	10	40	90	165	270	345	465	540
Asthma	Yes	140	115.7	115.8	9.8	5	690	10	37	67	150	278	378	470	480
Asthma	DK	14	189.3	208.6	55.7	10	810	10	45	123	255	340	810	810	810
Angina	No	1,853	117.7	112.3	2.6	1	790	13	40	90	160	265	345	465	540
Angina	Yes	75	122.9	103.8	12.0	5	394	5	30	90	210	270	320	370	394
Angina	DK	15	234.7	204.0	52.7	10	810	10	120	240	300	480	810	810	810
Bronchitis/Emphysema	No	1,816	118.1	112.9	2.7	1	790	10	40	90	160	270	355	465	540
Bronchitis/Emphysema	Yes	107	118.7	102.9	10.0	5	480	10	30	90	180	255	290	465	470
Bronchitis/Emphysema	DK	20	188.5	176.4	39.5	5	810	8	85	155	240	320	575	810	810

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)																
Yardwork/Maintenance[b]																
								Percentiles								
Category	Population Group	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		1,414	147.7	148.2	3.9	1	1,080	5	45	100	205	360	470	570	655
Sex	Male	804	174.8	160.2	5.6	2	1,080	10	60	120	250	415	510	600	670
Sex	Female	610	111.9	122.0	4.9	1	900	5	30	75	145	278	360	465	510
Age (years)	-	20	181.9	170.3	38.1	5	600	10	60	116	240	468	570	600	600
Age (years)	1 to 4	12	93.2	80.8	23.3	5	285	5	30	83	133	178	285	285	285
Age (years)	5 to 11	26	96.2	85.5	16.8	5	330	5	39	60	120	210	300	330	330
Age (years)	12 to 17	54	116.0	116.8	15.9	3	505	5	30	90	150	285	385	450	505
Age (years)	18 to 64	1,015	150.2	154.5	4.8	1	1,080	5	35	100	210	360	480	585	670
Age (years)	>64	287	149.3	133.8	7.9	2	810	10	60	120	205	330	420	525	630
Race	White	1,249	151.5	150.2	4.3	1	1,080	5	45	105	210	360	480	575	660
Race	Black	77	114.5	127.1	14.5	2	750	5	20	65	165	285	355	405	750
Race	Asian	13	140.0	150.1	41.6	5	425	5	15	85	210	360	425	425	425
Race	Some Others	26	117.2	110.6	21.7	5	380	5	30	88	178	290	360	380	380
Race	Hispanic	37	102.1	113.5	18.7	5	565	5	20	60	120	255	300	565	565
Race	Refused	12	177.1	190.8	55.1	30	600	30	60	98	215	510	600	600	600
Hispanic	No	1,331	148.7	148.0	4.1	1	1,080	5	45	105	209	360	465	570	660
Hispanic	Yes	65	106.2	127.4	15.8	5	575	5	20	60	120	255	300	565	575
Hispanic	DK	8	248.8	206.5	73.0	5	585	5	90	190	420	585	585	585	585
Hispanic	Refused	10	203.5	200.1	63.3	60	600	60	60	120	300	555	600	600	600
Employment	-	92	106.8	101.8	10.6	3	505	5	32	77	148	240	330	450	505
Employment	Full Time	664	146.7	155.5	6.0	1	1,080	5	35	90	203	360	490	575	690
Employment	Part Time	121	134.5	130.8	11.9	2	554	5	30	90	200	317	390	490	495
Employment	Not Employed	526	157.8	147.0	6.4	2	810	10	60	120	220	370	480	595	655
Employment	Refused	11	211.6	198.7	59.9	2	600	2	60	120	375	465	600	600	600
Education	-	105	113.5	113.9	11.1	2	600	5	33	79	150	285	360	450	505
Education	< High School	160	158.5	164.8	13.0	2	900	8	45	111	210	413	493	595	810
Education	High School Graduate	465	151.4	147.0	6.8	3	840	5	50	110	210	345	460	575	690
Education	< College	305	152.8	157.0	9.0	2	1,080	5	45	95	210	360	473	600	630
Education	College Graduate	211	145.4	138.8	9.6	1	625	5	40	105	225	330	465	525	533
Education	Post Graduate	168	142.2	147.8	11.4	2	690	5	30	90	180	340	470	570	630
Census Region	Northeast	291	140.5	139.6	8.2	3	840	5	40	90	200	330	450	525	600
Census Region	Midwest	314	145.1	143.2	8.1	2	780	10	55	95	195	360	445	560	655
Census Region	South	438	152.7	156.4	7.5	2	1,080	5	45	111	205	375	480	585	635
Census Region	West	371	149.6	149.3	7.8	1	750	5	40	104	210	350	480	575	690
Day Of Week	Weekday	878	140.9	140.8	4.8	1	810	5	40	93	190	345	460	560	625
Day Of Week	Weekend	536	158.9	159.2	6.9	2	1,080	5	50	117	225	380	510	600	690
Season	Winter	289	139.4	151.7	8.9	1	690	5	30	75	195	360	480	565	600
Season	Spring	438	162.2	150.5	7.2	3	900	10	60	120	220	360	480	570	700
Season	Summer	458	137.9	140.3	6.6	2	1,080	5	40	90	180	310	440	555	630
Season	Fall	229	150.0	153.4	10.1	2	720	5	40	97	210	390	480	600	655
Asthma	No	1,311	147.0	147.1	4.1	1	1,080	5	45	100	200	355	465	570	635
Asthma	Yes	98	149.3	155.8	15.7	5	670	5	30	90	210	445	480	670	670
Asthma	DK	5	312.0	230.0	102.9	60	600	60	120	300	480	600	600	600	600
Angina	No	1,360	145.3	145.1	3.9	1	900	5	45	100	200	355	465	570	655
Angina	Yes	42	192.6	203.4	31.4	5	1,080	15	60	143	255	465	485	1,080	1,080
Angina	DK	12	257.1	216.7	62.6	5	600	5	53	233	473	510	600	600	600
Bronchitis/Emphysema	No	1,352	148.5	148.5	4.0	1	1,080	5	45	105	205	360	470	570	660
Bronchitis/Emphysema	Yes	57	114.7	121.4	16.1	5	460	5	30	60	135	340	375	405	460
Bronchitis/Emphysema	DK	5	312.0	230.0	102.9	60	600	60	120	300	480	600	600	600	600

Table 16-26. Time Spent (minutes/day) in Selected Activities, Doers Only (continued)

-	= Indicates missing data.
DK	= The respondent replied "don't know".
Refused	= Refused data.
N	= Doer sample size.
SD	= Standard deviation.
SE	= Standard error.
Min	= Minimum number of minutes.
Max	= Maximum number of minutes.

[a] Includes cleaning house, other repairs, and household work.

[b] Includes car repair services, other repairs services, outdoor cleaning, car repair maintenance, other repairs, plant care, other household work, domestic crafts, domestic arts.

Source: U.S. EPA, 1996.

Table 16-27. Number of Showers Taken per Day, by Children <21 Years

Age (years)	*N*	Showers per Day				
		0	1	2	3	Don't Know
Birth to <1	37	36	1	0	0	0
1 to <2	53	48	5	0	0	0
2 to <3	67	54	10	2	0	1
3 to <6	187	153	25	7	1	1
6 to <11	245	122	95	25	1	2
11 to <16	258	51	150	53	3	1
16 to <21	232	23	147	57	5	0

N = Number of respondents.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-28. Time Spent (minutes) Bathing, Showering, and in Bathroom Immediately After Bathing and Showering, Children <21 Years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Duration of Bath (minutes)															
Birth to <1	26	19	5	5	5	6	8	10	18	28	30	30	45	53	60
1 to <2	37	23	10	10	10	10	10	15	20	30	30	32	41	43	45
2 to <3	48	23	1	2.9	5	7	10	15	20	30	30	45	60	60	60
3 to <6	125	24	5	5	5	6	10	15	25	30	35	60	60	61	61
6 to <11	89	24	5	5	5	10	10	15	20	30	31	46	60	60	61
11 to <16	38	25	5	6	6	10	10	16	20	30	40	43	60	61	61
16 to <21	17	33	10	11	12	14	18	20	30	45	60	60	61	61	61
Duration in Bathroom Immediately Following a Bath (minutes)															
Birth to <1	26	2	0	0	0	0	0	0	1	3	9	10	10	10	10
1 to <2	37	3	0	0	0	0	0	1	2	5	5	6	10	10	10
2 to <3	48	4	0	0	0	0	0	0	1.5	5	10	15	15	18	20
3 to <6	125	4	0	0	0	0	0	1	2	5	10	15	15	19	30
6 to <11	89	4	0	0	0	0	0	1	3	5	10	10	16	21	30
11 to <16	38	9	0	0	0	1	1	2	5	14	20	26	33	36	40
16 to <21	17	11	0	0	1	2	3	5	10	10	19	29	39	42	45
Sum of Duration in Bath and in Bathroom Immediately Following Bath (minutes)															
Birth to <1	26	22	6	7	8	9	10	12	19	29	32	38	55	63	70
1 to <2	37	26	10	10	11	12	16	17	30	32	35	41	46	48	50
2 to <3	48	26	6	7	8	10	14	16	23	34	45	50	60	61	61
3 to <6	125	28	5	6	7	10	12	18	30	32	48	60	66	69	76
6 to <11	89	28	6	6	9	10	13	20	25	33	41	60	63	71	80
11 to <16	38	33	7	8	10	12	16	23	31	41	52	64	70	70	70
16 to <21	17	45	15	15	16	17	21	30	40	60	73	77	82	83	85
Duration of Shower (minutes)															
Birth to <1	1	15	15	-	-	-	-	-	-	-	-	-	-	-	15
1 to <2	5	20	5	-	-	-	-	-	-	-	-	-	-	-	30
2 to <3	12	22	5	5	5	5	6	14	20	30	30	44	53	57	60
3 to <6	33	17	3	4	4	5	5	10	15	20	30	34	47	54	60
6 to <11	119	18	4	5	5	5	7	10	15	20	30	41	57	60	60
11 to <16	204	18	3	4	5	5	6	10	15	20	30	40	50	60	60
16 to <21	207	20	3	5	5	5	8	10	15	30	40	45	60	60	61
Duration in Shower Room Immediately Following a Shower (minutes)															
Birth to <1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1
1 to <2	5	10	0	-	-	-	-	-	-	-	-	-	-	-	45
2 to <3	12	5	0	0	0	1	1	1	4	6	10	12	14	14	15
3 to <6	33	7	0	0	1	2	2	3	5	10	15	20	22	23	25
6 to <11	119	6	0	0	0	0	1	2	5	10	13	16	26	30	30
11 to <16	204	8	0	0	0	0	1	3	5	10	19	30	40	45	60
16 to <21	207	8	0	0	0	0	1	3	5	10	15	20	30	39	61

Table 16-28. Time Spent (minutes) Bathing, Showering, and in Bathroom Immediately After Bathing and Showering, Children <21 Years (continued)

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Sum of Shower Duration and Time Spent in Shower Room Immediately Following Shower (minutes)															
Birth to <1	1	16	16	-	-	-	-	-	-	-	-	-	-	-	16
1 to <2	5	30	6	-	-	-	-	-	-	-	-	-	-	-	60
2 to <3	12	27	6	6	7	8	11	19	21	33	44	56	65	67	70
3 to <6	33	24	8	8	8	8	8	13	25	30	40	45	57	64	70
6 to <11	119	24	5	6	6	8	10	15	20	30	43	50	61	68	90
11 to <16	204	26	4	5	7	10	11	15	22	35	50	60	65	70	70
16 to <21	207	28	4	5	7	10	10	15	25	35	50	60	74	89	121

N = Doer sample size.
Min = Minimum.
Max = Maximum.
- = Percentiles were not calculated for sample sizes less than 10.
Note: A value of "61" was used for any shower, bath, or bathroom stay longer than 60 minutes. A value of "121" for the sum of shower duration and time spent in bathroom following shower (or the sum of bath duration and time spent in bathroom following bath) signifies that more than 120 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-29. Mean Time Spent (minutes/day) and Bathing/Showering, Adults 18 Years and Older, Doers Only

Age (years)	Mean No. Baths/Showers per Day[a]	Median Time Spent in Shower/Bath[b] (minutes/bath)	Time Spent in Shower/Bath[c] (minutes/day)
18 to 64	1.27	13.5	17.1
>64	1.14	15.0	17.1

[a] For additional statistics see Table 16-30. Calculated by averaging the reported number of baths/showers taken per day (truncated at 11), by the number of respondents. Respondents responding Missing and Don't Know were excluded (*N* = 5).
[b] For additional statistics see Table 16-31.
[c] Calculated by multiplying the mean number of showers/baths per day by the median time spent in shower/bath.

Source: U.S. EPA, 1996.

Table 16-30. Number of Times Respondent Took Shower or Bathed, Doers Only

Group Name	N	-	1	2	3	4	5	8	10	11+	DK
All	3,594	2	2,747	802	30	1	1	1	1	4	5
Sex											
Male	1,720	-	1,259	436	21	1	-	-	-	1	2
Female	1,872	2	1,486	366	9	-	1	1	1	3	3
Refused	2	-	2	-	-	-	-	-	-	-	-
Age (years)											
-	64	-	46	17	-	-	-	-	-	-	1
1 to 4	41	-	30	9	1	-	-	-	-	-	1
5 to 11	140	-	112	26	1	-	-	-	-	-	1
12 to 17	270	-	199	65	6	-	-	-	-	-	-
18 to 64	2,650	1	1,983	636	21	-	-	-	-	3	2
>64	429	1	377	49	1	-	-	-	-	1	-
Race											
White	2,911	2	2,323	562	17	-	1	-	-	4	2
Black	349	-	199	140	7	1	-	1	-	-	1
Asian	64	-	49	14	1	-	-	-	-	-	-
Some Others	65	-	40	23	2	-	-	-	-	-	-
Hispanic	162	-	103	56	2	-	-	-	1	-	-
Refused	43	-	33	7	1	-	-	-	-	-	2
Hispanic											
No	3,269	2	2,521	711	24	1	1	1	-	4	4
Yes	277	-	190	81	5	-	-	-	1	-	-
DK	17	-	13	4	-	-	-	-	-	-	-
Refused	31	-	23	6	1	-	-	-	-	-	1
Employment											
-	439	-	330	99	8	-	-	-	-	-	2
Full Time	1,838	1	1,361	454	17	-	-	-	1	2	2
Part Time	328	1	261	65	-	-	1	-	-	-	-
Not Employed	967	-	780	177	5	1	-	1	-	2	1
Refused	22	-	15	7	-	-	-	-	-	-	-
Education											
-	515	-	382	121	9	-	-	-	-	-	3
< High School	297	-	240	54	2	-	-	-	-	1	-
High School Graduate	1,042	1	789	243	5	-	1	1	-	1	1
< College	772	1	589	176	4	-	-	-	1	-	1
College Graduate	576	-	434	133	7	1	-	-	-	1	-
Post Graduate	392	-	313	75	3	-	-	-	-	1	-
Census Region											
Northeast	828	-	622	196	7	-	-	-	-	-	3
Midwest	756	-	621	131	3	-	-	-	-	-	1
South	1,246	1	893	334	14	1	-	-	-	3	-
West	764	1	611	141	6	-	1	1	1	1	1
Day Of Week											
Weekday	2,481	-	1,889	563	17	1	1	1	1	4	4
Weekend	1,113	2	858	239	13	-	-	-	-	-	1
Season											
Winter	941	-	732	198	9	-	-	-	-	1	1
Spring	889	-	674	205	7	-	-	-	1	-	2
Summer	1,003	-	735	254	10	1	-	-	-	2	1
Fall	761	2	606	145	4	-	1	1	-	1	1
Asthma											
No	3,312	2	2,543	730	25	1	1	1	1	4	4
Yes	261	-	189	67	5	-	-	-	-	-	-
DK	21	-	15	5	-	-	-	-	-	-	1
Angina											
No	3,481	1	2,653	730	25	1	1	1	1	4	4
Yes	261	-	189	67	5	-	-	-	-	-	-
DK	22	-	17	4	-	-	-	-	-	-	1

Table 16-30. Number of Times Respondent Took Shower or Bathed, Doers Only (continued)

Group Name	*N*	-	1	2	3	4	5	8	10	11+	DK
Bronchitis/Emphysema											
No	3,419	2	2,620	758	27	1	1	1	1	4	4
Yes	154	-	112	39	3	-	-	-	-	-	-
DK	21	-	15	5	-	-	-	-	-	-	1

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-31. Time Spent (minutes/day) Bathing and Showering, Doers Only [a]

								Percentiles							
Group Name	Group Code	*N*	Mean	SD	SE	Min	Max	5	25	50	75	90	95	98	99
All		6,416	26.1	29.7	0.4	1	705	5	10	20	30	50	60	90	120
Sex	Male	2,930	24.2	31.0	0.6	1	705	5	10	20	30	45	60	75	100
Sex	Female	3,484	27.6	28.4	0.5	1	555	5	10	20	30	60	75	105	135
Sex	Refused	2	20.0	14.1	10.0	10	30	10	10	20	30	30	30	30	30
Age (years)	-	114	29.0	39.0	3.7	2	300	5	10	20	30	60	60	105	275
Age (years)	1 to 4	330	30.0	19.4	1.1	1	170	10	15	30	31	55	60	85	90
Age (years)	5 to 11	438	25.8	35.3	1.7	1	690	5	15	20	30	45	60	60	75
Age (years)	12 to 17	444	23.1	18.7	0.9	1	210	5	10	18	30	45	60	65	90
Age (years)	18 to 64	4,383	25.4	27.2	0.4	1	555	5	10	20	30	50	60	90	120
Age (years)	>64	707	29.9	44.5	1.7	1	705	5	10	20	30	60	85	120	150
Race	White	5,117	25.0	28.5	0.4	1	705	5	10	20	30	45	60	90	115
Race	Black	707	31.5	31.6	1.2	1	295	5	15	22	40	60	80	120	170
Race	Asian	112	28.2	29.8	2.8	5	270	5	15	20	30	60	75	90	90
Race	Some Others	122	30.2	27.3	2.5	1	240	8	15	28	35	50	60	100	150
Race	Hispanic	280	28.8	39.3	2.3	2	546	5	15	20	32	55	63	90	155
Race	Refused	78	27.6	40.3	4.6	3	275	5	10	15	30	60	100	195	275
Hispanic	No	5,835	25.9	28.5	0.4	1	705	5	10	20	30	50	60	90	120
Hispanic	Yes	486	28.8	40.6	1.8	2	570	5	15	20	30	50	60	90	140
Hispanic	DK	33	25.8	16.8	2.9	5	65	10	15	20	30	55	65	65	65
Hispanic	Refused	62	24.3	37.2	4.7	3	275	5	10	15	25	30	60	105	275
Employment	-	1,189	26.1	26.4	0.8	1	690	5	15	20	30	45	60	75	90
Employment	Full Time	3,095	24.1	25.1	0.5	1	555	5	10	15	30	45	60	85	110
Employment	Part Time	558	24.8	23.2	1.0	1	295	5	10	20	30	46	60	90	110
Employment	Not Employed	1,528	30.3	39.9	1.0	1	705	5	10	20	30	60	85	120	155
Employment	Refused	46	30.4	45.2	6.7	3	275	5	10	15	30	55	105	275	275
Education	-	1,330	25.7	26.4	0.7	1	690	5	15	20	30	45	60	75	90
Education	< High School	474	33.3	53.0	2.4	1	570	5	15	21	33	60	85	110	300
Education	High School Graduate	1,758	25.8	23.6	0.6	1	270	5	10	20	30	50	60	90	120
Education	< College	1,288	26.4	27.0	0.8	1	255	5	10	20	30	55	75	105	150
Education	College Graduate	897	25.4	34.8	1.2	1	705	5	10	15	30	50	65	105	135
Education	Post Graduate	669	22.8	23.1	0.9	1	257	5	10	15	30	45	60	85	100
Census Region	Northeast	1,444	25.0	24.3	0.6	1	360	5	10	20	30	50	60	90	105
Census Region	Midwest	1,402	24.6	30.3	0.8	1	570	5	10	15	30	45	60	85	115
Census Region	South	2,266	27.4	26.1	0.5	1	300	5	15	20	30	55	65	100	135
Census Region	West	1,304	26.5	38.8	1.1	1	705	5	10	20	30	48	60	90	133
Day Of Week	Weekday	4,427	25.3	30.3	0.5	1	705	5	10	20	30	45	60	90	115
Day Of Week	Weekend	1,989	27.9	28.2	0.6	1	555	5	15	20	30	60	68	100	130
Season	Winter	1,796	26.9	26.9	0.6	1	546	5	11	20	30	50	60	90	110
Season	Spring	1,645	28.6	41.1	1.0	1	705	5	15	20	30	60	70	115	150
Season	Summer	1,744	23.9	20.7	0.5	1	270	5	10	20	30	45	60	80	100
Season	Fall	1,231	24.7	25.6	0.7	1	340	5	10	17	30	50	60	95	120
Asthma	No	5,912	26.1	30.0	0.4	1	705	5	10	20	30	50	60	90	120
Asthma	Yes	468	26.5	23.0	1.1	1	210	5	15	20	30	46	60	100	120
Asthma	DK	36	23.1	44.1	7.3	3	275	5	10	15	25	30	30	275	275
Angina	No	6,243	26.0	29.0	0.4	1	705	5	10	20	30	50	60	90	120
Angina	Yes	131	31.1	49.5	4.3	5	546	5	15	25	30	50	60	105	131
Angina	DK	42	22.2	40.9	6.3	3	275	5	10	15	25	30	30	275	275
Bronchitis/Emphysema	No	6,112	26.1	29.9	0.4	1	705	5	10	20	30	50	60	90	120
Bronchitis/Emphysema	Yes	268	27.2	22.2	1.4	1	150	5	13	20	30	60	60	95	131
Bronchitis/Emphysema	DK	36	22.5	44.1	7.3	3	275	5	10	15	23	30	30	275	275

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

[a] Includes baby and child care, personal care services, washing and personal hygiene (bathing, showering, etc.).

Source: U.S. EPA, 1996.

Table 16-32. Number of Times Washing the Hands at Specified Daily Frequencies, Children <21 Years

Age (years)	*N*	Number of Times/Day							
		0	1–2	3–5	6–9	10–19	20–29	30+	DK
Birth to <1	37	2	15	12	2	1	1	0	4
1 to <2	53	7	8	23	8	4	0	2	1
2 to <3	67	0	15	39	10	0	1	0	2
3 to <6	187	2	37	101	27	10	1	2	7
6 to <11	245	2	47	131	34	16	3	1	11
11 to <16	258	8	37	128	49	22	5	2	7
16 to <21	232	0	23	115	47	38	4	3	2

N = Number of respondents.
DK = Respondents answered "don't know."

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-33. Number of Times Washing the Hands at Specified Daily Frequencies, Doers Only

	Number of Times/Day									
	N	–	0–0	1–2	3–5	6–9	10–19	20–29	30+	DK
Overall	4,663	38	34	311	1,692	1,106	892	223	178	189
Sex										
Male	2,163	16	19	218	975	487	286	59	49	54
Female	2,498	22	15	92	716	619	606	164	129	135
Refused	2	-	-	1	1	-	-	-	-	-
Age (years)										
-	84	8	-	1	25	15	11	4	5	15
1 to 4	263	-	15	62	125	35	11	2	3	10
5 to 11	348	1	5	61	191	48	21	4	2	15
12 to 17	326	3	6	46	159	64	30	7	2	9
18 to 64	2,972	18	7	131	1,029	760	640	168	143	76
>64	670	8	1	10	163	184	179	38	23	64
Race										
White	3,774	21	28	251	1,377	902	740	181	140	134
Black	463	6	2	30	149	120	85	19	23	29
Asian	77	1	-	5	29	19	12	4	1	6
Some Others	96	-	1	10	39	16	15	8	5	2
Hispanic	193	1	3	14	78	42	31	10	5	9
Refused	60	9	-	1	20	7	9	1	4	9
Hispanic										
No	4,244	27	29	276	1,536	1,022	823	205	164	162
Yes	347	2	5	33	130	76	57	17	10	17
DK	26	-	-	1	12	4	5	1	1	2
Refused	46	9	-	1	14	4	7	-	3	8
Employment										
-	926	4	26	165	471	145	61	13	7	34
Full Time	2,017	12	4	96	707	525	406	116	103	48
Part Time	379	-	-	13	142	101	86	10	15	12
Not Employed	1,309	18	4	36	365	327	334	83	52	90
Refused	32	4	-	1	7	8	5	1	1	5
Education										
-	1,021	13	26	174	507	158	74	13	12	44
< High School	399	2	-	8	120	96	88	26	24	35
High School Graduate	1,253	12	4	56	391	318	298	70	47	57
< College	895	2	3	28	284	246	197	59	48	28
College Graduate	650	6	-	23	238	174	139	28	27	15
Post Graduate	445	3	1	22	152	114	96	27	20	10
Census Region										
Northeast	1,048	9	6	68	404	243	195	55	38	30
Midwest	1,036	5	7	68	373	251	212	41	38	41
South	1,601	14	11	108	559	379	299	79	66	86
West	978	10	10	67	356	233	186	48	36	32
Day of Week										
Weekday	3,156	34	22	199	1,103	764	599	155	147	133
Weekend	1,507	4	12	112	589	342	293	68	31	56
Season										
Winter	1,264	6	10	91	507	286	223	55	51	35
Spring	1,181	13	9	78	406	283	238	60	44	50
Summer	1,275	15	9	78	443	315	232	65	48	70
Fall	943	4	6	64	336	222	199	43	35	34
Asthma										
No	4,287	28	32	283	1,562	1,024	819	207	165	167
Yes	341	1	2	26	126	77	69	16	10	14
DK	35	9	-	2	4	5	4	-	3	8
Angina										
No	4,500	28	34	306	1,652	1,069	851	218	171	171
Yes	125	2	-	3	32	34	36	5	3	10
DK	38	8	-	2	8	3	5	-	4	8
Bronchitis/Emphysema										
No	4,424	27	33	302	1,627	1,040	835	213	172	175
Yes	203	3	1	7	57	61	55	10	3	6
DK	36	8	-	2	8	5	2	-	3	8

- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-34. Number of Times Swimming in a Month in Freshwater Swimming Pool, Children <21 Years

Age (year)	N	Times/Month															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Birth to <1	10	1	4	1	0	0	2	0	0	0	1	0	0	0	0	0	0
1to <2	8	2	3	1	0	1	0	0	1	0	0	0	0	0	0	0	0
2 to <3	18	3	4	1	0	1	1	0	1	1	2	0	2	0	0	1	0
3 to <6	45	5	7	6	5	2	1	1	2	0	2	0	0	1	1	5	0
6 to <11	76	15	10	5	5	5	3	1	3	0	6	0	5	0	0	7	2
11 to <16	66	19	10	6	3	5	4	1	3	1	4	0	1	0	0	2	0
16 to <21	50	6	6	2	6	6	2	2	1	0	5	1	1	0	0	0	0

Age (year)	N	Times/Month															
		18	20	23	24	25	26	28	29	30	32	40	42	45	50	60	DK
Birth to <1	10	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1to <2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 to <3	18	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
3 to <6	45	0	2	0	0	1	0	0	0	3	1	0	0	0	0	0	0
6 to <11	76	0	3	0	1	1	0	0	0	3	0	0	0	0	1	0	0
11 to <16	66	1	2	0	0	0	0	0	0	2	0	0	0	0	0	1	1
16 to <21	50	0	6	0	0	1	2	0	0	3	0	0	0	0	0	0	0

N = Doer sample size.
DK = Respondents answered "don't know."

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-35. Time Spent (minutes/month) Swimming in Freshwater Swimming Pool, Children <21 Years

Age (years)	N	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Birth to <1	10	96	6	-	-	-	-	-	-	-	-	-	-	-	181
1 to <2	7	105	45	-	-	-	-	-	-	-	-	-	-	-	181
2 to <3	18	116	15	16	17	19	27	60	120	181	181	181	181	181	181
3 to <6	42	137	6	8	9	12	40	83	181	181	181	181	181	181	181
6 to <11	72	151	8	13	17	30	60	150	181	181	181	181	181	181	181
11 to <16	65	139	4	8	11	20	30	90	181	181	181	181	181	181	181
16 to <21	50	145	2	3	5	25	39	124	181	181	181	181	181	181	181

N = Doer sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes of 10 or fewer.
Note: A value of 181 for number of minutes signifies that more than 180 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-36. Number of Times Swimming in a Month in Freshwater Swimming Pool, Doers Only

	Times/Month																
	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Overall	653	147	94	73	47	42	26	11	26	2	38	3	27	2	2	27	2
Sex																	
Male	300	62	47	37	20	16	17	5	9	2	16	2	13	1	-	16	1
Female	352	85	47	36	27	26	9	6	17	-	22	1	14	1	1	11	1
Refused	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Age (years)																	
-	8	2	2	1	1	1	1	-	-	-	-	-	-	-	-	-	-
1 to 4	63	11	14	7	3	3	4	1	3	1	4	-	2	1	1	2	-
5 to 11	100	16	15	7	9	6	4	2	4	-	7	-	5	-	-	11	2
12 to 17	84	21	13	7	4	8	4	2	3	1	8	-	1	-	-	2	-
18 to 64	360	86	48	50	27	22	11	5	14	-	18	3	15	1	1	10	-
>64	38	11	2	1	3	2	2	1	2	-	1	-	4	-	-	2	-
Race																	
White	555	126	74	64	44	32	25	10	23	2	36	1	23	2	2	21	1
Black	30	8	7	1	-	2	-	-	1	-	-	2	-	-	-	2	1
Asian	13	3	2	2	-	1	-	1	1	-	1	-	1	-	-	-	-
Some Others	12	2	-	2	2	1	-	-	-	-	-	-	-	-	-	4	-
Hispanic	35	5	8	4	1	6	1	-	1	-	1	-	3	-	-	-	-
Refused	8	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hispanic																	
No	591	135	81	68	44	35	25	10	25	2	36	3	24	1	2	24	2
Yes	55	10	11	5	2	6	1	1	1	-	2	-	3	1	-	3	-
DK	2	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Refused	5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employment																	
-	243	47	41	21	17	15	12	5	10	2	18	-	8	1	1	15	2
Full Time	240	56	38	38	15	13	10	3	8	-	10	1	8	1	1	6	-
Part Time	43	13	2	4	3	8	-	1	1	-	4	2	2	-	-	1	-
Not Employed	122	30	12	10	12	6	3	2	7	-	6	-	9	-	-	5	-
Refused	5	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Education																	
-	257	51	43	21	18	17	12	5	11	2	19	-	8	1	1	15	2
< High School	16	2	2	3	-	3	1	1	1	-	-	1	-	-	-	-	-
High School Graduate	112	28	15	16	11	6	5	1	1	-	5	1	5	-	1	3	-
<College	104	29	11	11	2	9	2	3	7	-	4	1	7	-	-	3	-
College Graduate	93	22	12	14	10	2	3	-	2	-	5	-	6	-	-	4	-
Post Graduate	71	15	11	8	6	5	3	1	4	-	5	-	1	1	-	2	-
Census Region																	
Northeast	136	32	15	10	16	9	4	1	4	-	13	1	8	1	2	4	-
Midwest	130	35	21	17	8	6	7	2	4	-	9	-	4	1	-	6	-
South	235	46	36	29	13	15	12	7	10	2	10	2	8	-	-	9	2
West	152	34	22	17	10	12	3	1	8	-	6	-	7	-	-	8	-
Day of Week																	
Weekday	445	97	67	52	36	25	15	9	14	1	24	2	18	2	2	21	1
Weekend	208	50	27	21	11	17	11	2	12	1	14	1	9	-	-	6	1
Season																	
Winter	62	19	12	5	3	1	2	-	6	-	2	1	3	-	-	-	-
Spring	174	55	25	19	13	9	7	3	7	-	8	-	7	-	-	2	1
Summer	363	61	45	41	29	26	15	8	12	2	27	2	14	2	2	24	1
Fall	54	12	12	8	2	6	2	-	1	-	1	-	3	-	-	1	-
Asthma																	
No	590	132	81	67	43	38	25	10	24	2	37	3	25	2	2	22	2
Yes	56	14	11	5	4	3	1	1	2	-	1	-	2	-	-	5	-
DK	7	1	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Angina																	
No	639	143	90	73	47	41	26	10	26	2	37	3	27	2	2	26	2
Yes	8	3	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-
DK	6	1	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Bronchitis/Emphysema																	
No	621	138	91	71	45	40	25	10	24	2	38	2	27	2	2	25	2
Yes	26	8	1	2	1	2	1	1	1	-	-	1	-	-	-	2	-
DK	6	1	2	-	1	-	-	-	1	-	-	-	-	-	-	-	-

Table 16-36. Number of Times Swimming in a Month in Freshwater Swimming Pool, Doers Only (continued)

	Times/Month																
	18	20	23	24	25	26	28	29	30	31	32	40	42	45	50	60	DK
Overall	2	25	1	1	9	2	1	1	26	2	1	2	2	1	1	2	5
Sex																	
Male	-	10	-	-	4	2	1	-	10	2	1	1	1	-	-	-	4
Female	2	15	1	1	5	-	-	1	16	-	-	1	1	1	1	2	1
Refused	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Age (years)																	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 to 4	-	2	-	-	-	-	-	1	2	-	1	-	-	-	-	-	-
5 to 11	-	3	-	1	2	-	-	-	5	-	-	-	-	-	1	-	-
12 to 17	1	4	-	-	-	1	-	-	2	-	-	-	-	-	-	1	1
18 to 64	-	15	1	-	7	1	1	-	15	2	-	2	1	1	-	-	3
>64	1	1	-	-	-	-	-	-	2	-	-	-	1	-	-	1	1
Race																	
White	2	19	1	1	9	2	1	1	19	2	1	2	2	-	-	2	5
Black	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Asian	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Some Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Hispanic	-	1	-	-	-	-	-	-	3	-	-	-	-	1	-	-	-
Refused	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hispanic																	
No	2	23	1	1	9	2	1	1	20	2	1	2	2	-	1	2	4
Yes	-	1	-	-	-	-	-	-	6	-	-	-	-	1	-	-	1
DK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Refused	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employment																	
-	1	9	-	1	2	1	-	1	9	-	1	-	-	-	1	1	1
Full Time	-	8	-	-	5	-	1	-	10	2	-	2	1	1	-	-	2
Part Time	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Not Employed	1	7	1	-	1	1	-	-	6	-	-	-	1	-	-	1	1
Refused	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Education																	
-	1	11	-	1	2	2	-	1	9	-	1	-	-	-	1	1	1
< High School	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
High School Graduate	-	6	-	-	1	-	-	-	4	-	-	-	1	-	-	1	1
< College	-	3	1	-	4	-	-	-	4	-	-	-	-	1	-	-	2
College Graduate	-	2	-	-	2	-	-	-	3	2	-	2	1	-	-	-	1
Post Graduate	1	2	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-
Census Region																	
Northeast	-	7	-	-	2	1	-	-	2	1	-	1	1	-	-	-	1
Midwest	-	4	-	-	1	-	-	-	4	-	-	-	1	-	-	-	-
South	2	7	1	1	4	-	1	1	9	1	-	1	-	-	1	1	4
West	-	7	-	-	2	1	-	-	11	-	1	-	-	1	-	1	-
Day of Week																	
Weekday	1	18	1	1	7	1	1	-	19	-	1	1	-	1	1	2	4
Weekend	1	7	-	-	2	1	-	1	7	2	-	1	2	-	-	-	1
Season																	
Winter	1	3	-	-	-	1	1	-	-	1	-	-	1	-	-	-	-
Spring	-	8	-	-	2	-	-	-	3	-	-	-	1	-	1	1	2
Summer	1	10	1	1	7	1	-	1	21	1	1	2	-	1	-	1	3
Fall	-	4	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Asthma																	
No	2	21	1	1	9	1	1	1	23	2	1	2	2	1	-	2	5
Yes	-	3	-	-	-	1	-	-	2	-	-	-	-	-	1	-	-
DK	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Angina																	
No	2	24	1	1	9	2	1	1	26	2	1	2	1	1	1	2	5
Yes	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
DK	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bronchitis/Emphysema																	
No	2	22	1	1	9	2	1	1	23	2	1	2	2	1	1	2	4
Yes	-	2	-	-	-	-	-	-	3	-	-	-	-	-	-	-	1
DK	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

- = Indicates missing data.
DK = The respondent replied “don’t know”.
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-37. Time Spent (minutes/month) in Freshwater Swimming Pool, Doers Only

Category	Population Group	Percentiles												
		N	1	2	5	10	25	50	75	90	95	98	99	100
Overall		640	2	3	10	15	30	60	90	180	181	181	181	181
Sex	Male	295	3	4	8	10	30	45	90	180	181	181	181	181
Sex	Female	345	2	3	10	15	30	60	90	180	181	181	181	181
Age (years)	1 to 4	60	3	3	7.5	15	20	42.5	120	180	181	181	181	181
Age (years)	5 to 11	95	2	3	20	30	45	60	120	180	181	181	181	181
Age (years)	12 to 17	83	4	5	15	20	40	60	120	180	181	181	181	181
Age (years)	18 to 64	357	2	3	5	10	20	45	60	120	181	181	181	181
Age (years)	>64	38	5	5	8	10	30	40	60	120	120	181	181	181
Race	White	548	2	3	10	15	30	45	90	180	181	181	181	181
Race	Black	27	10	10	15	30	60	60	150	181	181	181	181	181
Race	Asian	13	4	4	4	20	30	60	60	120	181	181	181	181
Race	Some Others	12	2	2	2	15	25	60	150	181	181	181	181	181
Race	Hispanic	34	3	3	5	10	20	60	120	180	181	181	181	181
Hispanic	No	580	2	3	10	15	30	60	90	180	181	181	181	181
Hispanic	Yes	54	3	5	5	15	30	52.5	120	180	181	181	181	181
Employment	Full Time	237	3	4	5	10	20	45	60	150	181	181	181	181
Employment	Part Time	43	2	2	5	15	20	30	90	120	181	181	181	181
Employment	Not Employed	121	2	2	8	10	20	45	60	120	180	181	181	181
Education	< High School	16	1	1	1	2	12.5	30	60.5	181	181	181	181	181
Education	High School Graduate	111	3	5	8	10	30	60	90	180	181	181	181	181
Education	< College	102	3	3	5	10	20	30	60	120	120	180	181	181
Education	College Graduate	92	2	3	10	15	22.5	42.5	60.5	150	181	181	181	181
Education	Post Graduate	71	5	10	10	10	20	30	60	70	120	180	181	181
Census Region	Northeast	134	4	8	10	15	30	45	120	180	181	181	181	181
Census Region	Midwest	127	5	5	10	15	30	45	90	150	180	181	181	181
Census Region	South	227	2	3	5	15	30	60	120	180	181	181	181	181
Census Region	West	152	2	3	5	10	20	45	61	120	180	181	181	181
Day of Week	Weekday	434	2	3	8	10	30	60	90	180	181	181	181	181
Day of Week	Weekend	206	4	5	10	15	30	60	90	180	181	181	181	181
Season	Winter	60	2	3	5	12.5	30	52.5	90	120	180.5	181	181	181
Season	Spring	171	2	4	5	10	20	40	60	120	180	181	181	181
Season	Summer	356	3	3	10	15	30	60	120	180	181	181	181	181
Season	Fall	53	2	10	10	10	20	45	70	180	181	181	181	181
Asthma	No	578	2	3	10	15	30	55	90	180	181	181	181	181
Asthma	Yes	55	2	3	4	10	30	60	120	180	181	181	181	181
Angina	No	626	2	3	10	15	30	60	90	180	181	181	181	181
Angina	Yes	8	15	15	15	15	25	42.5	75	120	120	120	120	120
Bronchitis/Emphysema	No	608	3	3	10	15	30	60	90	180	181	181	181	181
Bronchitis/Emphysema	Yes	26	2	2	5	5	15	42.5	60	181	181	181	181	181

N = Doer sample size.
Note: A Value of 181 for number of minutes signifies that more than 180 minutes were spent.

Source: U.S. EPA, 1996.

Table 16-38. Time Spent (minutes/day) Playing on Dirt, Sand/Gravel, or Grass Whole Population and Doers only, Children <21 Years

Age (years)	*N*	Mean	Min	Percentiles 1	2	5	10	25	50	75	90	95	98	99	Max
Playing on Dirt—Whole Population															
Birth to <1	11	15	0	0	0	0	0	0	0	10	20	71	101	111	121
1 to <2	37	20	0	0	0	0	0	0	0	10	84	121	121	121	121
2 to <3	61	18	0	0	0	0	0	0	0	20	60	120	121	121	121
3 to <6	179	29	0	0	0	0	0	0	0	59	120	121	121	121	121
6 to <11	98	28	0	0	0	0	0	0	0	60	120	121	121	121	121
11 to <16	35	25	0	0	0	0	0	0	1	30	77	120	120	121	121
16 to <21	7	9	0	-	-	-	-	-	-	-	-	-	-	-	30
Playing on Dirt—Doers Only															
Birth to <1	5	33	2	-	-	-	-	-	-	-	-	-	-	-	121
1 to <2	13	56	5	5	5	5	6	10	45	120	121	121	121	121	121
2 to <3	24	47	5	5	5	5	7	15	30	60	121	121	121	121	121
3 to <6	82	63	1	1	1	1	6	30	60	120	121	121	121	121	121
6 to <11	44	63	2	3	5	10	15	30	60	120	121	121	121	121	121
11 to <16	18	49	1	2	2	4	9	19	30	60	120	120	121	121	121
16 to <21	2	30	30	-	-	-	-	-	-	-	-	-	-	-	30
Playing on Sand/Gravel—Whole Population															
Birth to <1	10	4	0	-	-	-	-	-	-	-	-	-	-	-	20
1 to <2	37	17	0	0	0	0	0	0	0	30	60	84	121	121	121
2 to <3	58	24	0	0	0	0	0	0	0	30	120	121	121	121	121
3 to <6	186	30	0	0	0	0	0	0	2	60	120	121	121	121	121
6 to <11	101	30	0	0	0	0	0	0	0	60	120	121	121	121	121
11 to <16	36	30	0	0	0	0	0	0	0	38	120	121	121	121	121
16 to <21	8	42	0	-	-	-	-	-	-	-	-	-	-	-	121
Playing on Sand/Gravel—Doers Only															
Birth to <1	2	18	15	-	-	-	-	-	-	-	-	-	-	-	20
1 to <2	15	43	5	5	5	5	7	15	30	60	103	121	121	121	121
2 to <3	26	53	1	1	1	1	3	10	30	120	121	121	121	121	121
3 to <6	93	60	3	3	3	5	8	25	60	90	121	121	121	121	121
6 to <11	46	67	5	7	10	11	15	30	60	120	121	121	121	121	121
11 to <16	16	67	1	3	5	12	15	26	60	120	121	121	121	121	121
16 to <21	4	83	30	-	-	-	-	-	-	-	-	-	-	-	121
Playing on Grass—Whole Population															
Birth to <1	11	43	0	0	0	0	0	2	30	73	121	121	121	121	121
1 to <2	38	62	0	0	0	0	9	16	60	120	121	121	121	121	121
2 to <3	59	55	0	0	0	0	1	15	30	120	121	121	121	121	121
3 to <6	180	69	0	0	0	0	0	28	60	121	121	121	121	121	121
6 to <11	99	62	0	0	0	0	0	20	60	120	121	121	121	121	121
11 to <16	36	67	0	0	0	0	1	30	60	120	121	121	121	121	121
16 to <21	8	45	0	-	-	-	-	-	-	-	-	-	-	-	120
Playing on Grass—Doers Only															
Birth to <1	9	52	1	-	-	-	-	-	-	-	-	-	-	-	121
1 to <2	35	68	5	7	8	10	15	25	60	120	121	121	121	121	121
2 to <3	53	62	1	2	3	3	5	20	60	120	121	121	121	121	121
3 to <6	157	79	1	2	2	10	15	60	70	121	121	121	121	121	121
6 to <11	85	73	1	5	9	11	17	30	60	120	121	121	121	121	121
11 to <16	32	75	1	5	10	23	30	30	60	120	121	121	121	121	121
16 to <21	6	60	15	-	-	-	-	-	-	-	-	-	-	-	120

N = Sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes of 10 or fewer.
Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent.
Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-39. Number of Minutes Spent Playing on Selected Outdoor Surfaces (minutes/day), Doers Only

Dirt

			Percentiles											
Category	Population Group	*N*	1	2	5	10	25	50	75	90	95	98	99	100
Overall		647	0	0	0	0	0	0	30	100	121	121	121	121
Sex	Male	326	0	0	0	0	0	0	30	120	121	121	121	121
Sex	Female	320	0	0	0	0	0	0	30	60	121	121	121	121
Age (years)	1 to 4	205	0	0	0	0	0	0	30	120	121	121	121	121
Age (years)	5 to 11	185	0	0	0	0	0	0	30	120	121	121	121	121
Age (years)	12 to 17	38	0	0	0	0	0	0.5	30	60	120	120	120	120
Age (years)	18 to 64	214	0	0	0	0	0	0	15	60	120	121	121	121
Age (years)	>64	2	0	0	0	0	0	0	0	0	0	0	0	0
Race	White	528	0	0	0	0	0	0	30	120	121	121	121	121
Race	Black	60	0	0	0	0	0	0	30	74	120	121	121	121
Race	Asian	5	0	0	0	0	0	30	30	121	121	121	121	121
Race	Some Others	16	0	0	0	0	0	0	20	40	60	60	60	60
Race	Hispanic	36	0	0	0	0	0	1	60	120	121	121	121	121
Hispanic	No	574	0	0	0	0	0	0	30	90	121	121	121	121
Hispanic	Yes	69	0	0	0	0	0	1	30	120	121	121	121	121
Employment	Full Time	138	0	0	0	0	0	0	15	60	120	121	121	121
Employment	Part Time	25	0	0	0	0	0	0	10	60	60	121	121	121
Employment	Not Employed	52	0	0	0	0	0	0	10	60	60	121	121	121
Education	< High School	17	0	0	0	0	0	0	60	121	121	121	121	121
Education	High School Graduate	67	0	0	0	0	0	0	10	60	88	120	121	121
Education	< College	62	0	0	0	0	0	0	15	60	60	121	121	121
Education	College Graduate	51	0	0	0	0	0	0	15	30	60	121	121	121
Education	Post Graduate	18	0	0	0	0	0	0	0	60	120	120	120	120
Census Region	Northeast	118	0	0	0	0	0	0	30	60	121	121	121	121
Census Region	Midwest	116	0	0	0	0	0	0	20	60	120	121	121	121
Census Region	South	250	0	0	0	0	0	0	30	90	121	121	121	121
Census Region	West	163	0	0	0	0	0	1	60	121	121	121	121	121
Day of Week	Weekday	406	0	0	0	0	0	0	30	88	121	121	121	121
Day of Week	Weekend	241	0	0	0	0	0	0	30	120	121	121	121	121
Season	Winter	93	0	0	0	0	0	0	45	121	121	121	121	121
Season	Spring	230	0	0	0	0	0	0	30	105	121	121	121	121
Season	Summer	245	0	0	0	0	0	0	30	90	121	121	121	121
Season	Fall	79	0	0	0	0	0	0	10	60	120	121	121	121
Asthma	No	590	0	0	0	0	0	0	30	110	121	121	121	121
Asthma	Yes	56	0	0	0	0	0	10	60	60	121	121	121	121
Angina	No	646	0	0	0	0	0	0	30	100	121	121	121	121
Bronchitis/Emphysema	No	627	0	0	0	0	0	0	30	120	121	121	121	121
Bronchitis/Emphysema	Yes	20	0	0	0	0	0	0	37.5	60	90.5	121	121	121

Table 16-39. Number of Minutes Spent Playing on Selected Outdoor Surfaces (minutes/day), Doers Only (continued)

Sand or Gravel

			Percentiles											
Category	Population Group	*N*	1	2	5	10	25	50	75	90	95	98	99	100
Overall		659	0	0	0	0	0	0	45	120	121	121	121	121
Sex	Male	334	0	0	0	0	0	0	45	120	121	121	121	121
Sex	Female	324	0	0	0	0	0	1	60	120	121	121	121	121
Age (years)	1 to 4	203	0	0	0	0	0	0	30	120	121	121	121	121
Age (years)	5 to 11	193	0	0	0	0	0	3	60	121	121	121	121	121
Age (years)	12 to 17	40	0	0	0	0	0	0	45	120	121	121	121	121
Age (years)	18 to 64	219	0	0	0	0	0	0	45	120	121	121	121	121
Age (years)	>64	2	0	0	0	0	0	0	0	0	0	0	0	0
Race	White	534	0	0	0	0	0	0	50	120	121	121	121	121
Race	Black	64	0	0	0	0	0	0	15	120	121	121	121	121
Race	Asian	5	0	0	0	0	0	30	60	121	121	121	121	121
Race	Some Others	15	0	0	0	0	0	0	60	121	121	121	121	121
Race	Hispanic	39	0	0	0	0	0	15	60	121	121	121	121	121
Hispanic	No	583	0	0	0	0	0	0	45	120	121	121	121	121
Hispanic	Yes	72	0	0	0	0	0	1.5	60	120	121	121	121	121
Employment	Full Time	140	0	0	0	0	0	0	45	105	121	121	121	121
Employment	Part Time	27	0	0	0	0	0	10	60	121	121	121	121	121
Employment	Not Employed	53	0	0	0	0	0	0	30	120	121	121	121	121
Education	< High School	17	0	0	0	0	0	0	60	121	121	121	121	121
Education	High School Graduate	69	0	0	0	0	0	0	30	121	121	121	121	121
Education	< College	64	0	0	0	0	0	0	37.5	120	121	121	121	121
Education	College Graduate	50	0	0	0	0	0	0	30	60	60	121	121	121
Education	Post Graduate	20	0	0	0	0	0	15	60	120	120	120	120	120
Census Region	Northeast	116	0	0	0	0	0	0	60	120	121	121	121	121
Census Region	Midwest	122	0	0	0	0	0	0	30	60	121	121	121	121
Census Region	South	256	0	0	0	0	0	0	45	120	121	121	121	121
Census Region	West	165	0	0	0	0	0	0	60	121	121	121	121	121
Day of Week	Weekday	410	0	0	0	0	0	0	40	120	121	121	121	121
Day of Week	Weekend	249	0	0	0	0	0	0	60	121	121	121	121	121
Season	Winter	97	0	0	0	0	0	5	45	120	121	121	121	121
Season	Spring	232	0	0	0	0	0	1	52.5	120	121	121	121	121
Season	Summer	250	0	0	0	0	0	0	60	120	121	121	121	121
Season	Fall	80	0	0	0	0	0	0	30	105	121	121	121	121
Asthma	No	600	0	0	0	0	0	0	45	120	121	121	121	121
Asthma	Yes	58	0	0	0	0	0	3	60	120	121	121	121	121
Angina	No	659	0	0	0	0	0	0	45	120	121	121	121	121
Bronchitis/emphysema	No	638	0	0	0	0	0	0	45	120	121	121	121	121
Bronchitis/emphysema	Yes	21	0	0	0	0	0	30	60	121	121	121	121	121

Table 16-39. Number of Minutes Spent Playing on Selected Outdoor Surfaces (minutes/day), Doers Only (continued)

Grass															
			Percentiles												
Category	Population Group	*N*	1	2	5	10	25	50	75	90	95	98	99	100
Overall		657	0	0	0	0	20	60	120	121	121	121	121	121
Sex	Male	327	0	0	0	0	20	60	121	121	121	121	121	121
Sex	Female	329	0	0	0	0	15	60	120	121	121	121	121	121
Age (years)	1 to 4	206	0	0	0	0	15	60	120	121	121	121	121	121
Age (years)	5 to 11	185	0	0	0	0	30	60	121	121	121	121	121	121
Age (years)	12 to 17	39	0	0	0	0	30	60	120	121	121	121	121	121
Age (years)	18 to 64	221	0	0	0	0	20	60	120	121	121	121	121	121
Age (years)	>64	3	30	30	30	30	30	121	121	121	121	121	121	121
Race	White	532	0	0	0	0	20	60	121	121	121	121	121	121
Race	Black	65	0	0	0	3	20	58	90	121	121	121	121	121
Race	Asian	5	10	10	10	10	30	30	30	121	121	121	121	121
Race	Some Others	16	0	0	0	0	10	60	120	121	121	121	121	121
Race	Hispanic	37	0	0	0	0	30	60	110	121	121	121	121	121
Hispanic	No	581	0	0	0	0	20	60	121	121	121	121	121	121
Hispanic	Yes	72	0	0	0	0	10	35	100	121	121	121	121	121
Employment	Full Time	141	0	0	0	0	20	60	121	121	121	121	121	121
Employment	Part Time	27	0	0	0	0	15	60	120	121	121	121	121	121
Employment	Not Employed	55	0	0	0	5	23	60	121	121	121	121	121	121
Education	< High School	20	0	0	0	5	30	60	120.5	121	121	121	121	121
Education	High School Graduate	69	0	0	0	0	15	60	121	121	121	121	121	121
Education	< College	64	0	0	0	0	17.5	46.5	60	121	121	121	121	121
Education	College Graduate	51	0	0	0	1	30	60	121	121	121	121	121	121
Education	Post Graduate	19	0	0	0	0	25	60	121	121	121	121	121	121
Census Region	Northeast	119	0	0	0	0	30	60	121	121	121	121	121	121
Census Region	Midwest	120	0	0	0	7.5	30	60	121	121	121	121	121	121
Census Region	South	252	0	0	0	1	20	60	120	121	121	121	121	121
Census Region	West	166	0	0	0	0	10	45	120	121	121	121	121	121
Day of Week	Weekday	412	0	0	0	0	15	60	120	121	121	121	121	121
Day of Week	Weekend	245	0	0	0	1	30	60	121	121	121	121	121	121
Season	Winter	95	0	0	0	0	4	30	120	121	121	121	121	121
Season	Spring	231	0	0	0	1	30	60	121	121	121	121	121	121
Season	Summer	250	0	0	0	1.5	30	60	121	121	121	121	121	121
Season	Fall	81	0	0	0	0	10	35	120	121	121	121	121	121
Asthma	No	600	0	0	0	0	20	60	120	121	121	121	121	121
Asthma	Yes	56	0	0	0	0	22.5	60	120.5	121	121	121	121	121
Angina	No	656	0	0	0	0	20	60	120	121	121	121	121	121
Bronchitis/Emphysema	No	636	0	0	0	0	20	60	120	121	121	121	121	121
Bronchitis/Emphysema	Yes	21	0	0	0	0	30	60	121	121	121	121	121	121

N = Doer sample size.

NOTE: A value of "121" for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA, 1996.

Table 16-40. Time Spent (minutes/day) Working or Being Near Excessive Dust in the Air, Children <21 Years

Age (years)	*N*	Mean	Min	Percentiles											Max
				1	2	5	10	25	50	75	90	95	98	99	
Birth to <1	2	63	5	-	-	-	-	-	-	-	-	-	-	-	121
1 to <2	5	44	0	-	-	-	-	-	-	-	-	-	-	-	121
2 to <3	1	121	121	-	-	-	-	-	-	-	-	-	-	-	121
3 to <6	15	63	0	0	1	1	2	8	60	121	121	121	121	121	121
6 to <11	12	60	0	0	0	1	2	5	45	121	121	121	121	121	121
11 to <16	14	53	0	0	0	1	2	6	38	113	121	121	121	121	121
16 to <21	14	65	2	2	3	4	7	16	53	121	121	121	121	121	121

N = Doer sample size.
Min = Minimum.
Max = Maximum.
\- = Percentiles were not calculated for sample sizes of 10 or fewer.
Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA re-analysis of source data from U.S. EPA, 1996.

Table 16-41. Time Spent (minutes/day) Working or Being Near Excessive Dust in the Air, Doers Only

Category	Population Group	*N*	Percentiles 1	2	5	10	25	50	75	90	95	98	99	100
Overall		679	0	2	5	7	30	121	121	121	121	121	121	121
Sex	Male	341	1	2	5	8	30	121	121	121	121	121	121	121
Sex	Female	338	0	2	5	5	30	121	121	121	121	121	121	121
Age (years)	1 to 4	22	0	0	0	2	5	75	121	121	121	121	121	121
Age (years)	5 to 11	50	0	0.5	2	4	15	75	121	121	121	121	121	121
Age (years)	12 to 17	52	0	1	2	5	5	20	120	121	121	121	121	121
Age (years)	18 to 64	513	2	5	5	10	30	121	121	121	121	121	121	121
Age (years)	>64	38	2	2	2	5	35	105.5	121	121	121	121	121	121
Race	White	556	0	2	5	8	30	121	121	121	121	121	121	121
Race	Black	66	1	3	5	5	20	121	121	121	121	121	121	121
Race	Asian	7	20	20	20	20	60	90	121	121	121	121	121	121
Race	Some Others	15	5	5	5	10	60	120	121	121	121	121	121	121
Race	Hispanic	29	3	3	5	7	20	121	121	121	121	121	121	121
Hispanic	No	611	0	2	5	5	30	121	121	121	121	121	121	121
Hispanic	Yes	57	0	3	3	10	30	121	121	121	121	121	121	121
Employment	Full Time	368	2	5	7	15	37.5	121	121	121	121	121	121	121
Employment	Part Time	66	0	2	5	5	20	120	121	121	121	121	121	121
Employment	Not Employed	122	0	2	5	8	30	121	121	121	121	121	121	121
Education	< High School	52	2	5	5	7	35	121	121	121	121	121	121	121
Education	High School Graduate	199	0	0	5	10	30	121	121	121	121	121	121	121
Education	< College	140	5	5	10	20	60	121	121	121	121	121	121	121
Education	College Graduate	82	1	2	5	15	30	121	121	121	121	121	121	121
Education	Post Graduate	76	3	5	5	10	37.5	121	121	121	121	121	121	121
Census Region	Northeast	138	0	0	5	5	20	121	121	121	121	121	121	121
Census Region	Midwest	145	2	2	5	10	30	121	121	121	121	121	121	121
Census Region	South	227	1	2	5	5	30	121	121	121	121	121	121	121
Census Region	West	169	0	3	5	10	30	120	121	121	121	121	121	121
Day of Week	Weekday	471	0	1	5	7	30	121	121	121	121	121	121	121
Day of Week	Weekend	208	2	2	5	5	30	121	121	121	121	121	121	121
Season	Winter	154	0	0	5	5	30	121	121	121	121	121	121	121
Season	Spring	193	0	1	3	5	20	121	121	121	121	121	121	121
Season	Summer	193	2	2	5	10	30	121	121	121	121	121	121	121
Season	Fall	139	3	5	5	10	30	121	121	121	121	121	121	121
Asthma	No	606	0	2	5	5	30	121	121	121	121	121	121	121
Asthma	Yes	73	0	3	5	10	30	121	121	121	121	121	121	121
Angina	No	662	0	2	5	7	30	121	121	121	121	121	121	121
Angina	Yes	15	3	3	3	30	60	121	121	121	121	121	121	121
Bronchitis/Emphysema	No	637	0	2	5	7	30	121	121	121	121	121	121	121
Bronchitis/Emphysema	Yes	41	0	0	5	5	30	121	121	121	121	121	121	121

N = Doer sample size.

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent.

Source: U.S. EPA, 1996.

Table 16-42. Time Spent (minutes/day) with Smokers Present, Children <21 Years

Age (year)	*N*	Mean	SD	SE	Min	Percentiles								Max
						5	25	50	75	90	95	98	99	
1 to 4	155	367	325	26	5	30	90	273	570	825	1,010	1,140	1,305	1,440
5 to 11	224	318	314	21	1	25	105	190	475	775	1,050	1,210	1,250	1,440
12 to 17	256	246	244	15	1	10	60	165	360	595	774	864	1,020	1,260

N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum.
Max = Maximum.

Source: U.S. EPA, 1996.

Table 16-43. Time Spent (minutes/day) with Smokers Present, Doers Only

Category	Population Group	*N*	Mean	SD	SE	Min	Max	Percentiles 5	25	50	75	90	95	98	99
All		4,005	381.5	300.5	4.7	1	1,440	30	120	319	595	815	925	1,060	1,170
Sex	Male	1,967	411.4	313.0	7.1	1	1,440	30	135	355	638	855	965	1,105	1,217
Sex	Female	2,035	352.8	285.1	6.3	1	1,440	29	105	285	545	780	870	995	1,110
Sex	Refused	3	283.3	188.2	108.6	105	480	105	105	265	480	480	480	480	480
Age (years)	-	54	386.3	305.4	41.6	5	1,440	25	105	370	555	780	995	995	1,440
Age (years)	1 to 4	155	366.6	324.5	26.1	5	1,440	30	90	273	570	825	1,010	1,140	1,305
Age (years)	5 to 11	224	318.1	314.0	21.0	1	1,440	25	105	190	475	775	1,050	1,210	1,250
Age (years)	12 to 17	256	245.8	243.6	15.2	1	1,260	10	60	165	360	595	774	864	1,020
Age (years)	18 to 64	2,976	403.1	299.4	5.5	2	1,440	30	135	355	625	830	930	1,047	1,150
Age (years)	>64	340	342.7	292.2	15.8	5	1,440	30	100	240	540	798	880	1,015	1,205
Race	White	3,279	389.2	303.0	5.3	1	1,440	30	120	330	610	825	930	1,060	1,190
Race	Black	395	360.0	288.0	14.5	2	1,440	22	118	300	538	775	905	1,080	1,160
Race	Asian	48	262.1	209.9	30.3	5	800	10	64	213	413	560	630	800	800
Race	Some Others	79	420.7	339.2	38.2	10	1,328	30	135	310	655	885	1,140	1,305	1,328
Race	Hispanic	165	292.6	250.2	19.5	5	1,095	15	75	220	475	660	800	845	945
Race	Refused	39	393.5	325.3	52.1	25	1,110	30	115	290	655	865	1,040	1,110	1,110
Hispanic	No	3,666	384.9	301.2	5.0	1	1,440	30	120	324	600	822	930	1,060	1,170
Hispanic	Yes	288	336.2	280.9	16.6	1	1,440	20	115	252	512	760	850	1,010	1,260
Hispanic	DK	18	369.8	371.5	87.6	15	1,440	15	90	220	600	760	1,440	1,440	1,440
Hispanic	Refused	33	403.4	322.8	56.2	25	1,110	30	120	325	655	840	1,040	1,110	1,110
Employment	-	624	301.7	295.5	11.8	1	1,440	15	75	190	450	735	900	1,140	1,230
Employment	Full Time	2,042	405.9	296.3	6.6	2	1,440	30	135	365	625	835	925	1,005	1,110
Employment	Part Time	381	378.0	291.1	14.9	5	1,440	30	135	325	585	805	915	1,080	1,245
Employment	Not Employed	935	383.8	308.7	10.1	3	1,440	30	120	310	600	825	930	1,110	1,290
Employment	Refused	23	342.0	254.2	53.0	25	925	30	120	325	450	715	885	925	925
Education	-	704	308.6	292.8	11.0	1	1,440	15	88	205	465	741	900	1,095	1,217
Education	< High School	377	497.7	317.8	16.4	2	1,440	40	225	465	775	905	990	1,120	1,369
Education	High School Graduate	1,315	425.7	301.7	8.3	3	1,440	30	155	390	650	840	928	1,060	1,202
Education	< College	829	388.8	295.8	10.3	5	1,435	30	135	330	600	810	930	1,050	1,155
Education	College Graduate	473	325.9	272.7	12.5	2	1,140	30	90	240	499	735	860	990	1,035
Education	Post Graduate	307	282.5	257.1	14.7	3	1,205	20	60	200	430	665	810	900	983
Census Region	Northeast	932	369.5	287.7	9.4	2	1,440	30	120	314	565	800	892	990	1,095
Census Region	Midwest	938	384.1	304.8	10.0	2	1,440	29	120	320	600	825	930	1,080	1,140
Census Region	South	1,409	404.0	308.5	8.2	1	1,440	30	130	345	630	840	943	1,090	1,205
Census Region	West	726	349.9	292.0	10.8	1	1,440	30	110	274	541	800	900	1,045	1,180
Day Of Week	Weekday	2,661	374.7	296.2	5.7	1	1,440	30	120	315	578	810	915	1,045	1,150
Day Of Week	Weekend	1,344	394.9	308.5	8.4	1	1,440	30	120	322	625	833	940	1,110	1,260
Season	Winter	1,046	374.2	304.2	9.4	1	1,440	25	115	295	590	815	925	1,080	1,170
Season	Spring	1,034	384.8	301.6	9.4	2	1,440	30	120	320	610	810	900	1,105	1,215
Season	Summer	1,059	385.1	300.4	9.2	2	1,440	30	120	330	591	840	940	1,040	1,130
Season	Fall	866	382.0	295.1	10.0	2	1,440	30	120	324	590	810	915	1,030	1,150
Asthma	No	3,687	378.8	298.4	4.9	1	1,440	30	120	315	591	810	915	1,050	1,170
Asthma	Yes	298	416.9	324.0	18.8	5	1,440	20	135	343	652	870	1,015	1,202	1,335
Asthma	DK	20	350.0	304.3	68.0	25	995	28	60	290	540	795	902.5	995	995
Angina	No	3,892	380.9	299.5	4.8	1	1,440	30	120	320	595	815	920	1,060	1,170
Angina	Yes	87	404.3	345.1	37.0	2	1,380	30	120	270	703	910	1,015	1,320	1,380
Angina	DK	26	390.6	300.4	58.9	25	995	30	115	343	670	780	790	995	995
Bronchitis/Emphysema	No	3,749	378.7	298.6	4.9	1	1,440	30	120	315	590	810	915	1,060	1,170
Bronchitis/Emphysema	Yes	236	431.2	326.8	21.3	5	1,380	30	150	363	680	892	980	1,205	1,260
Bronchitis/Emphysema	DK	20	326.3	291.1	65.1	10	995	18	85	223	540	755	888	995	995

\- = Indicates missing data.
DK = The respondent replied "don't know".
Refused = Refused data.
N = Doer sample size.
SD = Standard deviation.
SE = Standard error.
Min = Minimum number of minutes.
Max = Maximum number of minutes.

Source: U.S. EPA, 1996.

Table 16-44. Mean Time Spent (hours/week)[a] in Ten Major Activity Categories Grouped by Regions

Activity	West N = 200	North Central N = 304	Northeast N = 185	South N = 286	Total[b] N = 975 Mean	 SD[c]
Activity Category						
Market Work	23.44	29.02	27.34	24.21	26.15	23.83
House/yard work	14.64	14.17	14.29	15.44	14.66	12.09
Child care	2.50	2.82	2.32	2.66	2.62	5.14
Services/shop	5.22	5.64	4.92	4.72	5.15	5.40
Personal care	79.23	76.62	78.11	79.38	78.24	12.70
Education	2.94	1.43	0.95	1.45	1.65	6.34
Organizations	3.42	2.97	2.45	2.68	2.88	5.40
Social entertainment	8.26	8.42	8.98	8.22	8.43	8.17
Active leisure	5.94	5.28	4.77	5.86	5.49	7.81
Passive leisure	22.47	21.71	23.94	23.47	22.80	13.35
Total Time	168.00	168.00	168.00	168.00	168.00	0.09

a Weighted for day of week, panel loss (not defined in report), and correspondence to Census. Data may not add to totals shown due to rounding.
b *N* = surveyed population.
c SD = standard deviation.

Source: Hill, 1985.

Table 16-45. Total Mean Time Spent (minutes/day) in Ten Major Activity Categories Grouped by Type of Day

	Time Duration (minutes/day) Weekday [N[a] = 831]	 Saturday [N = 831]	 Sunday [N = 831]
Activity Category			
Market Work	288.0 (257.7)[b]	97.9 (211.9)	58.0 (164.8)
House/Yardwork	126.3 (119.3)	160.5 (157.2)	124.5 (133.3)
Child Care	26.6 (50.9)	19.4 (51.5)	24.8 (61.9)
Services/Shopping	48.7 (58.7)	64.4 (92.5)	21.6 (49.9)
Personal Care	639.2 (114.8)	706.8 (169.8)	734.3 (156.5)
Education	16.4 (64.4)	5.4 (38.1)	7.3 (48.0)
Organizations	21.1 (49.7)	18.4 (75.2)	58.5 (104.5)
Social Entertainment	54.9 (69.2)	1,114.1 (156.0)	110.0 (151.2)
Active Leisure	37.9 (71.11)	61.4 (126.5)	64.5 (120.6)
Passive Leisure	181.1 (121.9)	191.8 (161.6)	236.5 (167.1)
Total Time	1,440	1,440	1,440

a *N* = Number of respondents.
b ( ) = Numbers in parentheses are standard deviations.

Source: Hill, 1985.

Table 16-46. Mean Time Spent (minutes/day) in Ten Major Activity Categories During 4 Waves of Interviews[a]

	Fall (Nov. 1, 1975)[b] *N* = 861	Spring (June 1, 1976)[b] *N* = 861	Spring (June 1, 1976)[b] *N* = 861	Summer (Sept. 21, 1976)[b] *N* = 861	Range of Standard Deviations
Activity Category	**Wave 1**	**Wave 2**	**Wave 3**	**Wave 4**	
Market work	222.94	226.53	210.44	230.92	272–287
House/yard work	133.16	135.58	143.10	119.95	129–156
Child care	25.50	22.44	25.51	21.07	49–58
Services/shop	48.98	44.09	44.61	47.75	76–79
Personal care	652.95	678.14	688.27	674.85	143–181
Education	22.79	12.57	2.87	10.76	32–93
Organizations	25.30	22.55	23.21	29.91	68–87
Social entertainment	63.87	67.11	83.90	72.24	102–127
Active leisure	42.71	47.46	46.19	42.30	96–105
Passive leisure	210.75	183.48	171.85	190.19	144–162
Total Time	1,440.00	1,440.00	1,440.00	1,440.00	--

[a] Weighted for day of week, panel loss (not defined in report), and correspondence to Census.
[b] Dates by which 50% of the interviews for each wave were taken.

Source: Hill, 1985.

Table 16-47. Mean Time Spent (hours/week) in Ten Major Activity Categories Grouped by Sex[a]

	Time Duration (hours/week)					
	Men *N* = 140		Women *N* = 561		Men and Women *N* = 971	
Activity Category						
Market work	35.8	(23.6)[b]	17.9	(20.7)	26.2	(23.8)
House/yard	8.5	(9.0)	20.0	(11.9)	14.7	(12.1)
Child care	1.2	(2.5)	3.9	(6.4)	2.6	(5.2)
Services/shop	3.9	(4.5)	6.3	(5.9)	5.2	(5.4)
Personal care	77.3	(13.0)	79.0	(12.4)	78.2	(12.7)
Education	2.3	(7.7)	1.1	(4.8)	1.7	(6.4)
Organizations	2.5	(5.5)	3.2	(5.3)	2.9	(5.4)
Social entertainment	7.9	(8.3)	8.9	(8.0)	8.4	(8.2)
Active leisure	5.9	(8.2)	5.2	(7.4)	5.5	(7.8)
Passive leisure	22.8	(14.1)	22.7	(12.7)	22.8	(13.3)
Total time	168.1		168.1		168.1	

[a] Detailed components of activities (87) are presented in Table 1A-4 of the original study.
[b] ( ) = Numbers in parentheses are standard deviations.

Source: Hill, 1985.

Table 16-48. Mean Time Spent (minutes/day) Performing Major Activities, by Age, Sex and Type of Day

Activity	Age (3 to 11 years)				Age (12 to 17 years)			
	Weekday		Weekend		Weekday		Weekend	
	Boy (*N* = 118)	Girl (*N* = 111)	Boy (*N* = 118)	Girl (*N* = 111)	Boy (*N* = 77)	Girl (*N* = 83)	Boy (*N* = 77)	Girl (*N* = 83)
Market Work	16	0	7	4	23	21	58	25
Household Work	17	21	32	43	16	40	46	89
Personal Care	43	44	42	50	48	71	35	76
Eating	81	78	78	84	73	65	58	75
Sleeping	584	590	625	619	504	478	550	612
School	252	259	-	-	314	342	-	-
Studying	14	19	4	9	29	37	25	25
Church	7	4	53	61	3	7	40	36
Visiting	16	9	23	37	17	25	46	53
Sports	25	12	33	23	52	37	65	26
Outdoors	10	7	30	23	10	10	36	19
Hobbies	3	1	3	4	7	4	4	7
Art Activities	4	4	4	4	12	6	11	9
Playing	137	115	177	166	37	13	35	24
TV	117	128	181	122	143	108	187	140
Reading	9	7	12	10	10	13	12	19
Household Conversations	10	11	14	9	21	30	24	30
Other Passive Leisure	9	14	16	17	21	14	43	33
Unknown	22	25	20	29	14	17	10	4
Percent of Time Accounted for by Activities Above	94	92	93	89	93	92	88	89

N = Sample size.
\- = No data

Source: Timmer et al., 1985.

Table 16-49. Mean Time Spent (minutes/day) in Major Activities, by Type of Day for 5 Different Age Groups

Activity	Weekday Age (years)					Weekend Age (years)					Significant Effect[a]
	3–5	6–8	9–11	12–14	15–17	3–5	6–8	9–11	12–14	15–17	
Market Work	-	14	8	14	28	-	4	10	29	48	
Personal Care	41	49	40	56	60	47	45	44	60	51	A, S, AxS (F > M)
Household Work	14	15	18	27	34	17	27	51	72	60	A, S, AxS (F > M)
Eating	82	81	73	69	67	81	80	78	68	65	A
Sleeping	630	595	548	473	499	634	641	596	604	562	A
School	137	292	315	344	314	-	-	-	-	-	
Studying	2	8	29	33	33	1	2	12	15	30	A
Church	4	9	9	9	3	55	56	53	32	37	A
Visiting	14	15	10	21	20	10	8	13	22	56	A (Weekend Only)
Sports	5	24	21	40	46	3	30	42	51	37	A, S (M > F)
Outdoor Activities	4	9	8	7	11	8	23	39	25	26	
Hobbies	0	2	2	4	6	1	5	3	8	3	
Art Activities	5	4	3	3	12	4	4	4	7	10	
Other Passive Leisure	9	1	2	6	4	6	10	7	10	18	A
Playing	218	111	65	31	14	267	180	92	35	21	A, S (M > F)
TV	111	99	146	142	108	122	136	185	169	157	A, S, AxS (M > F)
Reading	5	5	9	10	12	4	9	10	10	18	A
Being Read to	2	2	0	0	0	3	2	0	0	0	A
Unknown	30	14	23	25	7	52	7	14	4	9	A

[a] Effects are significant for weekdays and weekends, unless otherwise specified. A = age effect, $p < 0.05$, for both weekdays and weekend activities; S = sex effect $p < 0.05$, F > M, M > F = females spend more time than males, or vice versa; and AxS = age by sex interaction, $p < 0.05$.

- = No data.

Source: Timmer et al., 1985.

Table 16-50. Mean Time Spent (hours/day) Indoors and Outdoors, by Age and Day of the Week

Age Group	Indoors[a]		Outdoors[b]	
	Weekday	Weekend	Weekday	Weekend
3 to 5 years	19.4	18.9	2.5	3.1
6 to 8 years	20.7	18.6	1.8	2.5
9 to 11 years	20.8	18.6	1.3	2.3
12 to 14 years	20.7	18.5	1.6	1.9
15 to 17 years	19.9	17.9	1.4	2.3

[a] Time indoors was estimated by adding the average times spent performing indoor activities (household work, personal care, eating, sleeping, attending school, studying, attending church, watching television, and engaging in conversation) and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., market work, sports, hobbies, art activities, playing, reading, and other passive leisure).

[b] Time outdoors was estimated by adding the average time spent in outdoor activities and half the time spent in each activity which could have occurred either indoors or outdoors (i.e., market work, sports, hobbies, art activities, playing, reading, and other passive leisure).

Source: Adapted from Timmer et al., 1985.

Table 16-51. Mean Time Spent (minutes/day) in Various Microenvironments by Age Group (years) for the National and California Surveys

Microenvironment	National Data Mean Duration (Standard Error)									
	Age 12–17 *N* = 340[a]	Doer[b]	Age 18–24 *N* = 340	Doer	Age 24–44 *N* = 340	Doer	Age 45–64 *N* = 340	Doer	Age 65+ *N* = 340	Doer
Autoplaces	2 (1)	73	7 (2)	137	2 (1)	43	4 (1)	73	4 (2)	57
Restaurant/bar	9 (2)	60	28 (3)	70	25 (3)	86	19 (2)	67	20 (5)	74
In-vehicle/internal combustion	79 (7)	88	103 (8)	109	94 (4)	101	82 (5)	91	62 (5)	80
In-vehicle/other	0 (0)	12	1 (1)	160	1 (0)	80	1 (1)	198	1 (1)	277
Physical/outdoors	32 (8)	130	17 (4)	110	19 (4)	164	7 (1)	79	15 (4)	81
Physical/indoors	15 (3)	87	8 (2)	76	7 (1)	71	7 (2)	77	7 (1)	51
Work/study-residence	22 (4)	82	19 (6)	185	16 (2)	181	9 (2)	169	5 (3)	297
Work/study-other	159 (14)	354	207 (20)	391	220 (11)	422	180 (13)	429	35 (6)	341
Cooking	11 (3)	40	18 (2)	39	38 (2)	57	43 (3)	64	50 (5)	65
Other activities/kitchen	53 (4)	64	42 (3)	55	70 (4)	86	90 (6)	101	108 (9)	119
Chores/child	91 (7)	92	124 (9)	125	133 (6)	134	121 (6)	122	119 (7)	121
Shop/errands	26 (4)	68	31 (4)	65	33 (2)	66	33 (3)	67	35 (5)	69
Other/outdoors	70 (13)	129	34 (4)	84	48 (6)	105	60 (7)	118	82 (13)	140
Social/cultural	87 (10)	120	100 (12)	141	56 (3)	94	73 (6)	116	85 (8)	122
Leisure-eat/indoors	237 (16)	242	181 (11)	189	200 (8)	208	238 (11)	244	303 (20)	312
Sleep/indoors	548 (31)	551	511 (26)	512	479 (14)	480	472 (15)	472	507 (26)	509
Microenvironment	CARB Data Mean Duration (Standard Error)									
	Age 12–17 *N* = 340[a]	Doer	Age 18–24 *N* = 340	Doer	Age 24–44 *N* = 340	Doer	Age 45–64 *N* = 340	Doer	Age 65+ *N* = 340	Doer
Autoplaces	16 (8)	124	16 (4)	71	25 (9)	114	20 (5)	94	9 (2)	53
Restaurant/bar	16 (4)	44	40 (8)	98	44 (5)	116	31 (4)	82	25 (7)	99
In-vehicle/internal combustion	78 (11)	89	111 (13)	122	98 (5)	111	100 (11)	117	63 (8)	89
In-vehicle/other	1 (0)	19	3 (1)	60	5 (2)	143	2 (1)	56	2 (1)	53
Physical/outdoors	32 (7)	110	13 (3)	88	17 (3)	128	14 (3)	123	15 (4)	104
Physical/indoors	20 (4)	65	5 (2)	77	6 (1)	61	5 (1)	77	3 (1)	48
Work/study-residence	25 (5)	76	30 (11)	161	7 (2)	137	10 (3)	139	5 (3)	195
Work/study-other	196 (30)	339	201 (24)	344	215 (14)	410	173 (20)	429	30 (11)	336
Cooking	3 (1)	19	14 (2)	40	32 (2)	59	31 (3)	68	41 (7)	69
Other activities/kitchen	31 (4)	51	31 (5)	55	43 (3)	65	62 (6)	91	97 (14)	119
Chores/child	72 (11)	77	79 (8)	85	110 (6)	119	99 (8)	109	123 (15)	141
Shop/errands	14 (3)	50	35 (7)	71	33 (4)	71	32 (3)	77	35 (5)	76
Other/outdoors	58 (8)	78	80 (15)	130	68 (8)	127	76 (12)	134	55 (7)	101
Social/cultural	63 (14)	109	65 (10)	110	50 (5)	122	50 (5)	107	49 (7)	114
Leisure-eat/indoors	260 (27)	270	211 (19)	234	202 (9)	215	248 (15)	261	386 (34)	394
Sleep/indoors	557 (44)	560	506 (30)	510	487 (17)	491	485 (23)	491	502 (31)	502

[a] All *N*'s are weighted number.
[b] Doer = Respondents who reported participating in each activity/location spent in microenvironments.

Source: Robinson and Thomas, 1991.

Table 16-52. Mean Time Spent in Ten Major Activity Categories Grouped by Total Sample and Sex for the CARB and National Studies (age 18–64 years)

Activity Category	Time Duration (minutes/day)					
	CARB (1987–1988)	National (1985)	CARB (1987–1988)		National (1985)	
	Total Sample		Men	Women	Men	Women
	N[a] = 1,359	*N* = 1,980	*N* = 639	*N* = 720	*N* = 921	*N* = 1,059
Paid Work	273	252	346	200	323	190
Household Work	102	118	68	137	79	155
Child Care	23	25	12	36	11	43
Obtaining Goods and Services	61	55	48	73	44	62
Personal Needs and Care	642	642	630	655	636	645
Education and Training	22	19	25	20	21	16
Organizational Activities	12	17	11	13	12	20
Entertainment/Social Activities	60	62	57	55	64	62
Recreation	43	50	53	31	69	43
Communication	202	196	192	214	197	194

[a] *N* = total diary days.

Source: Robinson and Thomas, 1991.

Table 16-53. Total Mean Time Spent at 3 Major Locations Grouped by Total Sample and Sex for the CARB and National Study (age 18–64 years)

Location[a]	CARB (1987–1988)	National (1985)	CARB (1987–1988)		National (1985)	
	Total Sample		Men	Women	Men	Women
	N[a] = 1,359	*N* = 1,980	*N* = 39	*N* = 720	*N* = 921	*N* = 1,059
At Home	892	954	822	963	886	1,022
Away From Home	430	384	487	371	445	324
Travel	116	94	130	102	101	87
Not Ascertained	2	8	1	4	8	7
Total Time	1,440	1,440	1,440	1,440	1,440	1,440

[a] *N* = total diary days.

Source: Robinson and Thomas, 1991.

Table 16-54. Mean Time Spent at 3 Locations for both CARB and National Studies (ages 12 years and older)

Location Category	Mean Duration (minutes/day)			
	CARB (N = 1,762)[a]	SE[b]	National (N = 2,762)[a]	SE
Indoor	1,255[c]	28	1,279[c]	21
Outdoor	86[d]	5	74[d]	4
In-Vehicle	98[d]	4	87[d]	2
Total Time Spent	1,440		1,440	

[a] N = Weighted Number – National sample population was weighted to obtain a ratio of 46.5 males and 53.5 females, in equal proportion for each day of the week, and for each quarter of the year.
[b] SE = Standard error of mean.
[c] Difference between the mean values for the CARB and national studies is not statistically significant.
[d] Difference between the mean values for the CARB and national studies is statistically significant at the 0.05 level.

Source: Robinson and Thomas, 1991.

Table 16-55. Sample Sizes for Sex and Age Groups

Age Group	Group	Sample Size	Age Range
Adults	Men	724	≥18 years
	Women	855	≥18 years
Adolescents	Male	98	12–17 years
	Female	85	12–17 years
Children[a]	Young male	145	6–8 years
	Young female	124	6–8 years
	Old male	156	9–11 years
	Old female	160	9–11 years

[a] Children under the age of 6 are excluded for the present study (too few responses in CARB study).

Source: Funk et al., 1998.

Table 16-56. Assignment of At Home Activities to Inhalation Rate Levels for All Individuals

Children		Adolescent and Adult		
Low	Moderate	Low	Moderate	High
Watching child care	Outdoor cleaning	Night sleep	Food preparation	Outdoor cleaning
Night sleep	Food Preparation	Naps/resting	Food clean-up	
Watch personal care	Metal clean-up	Doing homework	Cleaning house	
Homework	Cleaning house	Radio use	Clothes care	
Radio use	Clothes care	TV use	Car care	
TV use	Car/boat repair	Records/tapes	Household repairs	
Records/tapes	Home repair	Read books	Plant care	
Reading books	Plant care	Read magazines	Animal care	
Reading magazines	Other household	Writing/paperwork	Other household	
Reading newspapers	Pet care	Other passive leisure	Baby care	
Letters/writing	Baby care		Child care	
Other leisure	Child care		Helping/teaching	
Homework/watch TV	Helping/teaching		Talking/reading	
Reading/TV	Talking/reading		Indoor playing	
Reading/listen music	Indoor playing		Outdoor playing	
Paperwork	Outdoor playing		Medical child care	
	Medical child care		Washing	
	Washing, hygiene		Medical care	
	Medical care		Help and care	
	Help and care		Meals at home	
	Meals at home		Dressing/grooming	
	Dressing		Not ascertained	
	Visiting at home		Visiting at home	
	Hobbies		Hobbies	
	Domestic crafts		Domestic crafts	
	Art		Art	
	Music/dance/drama		Music/drama/dance	
	Indoor dance		Games	
	Conservations		Computer use	
	Painting room/home		Conversations	
	Building fire			
	Washing/dressing			
	Outdoor play			
	Playing/eating			
	Playing/talking			
	Playing/watch TV			
	TV/eating			
	TV/something else			
	Reading book/eating			
	Read magazine/eat			
	Read newspaper/eat			

Source: Funk et al., 1998.

Table 16-57. Aggregate Time Spent (minutes/day) At Home in Activity Groups[a]

Activity Group	Adult		Adolescent		Children	
	Mean	SD	Mean	SD	Mean	SD
Low	702	214	789	230	823	153
Moderate	257	183	197	131	241[b]	136
High	9	38	1	11	3	17
$High_{participants}$[c]	92	83	43	72	58	47

[a] Time spent engaging in all activities embodied by inhalation rate category (minutes/day).
[b] Significantly different from adolescents ($p < 0.05$).
[c] Participants in high inhalation rate level activities (i.e., doers).
SD = Standard deviation.

Source: Funk et al., 1998.

Table 16-58. Comparison of Mean Time Spent (minutes/day) At Home, by Sex[a]

	Male		Female	
Activity Group	Mean	SD	Mean	SD
Adults				
Low	691	226	714	200
Moderate	190	150	323[b]	189
High	14	50	4[b]	18
$High_{participants}$[c]	109	97	59[b]	40
Adolescents				
Low	775	206	804	253
Moderate	181	126	241	134
High	2	16	0	0

[a] Time spent engaging in all activities embodied by inhalation rate category (minutes/day).
[b] Significantly different from male ($p < 0.05$).
[c] Participants in high inhalation rate activities (i.e., doers).
SD = Standard deviation.

Source: Funk et al., 1998.

Table 16-59. Comparison of Mean Time Spent (minutes/day) At Home, by Sex and Age for Children[a]								
Activity Group	Male				Female			
	6 to 8 Years		9 to 11 Years		6 to 8 Years		9 to 11 Years	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Low	806	134	860	157	828	155	803	162
Moderate	259	135	198	111	256	141	247	146
High	3	17	7	27	1	9	2	10
$High_{participant}$[b]	77	59	70	54	68	11	30	23

a Time spent engaging in all activities embodied by inhalation rate category (minutes/day).
b Participants in high inhalation rate activities (i.e., doers).
SD = Standard deviation.

Source : Funk et al., 1998.

Table 16-60. Number of Person-Days/Individuals[a] for Children Less than 12 Years in CHAD Database					
Age Group	All Studies	California[b]	Cincinnati[c]	NHAPS-Air	NHAPS-Water
0 Years	223/199	104	36/12	39	44
0 to 6 Months	-	50	15/5	-	-
6 to 12 Months	-	54	21/7	-	-
1 Year	259/238	97	31/11	64	67
12 to 18 Months	-	57	-	-	-
18 to 24 Months	-	40	-	-	-
2 Years	317/264	112	81/28	57	67
3 Years	278/242	113	54/18	51	60
4 Years	259/232	91	41/14	64	63
5 Years	254/227	98	40/14	52	64
6 Years	237/199	81	57/19	59	40
7 Years	243/213	85	45/15	57	56
8 Years	259/226	103	49/17	51	55
9 Years	229/195	90	51/17	42	46
10 Years	224/199	105	38/13	39	42
11 Years	227/206	121	32/11	44	30
Total	3,009/2,640	1,200	556/187	619	634

a The number of person-days of data are the same as the number of individuals for all studies except for the Cincinnati study. Since up to 3 days of activity pattern data were obtained from each participant in this study, the number of person-days of data is approximately 3 times the number of individuals.
b The California study referred to in this table is the Wiley et al. (1991) study.
c The Cincinnati study referred to in this table is the Johnson (1989) study.
\- = No data.

Source: Cohen Hubal et al., 2000.

Table 16-61. Time Spent (hours/day) in Various Microenvironments, by Age

Age (years)	Average Time ± Standard Deviation (Percent > 0 Hours)				
	Indoors at Home	Outdoors at Home	Indoors at School	Outdoors at Park	In Vehicle
0	19.6 ± 4.3 (99)	1.4 ± 1.5 (20)	3.5 ± 3.7 (2)	1.6 ± 1.5 (9)	1.2 ± 1.0 (65)
1	19.5 ± 4.1 (99)	1.6 ± 1.3 (35)	3.4 ± 3.8 (5)	1.9 ± 2.7 (10)	1.1 ± 0.9 (66)
2	17.8 ± 4.3 (100)	2.0 ± 1.7 (46)	6.2 ± 3.3 (9)	2.0 ± 1.7 (17)	1.2 ± 1.5 (76)
3	18.0 ± 4.2 (100)	2.1 ± 1.8 (48)	5.7 ± 2.8 (14)	1.5 ± 0.9 (17)	1.4 ± 1.9 (73)
4	17.3 ± 4.3 (100)	2.4 ± 1.8 (42)	4.9 ± 3.2 (16)	2.3 ± 1.9 (20)	1.1 ± 0.8 (78)
5	16.3 ± 4.0 (99)	2.5 ± 2.1 (52)	5.4 ± 2.5 (39)	1.6 ± 1.5 (28)	1.3 ± 1.8 (80)
6	16.0 ± 4.2 (98)	2.6 ± 2.2 (48)	5.8 ± 2.2 (34)	2.1 ± 2.4 (32)	1.1 ± 0.8 (79)
7	15.5 ± 3.9 (99)	2.6 ± 2.0 (48)	6.3 ± 1.3 (40)	1.5 ± 1.0 (28)	1.1 ± 1.1 (77)
8	15.6 ± 4.1 (99)	2.1 ± 2.5 (44)	6.2 ± 1.1 (41)	2.2 ± 2.4 (37)	1.3 ± 2.1 (82)
9	15.2 ± 4.3 (99)	2.3 ± 2.8 (49)	6.0 ± 1.5 (39)	1.7 ± 1.5 (34)	1.2 ± 1.2 (76)
10	16.0 ± 4.4 (96)	1.7 ± 1.9 (40)	5.9 ± 1.5 (39)	2.2 ± 2.3 (40)	1.1 ± 1.1 (82)
11	14.9 ± 4.6 (98)	1.9 ± 2.3 (45)	5.9 ± 1.5 (41)	2.0 ± 1.7 (44)	1.6 ± 1.9 (74)

Source: Cohen Hubal et al., 2000.

Table 16-62. Mean Time Children Spent (hours/day) Doing Various Macroactivities While Indoors at Home

Age (years)	Mean Time (Percent > 0 Hours)						
	Eat	Sleep or Nap	Shower or Bath	Play Games	Watch TV or Listen to Radio	Read, Write, Homework	Think, Relax, Passive
0	1.9 (96)	12.6 (99)	0.4 (44)	4.3 (29)	1.1 (9)	0.4 (4)	3.3 (62)
1	1.5 (97)	12.1 (99)	0.5 (56)	3.9 (68)	1.8 (41)	0.6 (19)	2.3 (20)
2	1.3 (92)	11.5 (100)	0.5 (53)	2.5 (59)	2.1 (69)	0.6 (27)	1.4 (18)
3	1.2 (95)	11.3 (99)	0.4 (53)	2.6 (59)	2.6 (81)	0.8 (27)	1.0 (19)
4	1.1 (93)	10.9 (100)	0.5 (52)	2.6 (54)	2.5 (82)	0.7 (31)	1.1 (17)
5	1.1 (95)	10.5 (98)	0.5 (54)	2.0 (49)	2.3 (85)	0.8 (31)	1.2 (19)
6	1.1 (94)	10.4 (98)	0.4 (49)	1.9 (35)	2.3 (82)	0.9 (38)	1.1 (14)
7	1.0 (93)	9.9 (99)	0.4 (56)	2.1 (38)	2.5 (84)	0.9 (40)	0.6 (10)
8	0.9 (91)	10.0 (96)	0.4 (51)	2.0 (35)	2.7 (83)	1.0 (45)	0.7 (7)
9	0.9 (90)	9.7 (96)	0.5 (43)	1.7 (28)	3.1 (83)	1.0 (44)	0.9 (17)
10	1.0 (86)	9.6 (94)	0.4 (43)	1.7 (38)	3.5 (79)	1.5 (47)	0.6 (10)
11	0.9 (89)	9.3 (94)	0.4 (45)	1.9 (27)	3.1 (85)	1.1 (47)	0.6 (10)

Source: Cohen Hubal et al., 2000.

Table 16-63. Time Children Spent (hours/day) in Various Microenvironments, by Age Recast into New Standard Age Categories

Age Group	*N*	Indoors at Home		Outdoors at Home		Indoors at School		Outdoors at Park		In Vehicle	
		Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing
Birth to <1 month	123	19.6	98	1.7	21	4.3	3	1.3	3	1.3	63
1 to <3 months	33	20.9	100	1.8	9	0.2	3	1.6	9	1.3	27
3 to <6 months	120	19.6	100	0.8	8	7.8	7	1.3	6	1.1	14
6 to <12 months	287	19.1	99	1.1	15	7.6	8	1.8	5	1.3	14
1 to <2 years	728	19.2	99	1.4	34	6.4	9	1.5	5	1.1	27
2 to <3 years	765	18.2	99	1.8	38	6.8	12	2.1	7	1.3	28
3 to <6 years	2,110	17.3	100	1.9	43	5.9	26	1.6	10	1.3	29
6 to <11 years	3,283	15.7	99	1.9	40	6.5	44	2.1	17	1.1	29
11 to <16 years	2,031	15.5	97	1.7	30	6.6	45	2.6	15	1.3	42
16 to <21 years	1,005	14.6	98	1.4	20	5.7	33	3.1	10	1.7	90

N = Sample size.

Source: Based on data source (CHAD) used by Cohen Hubal et al., 2000.

Table 16-64. Time Children Spent (hours/day) in Various Macroactivities While Indoors at Home Recast Into New Standard Age Categories

Age Group	*N*	Eat		Sleep or Nap		Shower or Bath		Play Game		Watch TV/ Listen to Radio		Read, Write, Homework		Think, Relax, Passive	
		Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing	Mean Time	% Doing
Birth to <1 month	123	2.2	98	13.0	100	0.5	41	5.0	53	1.3	8	0.7	2	2.7	48
1 to <3 months	33	2.4	100	14.8	100	0.4	24	0.7	6	1.6	15	0.0	0	3.5	79
3 to <6 months	120	2.0	100	13.5	100	0.5	9	1.3	31	1.0	21	1.1	3	2.5	59
6 to <12 months	287	1.8	100	12.9	100	0.4	11	1.1	30	1.3	25	0.5	4	2.5	35
1 to <2 years	728	1.7	99	12.5	100	0.5	21	3.2	45	1.8	52	0.6	13	1.4	26
2 to <3 years	765	1.5	98	12.0	100	0.5	22	2.6	45	2.0	77	0.6	18	0.8	30
3 to <6 years	2,110	1.4	99	11.2	100	0.5	38	2.5	38	2.3	86	0.7	25	0.8	28
6 to <11 years	3,283	1.2	98	10.2	100	0.4	54	2.0	28	2.6	84	1.0	43	0.8	20
11 to <16 years	2,031	1.1	94	9.7	98	0.4	50	1.8	18	3.0	85	1.4	45	0.8	20
16 to <21 years	1,005	1.0	84	8.9	98	0.4	45	1.9	5	3.2	73	2.2	37	1.3	24

N = Sample size.

Source: Based on data source (CHAD) used by Cohen Hubal et al., 2000.

Table 16-65. Number and Percentage of Respondents with Children and Those Reporting Outdoor Play[a] Activities in Both Warm and Cold Weather

Source	Respondents with Children	Child Player[a]		Child Non-Player		Warm Weather Player[b]	Cold Weather Player	Player in Both Seasons
	N	*N*	%	*N*	%	*N*	*N*	%
SCS-II base	197	128	65.0	69	35.0	127	100	50.8
SCS-II over sample	483	372	77.0	111	23.0	370	290	60.0
Total	680	500	73.5	180	26.5	497	390	57.4

a "Play" and "player" refer specifically to participation in outdoor play on bare dirt or mixed grass and dirt.
b Does not include three "Don't know/refused" responses regarding warm weather play.
N = Sample size.

Source: Wong et al., 2000.

Table 16-66. Play Frequency and Duration for all Child Players (from SCS-II data)

Statistic	Cold Weather			Warm Weather		
	Frequency (days/week)	Duration (hours/day)	Total (hours/week)	Frequency (days/week)	Duration (hours/day)	Total (hours/week)
N	372	374	373	488	479	480
5th Percentile	1	1	1	2	1	4
50th Percentile	3	1	5	7	3	20
95th Percentile	7	4	20	7	8	50

N = Sample size.

Source: Wong et al., 2000.

Table 16-67. Hand Washing and Bathing Frequency for all Child Players (from SCS-II data)

Statistic	Cold Weather		Warm Weather	
	Hand Washing (times/day)	Bathing (times/week)	Hand Washing (times/day)	Bathing (times/week)
N	329	388	433	494
5th Percentile	2	2	2	3
50th Percentile	4	7	4	7
95th Percentile	10	10	12	14

N = Sample size.

Source: Wong et al., 2000.

Table 16-68. NHAPS and SCS-II Play Duration[a] Comparison (Children Only)

Data Source	Mean Play Duration (minutes/day)			χ^2 test[b]
	Cold Weather	Warm Weather	Total	
NHAPS	114	109	223	$p < 0.0001$
SCS-II	102	206	308	

[a] Selected previous day activities in NHAPS; average day outdoor play on bare dirt or mixed grass and dirt in SCS-II.
[b] 2×2 Chi-square test for contingency between NHAPS and SCS-II.

Source: Wong et al., 2000.

Table 16-69. NHAPS and SCS-II Hand Wash Frequency[a] Comparison (Children only)

Data Source	Season	Percent[b] Reporting Frequency (times/day) of:								χ^2 test[c]
		0	1–2	3–5	6–9	10–19	20–29	30+	"Don't Know"	
NHAPS	Cold	3	18	51	17	7	1	1	3	$p = 0.06$
SCS-II	Cold	1	16	50	11	7	1	0	15	
NHAPS	Warm	3	18	51	15	7	2	1	4	$p = 0.001$
SCS-II	Warm	0	12	46	16	10	1	0	13	

[a] Selected previous day activities in NHAPS; average day outdoor play on bare dirt or mixed grass and dirt in SCS-II.
[b] Results are reported as percentage of total for clarity. Incidence data were used in statistical tests.
[c] 2×2 Chi-square test for contingency between NHAPS and SCS-II.

Source: Wong et al., 2000.

Table 16-70. Time Spent (minutes/day) Outdoors Based on CHAD Data (Doers Only)[a]

Age Group	*N*	Time Spent Outdoors					COV(%)	Participation[b] (%)
		Minimum	Median	Maximum	Mean	SD		
<1 month	57	2	60	700	99	124	125	47
1 to 2 months	5	4	60	225	102	90	89	36
3 to 5 months	27	10	90	510	114	98	86	23
6 to 11 months	91	5	60	450	91	76	84	33
1 year	389	1	75	1,035	102	99	97	58
2 years	448	1	100	550	134	108	80	64
3 to 5 years	1,336	1	120	972	146	117	80	68
6 to 10 years	2,216	1	120	1,440	162	144	89	71
11 to 15 years	1,423	1	110	1,440	154	163	106	73
16 to 17 years	356	1	85	1,083	129	145	112	81
18 to 20 years	351	1	70	788	132	155	118	72
21 to 44 years	3,660	1	61	1,305	131	165	126	62
45 to 64 years	1,914	1	69	1,015	135	162	120	62
>64 years	1,002	1	65	840	118	130	110	57

a Only data for individuals that spent >0 time outdoors and had 30 or more records are included in the analysis.

b Participation rates or percent of sample days in the study spending some time (>0 minutes per day) outdoors. The mean time spent outdoors for the age group may be obtained by multiplying the participation rate by the mean time shown above.

SD = Standard deviation.

COV = Coefficient of variation (SD/mean × 100).

Source: Graham and McCurdy, 2004.

Table 16-71. Comparison of Daily Time Spent Outdoors (minutes/day), Considering Sex and Age Cohort (Doers Only)[a]

Age Group	Sex	*N*	Time Spent Outdoors in Minutes: Minimum	Median	Maximum	Mean	SD	COV (%)	K-S Test[b]: D_n	χ^2	*p*	Reject H_0
<1 month	Male	35	7	69	700	116	144	125	0.24	0.90X	0.3964	No
		22	2	58	333	73	78	106				
1 to 2 months	Male	4	4	58	165	71	68	95	Cannot Test			
		1	225	225	225	225	-	0				
3 to 5 months	Male	20	10	86	210	89	56	63	0.42	0.96	0.3158	No
		7	50	140	510	187	153	81				
6 to 11 months	Male	53	10	60	450	95	83	87	0.07	1.00	0.3200	No
		38	5	68	270	86	67	77				
1 year	Male	184	1	80	1,035	110	114	104	0.07	0.71	0.6896	No
	Female	205	4	70	511	95	82	86				
2 years	Male	232	1	105	550	136	105	77	0.09	1.00	0.2705	No
	Female	216	2	90	525	131	111	84				
3 to 5 years	Male	723	1	120	972	146	119	81	0.04	0.74	0.6465	No
	Female	612	2	120	701	144	113	78				
6 to 10 years	Male	1,228	1	132	1,440	173	148	86	0.09	2.05	0.0004	Yes
	Female	987	2	115	1,380	148	138	93				
11 to 15 years	Male	779	1	125	1,440	171	169	99	0.17	3.12	<0.0001	Yes
	Female	640	1	90	1,371	134	153	114				
16 to 17 years	Male	168	2	113	810	151	147	97	0.19	1.80	0.0030	Yes
	Female	188	1	68	1,083	109	141	127				
18 to 20 years	Male	184	2	95	788	162	176	109	0.20	1.84	0.0023	Yes
	Female	167	1	50	606	99	119	120				
21 to 44 years	Male	1,702	1	82	1,005	164	191	117	0.14	4.23	<0.0001	Yes
	Female	1,956	1	55	1,305	103	133	129				
45 to 64 years	Male	839	1	91	1,015	178	193	109	0.18	3.90	<0.0001	Yes
		1,075	1	58	930	102	124	121				
>64 years	Male	396	2	118	840	164	156	96	0.25	3.81	<0.0001	Yes
	Female	605	1	60	630	88	98	111				

[a] Only data for individuals that spent >0 time outdoors and had 30 or more records are included in the analysis.
[b] The 2-sample Kolmogoroz-Smirnov (K-S) test H_0 is that the distribution of variable 1 is the same as variable 2, using D_n (test statistic) and a χ^2 test statistic at α = 0.050.
\- Data not available.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean × 100).
Source: Graham and McCurdy, 2004.

Table 16-72. Time Spent (minutes/day) Indoors Based on CHAD Data (Doers Only)[a]

Age Group	*N*	Time Spent Indoors					COV (%)	Participation[b] (%)
		Minimum	Median	Maximum	Mean	SD		
<1 month	121	490	1,380	1,440	1,336	137	10	100.0
1 to 2 months	14	1,125	1,380	1,440	1,348	105	8	100.0
3 to 5 months	115	840	1,385	1,440	1,359	93	7	100.0
6 to 11 months	278	840	1,370	1,440	1,353	81	6	100.0
1 year	668	315	1,350	1,440	1,324	107	8	100.0
2 years	700	290	1,319	1,440	1,286	138	11	100.0
3 to 5 years	1,977	23	1,307	1,440	1,276	136	11	100.0
6 to 10 years	3,118	7	1,292	1,440	1,256	153	12	100.0
11 to 15 years	1,939	69	1,300	1,440	1,255	160	13	99.8
16 to 17 years	438	161	1,296	1,440	1,251	171	14	100.0
18 to 20 years	485	512	1,310	1,440	1,242	180	15	100.0
21 to 44 years	5,872	60	1,317	1,440	1,259	176	14	100.0
45 to 64 years	3,073	23	1,320	1,440	1,262	172	14	100.0
>64 years	1,758	600	1,350	1,440	1,310	141	11	100.0

[a] Only data for individuals that spent >0 time indoors and had 30 or more records are included in the analysis.
[b] Participation rates or percent of sample days in the study spending some time (>0 minutes/day) indoors. The mean time spent indoors for the age group may be obtained by multiplying the participation rate (as a decimal) by the mean time shown above.
N = Sample size.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean × 100).

Source: Graham and McCurdy, 2004.

Table 16-73. Time Spent (minutes/day) in Motor Vehicles Based on CHAD Data (Doers Only)[a]

Age Group	*N*	Time Spent in Motor Vehicle					COV (%)	Participation[b] (%)
		Minimum	Median	Maximum	Mean	SD		
<1 month	80	2	68	350	86	68	79	66
1 to 2 months	9	20	83	105	67	32	48	64
3 to 5 months	75	13	60	335	71	49	69	65
6 to 11 months	226	4	51	425	62	47	76	81
1 year	515	1	52	300	67	50	76	77
2 years	581	2	54	955	73	76	104	83
3 to 5 years	1,702	1	55	1,389	70	70	99	86
6 to 10 years	2,766	1	58	1,214	71	68	95	89
11 to 15 years	1,685	1	60	825	76	74	97	87
16 to 17 years	400	4	73	1,007	92	90	98	91
18 to 20 years	449	4	76	852	109	106	98	93
21 to 44 years	5,429	1	80	1,440	105	100	96	92
45 to 64 years	2,739	1	75	1,357	102	105	103	89
>64 years	1,259	4	60	798	86	85	99	72

[a] Only data for individuals that spent >0 time in motor vehicles and had 30 or more records are included in the analysis.
[b] Participation rates or percent of sample days in the study spending some time (>0 minutes/day) in motor vehicles. The mean time spent in motor vehicles for the age group may be obtained by multiplying the participation rate (as a decimal) by the mean time shown above.

N = Sample size.
SD = Standard deviation.
COV = Coefficient of variation (SD/mean × 100).

Source: Graham and McCurdy, 2004.

Table 16-74. Mean Time Spent (minutes/day) in Various Activity Categories, by Age—Weekday (children only)

Activity Category	2002–2003				1981–1982			
	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years
Market work	0	0	1	22	-	-	-	28
Household work	25	32	38	39	15	18	27	34
Personal care	68	66	68	73	49	40	56	60
Eating	60	57	54	49	81	73	69	67
Sleeping, naps	607	583	542	515	595	548	473	499
School	406	398	395	352	292	315	344	314
Studying	29	39	49	50	8	29	33	33
Church	4	5	5	3	9	9	9	3
Visiting, socializing	16	25	25	53	-	-	-	-
Sports	10	17	33	33	24	21	40	46
Outdoor Activities	6	6	4	6	9	8	7	11
Hobbies	1	1	1	2	2	2	4	6
Art Activities	8	7	7	4	4	3	3	12
Television	94	106	111	115	99	146	142	108
Other passive leisure	9	10	24	39	-	-	-	-
Playing	74	56	45	35	111	65	31	14
Reading	11	12	11	7	5	9	10	12
Being read to	2	1	0	0	-	-	-	-
Computer activities	6	10	25	38	-	-	-	-
Missing data	4	8	4	6	-	-	-	-

- Data not provided.

Source: Juster et al., 2004.

Table 16-75. Mean Time Spent (minutes/day) in Various Activity Categories, by Age—Weekend Day (children only)

Activity Category	2002–2003				1981–1982			
	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years	6 to 8 years	9 to 11 years	12 to 14 years	15 to 17 years
Market work	0	0	9	39	-	-	-	48
Household work	81	91	100	79	27	51	72	60
Personal care	78	72	73	77	45	44	60	51
Eating	89	80	69	64	80	78	68	65
Sleeping, naps	666	644	633	629	641	596	604	562
School	3	6	7	7	-	-	-	-
Studying	5	9	20	24	2	12	15	30
Church	41	37	36	30	56	53	32	37
Visiting, socializing	61	66	58	91	-	-	-	-
Sports	23	40	40	27	30	42	51	37
Outdoor Activities	12	12	12	11	23	39	25	26
Hobbies	2	1	4	5	5	3	8	3
Art Activities	11	7	9	6	4	4	7	10
Television	155	184	181	162	136	185	169	157
Other passive leisure	14	15	40	54	-	-	-	-
Playing	163	134	148	59	180	92	35	21
Reading	14	15	13	7	9	10	10	18
Being read to	1	1	0	0	-	-	-	-
Computer activities	12	19	39	58	-	-	-	-
Missing data	9	8	9	11	-	-	-	-

- Data not provided.

Source: Juster et al., 2004.

Table 16-76. Mean Time Spent (minutes/week) in Various Activity Categories for Children, Ages 6 to 17 Years

Activity Category	2002–2003	1981–1982
Market work	53	126
Household work	343	223
Personal care	493	356
Eating	426	508
Sleeping, naps	4,092	3,758
School	1,947	1,581
Studying	238	158
Church	94	125
Visiting, socializing	287	132
Sports	179	244
Outdoor Activities	50	100
Hobbies	12	27
Art Activities	48	40
Television	876	944
Other passive leisure	166	39
Playing	485	440
Reading	77	69
Being read to	5	3
Computer activities	165	0
Missing data	45	1,206

Source: Juster et al., 2004.

Table 16-77. Time Spent (minutes/2-day period)[a] in Various Activities by Children Participating in the Panel Study of Income Dynamics (PSID), 1997 Child Development Supplement (CDS)

Age Group	Boys (*N* = 1,444)		Girls (*N* = 1,387)	
	Mean[a]	Standard Deviation	Mean[a]	Standard Deviation
Television Use				
1 to 5 years	197	168	184	163
6 to 8 years	263	165	239	159
9 to 12 years	251	185	266	194
Electronic Game Use				
1 to 5 years	8	38	5	40
6 to 8 years	44	113	14	39
9 to 12 years	57	102	18	47
Computer Use				
1 to 5 years	7	28	7	35
6 to 8 years	13	43	8	28
9 to 12 years	27	71	15	43
Print Use[b]				
1 to 5 years	21	32	23	34
6 to 8 years	20	37	20	32
9 to 12 years	19	47	29	56
Highly Active Activities[c]				
1 to 5 years	42	74	34	78
6 to 8 years	107	123	62	92
9 to 12 years	137	149	63	88
Moderately Active Activities[d]				
1 to 5 years	55	81	59	92
6 to 8 years	31	65	37	69
9 to 12 years	40	73	46	89
Sedentary Activities[e]				
1 to 5 years	55	71	54	71
6 to 8 years	75	77	80	84
9 to 12 years	110	109	122	111

[a] Means represent minutes spent in each activity over a 2-day period (1 weekday and 1 weekend day).
[b] Print use represents time spent using print media including reading and being read to.
[c] Includes all sport activities such as basketball, soccer, swimming, running or bicycling.
[d] Includes activities such as singing, camping, taking music lessons, fishing, and boating.
[e] Includes activities such as playing board games, doing puzzles, talking on the phone, and relaxing.
N = Sample size.

Source: Vanderwater et al., 2004.

Table 16-78. Annual Average Time Spent (hours/day) On Various Activities According to Age, Race, Ethnicity, Marital Status, and Educational Level (ages 15 years and over)

Characteristic	Personal care[a]	Eating and Drinking[b]	Household Activity[c]	Purchasing Goods and Services[d]	Caring for and Helping Household Member[e]	Caring for and Helping Non-Household Member[f]	Working on WorkRrelated Activity[g]	Educational Activity[h]	Organizational Civic and Religious Activity[i]	Leisure and Sport[j]	Telephone Call, Mail, and E-mail[k]	Other Activity not Elsewhere Classified[l]
Age (years)												
15+	9.41	1.23	1.79	0.81	0.53	0.21	3.75	0.49	0.30	5.09	0.19	0.21
15 to 19	10.30	1.07	0.76	0.56	0.15	0.21	1.39	3.29	0.34	5.40	0.33	0.22
20 to 24	9.64	1.21	1.05	0.67	0.51	0.20	4.23	0.80	0.21	5.03	0.19	0.24
25 to 34	9.31	1.19	1.55	0.81	1.07	0.12	4.77	0.39	0.16	4.30	0.14	0.17
35 to 44	9.12	1.18	1.87	0.87	0.98	0.19	4.96	0.15	0.30	4.09	0.13	0.16
45 to 54	9.10	1.17	1.97	0.82	0.36	0.24	5.06	0.09	0.29	4.52	0.17	0.20
55 to 64	9.19	1.31	2.11	0.91	0.16	0.28	3.80	0.04	0.39	5.41	0.18	0.20
65 to 74	9.68	1.44	2.64	0.93	0.13	0.30	0.94	0.05	0.38	6.97	0.24	0.29
75+	9.83	1.50	2.32	0.80	0.12	0.21	0.34	0.06	0.43	7.82	0.30	0.27
Sex												
Male	9.21	1.25	1.33	0.64	0.33	0.18	4.53	0.45	0.29	5.47	0.12	0.20
Female	9.59	1.22	2.23	0.96	0.71	0.24	3.02	0.53	0.31	4.72	0.26	0.22
Race/Ethnicity												
White	9.30	1.28	1.85	0.81	0.53	0.21	3.76	0.47	0.29	5.09	0.18	0.21
Black	10.08	0.87	1.38	0.75	0.46	0.20	3.54	0.43	0.37	5.49	0.25	0.18
Hispanic/Latino	9.67	1.18	1.85	0.77	0.60	0.15	3.92	0.69	0.23	4.63	0.13	0.18
Marital Status												
Married	9.12	1.28	2.09	0.88	0.75	0.21	4.08	0.11	0.33	4.79	0.14	0.21
Other	9.75	1.18	1.43	0.72	0.25	0.22	3.34	0.94	0.27	5.45	0.25	0.20
Education												
< High School grad	9.86	1.10	2.38	0.80	0.50	0.20	2.57	0.04	0.25	6.01	0.10	0.17
HS grad, no college	9.42	1.19	2.05	0.76	0.46	0.25	3.58	0.07	0.28	5.57	0.15	0.21
Some college	9.21	1.24	1.94	0.92	0.58	0.23	4.25	0.22	0.29	4.76	0.19	0.18
BS or higher	8.94	1.41	1.77	0.91	0.71	0.18	4.72	0.22	0.37	4.33	0.22	0.23

a Includes sleeping, bathing, dressing, health-related self-care, and personal and private activities.
b Includes time spent eating or drinking (except when identified as part of work or volunteer activity); does not include time spent purchasing meals, snacks, or beverages.
c Includes housework, cooking, yard care, pet care, vehicle maintenance and repair, home maintenance, repair, decoration, and renovation.
d Includes purchase of consumer goods, professional (e.g., banking, legal, medical, real estate) and personal care services (e.g., hair salons, barbershops, day spas, tanning salons), household services (e.g., housecleaning, lawn care and landscaping, pet care, dry cleaning, vehicle maintenance, construction), and government services (e.g., applying for food stamps, government required licenses, or paying fines).
e Includes time spent caring or helping to care for child or adult household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up, or waiting for children).
f Includes time spent caring or helping to care for child or adult who is not a household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children). Does not include activities done through a volunteer organization.
g Includes time spent as part of the job, income-generating activities, or job search activities. Also includes travel time for work-related activities.
h Includes taking classes, doing research and homework, registering for classes, and before and after school extra-curricular activities, except sports.
i Includes time spent volunteering for or through civic obligations (e.g., jury duty, voting, attending town hall meetings), or through participating in religious or spiritual activities (e.g., church choir, youth groups, praying).
j Includes sports, exercise, and recreation. This category is broken down into subcategories for the 15 to 19 years old age category.
k Includes telephone use, mail, and e-mail. Does not include communications related to purchase of goods and services or those related to work or volunteering.
l Includes residual activities that could not be coded or where information was missing.

Source: DOL, 2007.

Table 16-79. Annual Average Time Use by the U.S. Civilian Population, Ages 15 Years and Older

Activity	hours/day				
	Total	Male	Female	Weekday	Weekend and Holiday
Personal Care[a]	9.41	9.21	9.59	9.12	10.08
sleeping	8.63	8.56	8.69	8.33	9.32
Eating and Drinking[b]	1.23	1.25	1.22	1.18	1.37
Household Activities[c]	1.79	1.33	2.23	1.66	2.11
housework	0.61	0.25	0.95	0.57	0.70
food preparation/cleanup	0.53	0.29	0.75	0.51	0.57
lawn and garden care	0.20	0.26	0.14	0.16	0.27
household management	0.13	0.11	0.14	0.12	0.15
Purchasing Goods and Services[d]	0.81	0.64	0.96	0.76	0.93
consumer goods purchase	0.40	0.29	0.51	0.34	0.53
professional/personal goods purchase	0.09	0.06	0.11	0.10	0.04
Caring for and Helping Household Members[e]	0.53	0.33	0.71	0.56	0.45
caring for household children	0.41	0.24	0.57	0.43	0.37
Caring for and Helping Non-Household Members[f]	0.21	0.18	0.24	0.19	0.26
caring for non-household adults	0.07	0.07	0.08	0.06	0.11
Working on Work-related Activities[g]	3.75	4.53	3.02	4.77	1.36
Working	3.40	4.10	2.74	4.33	1.23
Educational Activities[h]	0.49	0.45	0.53	0.63	0.16
attending classes	0.30	0.29	0.32	0.42	0.04
homework and research	0.15	0.12	0.17	0.16	0.10
Organizational Civic and Religious Activities[i]	0.30	0.29	0.31	0.20	0.53
religious and spiritual activities	0.12	0.11	0.13	0.04	0.30
volunteering (organizational and civic activities)	0.13	0.13	0.13	0.13	0.15
Leisure and Sports[j]	5.09	5.47	4.72	4.54	6.37
socializing and communicating	0.76	0.71	0.80	0.60	1.11
watching TV	2.58	2.80	2.36	2.35	3.10
sports, exercise, recreation	0.28	0.38	0.18	0.26	0.33
Telephone Calls, Mail, and E-mail[k]	0.19	0.12	0.26	0.20	0.17
Other Activities not Elsewhere Classified[l]	0.21	0.20	0.22	0.20	0.22

[a] Includes sleeping, bathing, dressing, health-related self-care, and personal and private activities.

[b] Includes time spent eating or drinking (except when identified as part of work or volunteer activity); does not include time spent purchasing meals, snacks, or beverages.

[c] Includes housework, cooking, yard care, pet care, vehicle maintenance and repair, home maintenance, repair, decoration, and renovation.

[d] Includes purchase of consumer goods, professional (e.g., banking, legal, medical, real estate) and personal care services (e.g., hair salons, barbershops, day spas, tanning salons), household services (e.g., housecleaning, lawn care and landscaping, pet care, dry cleaning, vehicle maintenance, construction), and government services (e.g., applying for food stamps, government required licenses or paying fines).

[e] Includes time spent caring or helping to care for child or adult household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children).

[f] Includes time spent caring or helping to care for child or adult who is not a household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children). Does not include activities done through a volunteer organization.

[g] Includes time spent as part of the job, income-generating activities, or job search activities. Also includes travel time for work-related activities.

[h] Includes taking classes, doing research and homework, registering for classes, and before and after school extra-curricular activities, except sports.

[i] Includes time spent volunteering for or through civic obligations (e.g., jury duty, voting, attending town hall meetings), or through participating in religious or spiritual activities (e.g., church choir, youth groups, praying).

[j] Includes sports, exercise, and recreation. This category is broken down into subcategories for the 15 to 19 years old age category.

[k] Includes telephone use, mail and e-mail. Does not include communications related to purchase of goods and services or those related to work or volunteering.

[l] Includes residual activities that could not be coded or where information was missing.

Source: DOL, 2007.

Table 16-80. Mean Time Use (hours/day) by Children, Ages 15 to 19 Years

Activity	hours/day		
	Male	Female	All
Personal Care[a]	10.26	10.34	10.30
Eating and Drinking[b]	1.02	1.11	1.07
Household Activities[c]	0.61	0.92	0.76
Purchasing Goods and Services[d]	0.38	0.74	0.56
Caring for and Helping Household Members[e]	0.10	0.19	0.15
Caring for and Helping Non-Household Members[f]	0.20	0.23	0.21
Working on Work-related Activities[g]	1.53	1.24	1.39
Educational Activities[h]	3.08	3.51	3.29
Organizational Civic and Religious Activities[i]	0.34	0.33	0.34
Leisure and Sports[j]	6.02	4.75	5.40
total leisure and sports – weekdays	-	-	4.85
total leisure and sports – weekends	-	-	6.68
sports, exercise, recreation – weekdays	-	-	0.58
sports, exercise, recreation – weekends/holidays	-	-	0.69
socializing and communicating – weekdays	-	-	0.76
socializing and communicating, – weekends/holidays	-	-	1.32
watching TV – weekdays	-	-	1.96
watching TV – weekends/holidays	-	-	2.45
reading – weekdays	-	-	0.11
reading – weekends/holidays	-	-	0.11
relaxing, thinking – weekdays	-	-	0.15
relaxing, thinking – weekends/holidays	-	-	0.13
playing games, computer use for leisure – weekdays	-	-	0.69
playing games, computer use for leisure – weekends/holidays	-	-	1.00
other sports/leisure including travel – weekdays	-	-	0.61
other sports/leisure including travel – weekends/holidays	-	-	0.98
Telephone Calls, Mail, and E-mail[k]	0.24	0.42	0.33
Other Activities not Elsewhere Classified[l]	0.23	0.21	0.22

[a] Includes sleeping, bathing, dressing, health-related self-care, and personal and private activities.
[b] Includes time spent eating or drinking (except when identified as part of work or volunteer activity); does not include time spent purchasing meals, snacks, or beverages.
[c] Includes housework, cooking, yard care, pet care, vehicle maintenance and repair, home maintenance, repair, decoration, and renovation.
[d] Includes purchase of consumer goods, professional (e.g., banking, legal, medical, real estate) and personal care services (e.g., hair salons, barbershops, day spas, tanning salons), household services (e.g., housecleaning, lawn care and landscaping, pet care, dry cleaning, vehicle maintenance, construction), and government services (e.g., applying for food stamps, government required licenses or paying fines).
[e] Includes time spent caring or helping to care for child or adult household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children).
[f] Includes time spent caring or helping to care for child or adult who is not a household member (e.g., physical care, playing with children, reading to child or adult, attending to health care needs, dropping off, picking up or waiting for children). Does not include activities done through a volunteer organization.
[g] Includes time spent as part of the job, income-generating activities, or job search activities. Also includes travel time for work-related activities.
[h] Includes taking classes, doing research and homework, registering for classes, and before and after school extra-curricular activities, except sports.
[i] Includes time spent volunteering for or through civic obligations (e.g., jury duty, voting, attending town hall meetings), or through participating in religious or spiritual activities (e.g., church choir, youth groups, praying).
[j] Includes sports, exercise, and recreation. This category is broken down into subcategories for the 15 to 19 years old age category.
[k] Includes telephone use, mail and e-mail. Does not include communications related to purchase of goods and services or those related to work or volunteering.
[l] Includes residual activities that could not be coded or where information was missing.

Source: DOL, 2007.

Table 16-81. Mean Time Spent (minutes/day) in Moderate-to-Vigorous Physical Activity (children only)

Age (years)	Number of Participants		Weekday Mean (SD)			Weekend Mean (SD)		
	Boys	Girls	Boys	Girls	Both	Boys	Girls	Both
9	555	543	190.8(53.2)	173.3(46.6)	181.8(50.6)	184.3(68.6)	173.3(64.3)	178.6(66.6)
11	544	540	133.0(42.9)	115.6(36.3)	124.1(40.6)	127.1(59.5)	112.6(53.2)	119.7(56.8)
12	532	532	105.3(40.2)	86.0(32.5)	95.6(37.8)	93.4(55.3)	73.9(45.8)	83.6(51.7)
15	503	506	58.2(31.8)	38.7(23.6)	49.2(29.9)	43.2(38.0)	25.5(23.3)	35.1(33.3)

SD = Standard deviation.

Source: Nader et al., 2008.

Table 16-82. Occupational Tenure of Employed Individuals[a] by Age and Sex

Age Group (years)	Median Tenure (years)					
	N	All Workers	*N*	Men	*N*	Women
16 to 24	19,090	1.9	9,520	2.0	9,270	1.9
25 to 29	16,326	4.4	8,974	4.6	7,353	4.1
30 to 34	15,833	6.9	8,971	7.6	6,863	6.0
35 to 39	14,674	9.0	8,109	10.4	6,565	7.0
40 to 44	11,871	10.7	6,463	13.8	5,408	8.0
45 to 49	9,350	13.3	5,208	17.5	4,152	10.0
50 to 54	7,684	15.2	4,341	20.0	3,343	10.8
55 to 59	6,914	17.7	4,006	21.9	2,908	12.4
60 to 64	4,500	19.4	2,673	23.9	1,827	14.5
65 to 69	1,692	20.1	1,000	26.9	692	15.6
70 and older	1,146	21.9	678	30.5	467	18.8
Total	109,090	6.6	60,242	7.9	41,949	5.4

[a] Working population = 109.1 million persons.

N = Number of individuals.

Source: Carey, 1988.

Table 16-83. Occupational Tenure for Employed Individuals[a] Grouped by Sex and Race

Race	Median Tenure (years)					
	N	All Individuals	*N*	Men	*N*	Women
White	95,044	6.7	53,096	8.3	41,949	5.4
Black	10,851	5.8	5,447	5.8	5,404	5.8
Hispanic	7,198	4.5	4,408	5.1	2,790	3.7

[a] Working population = 109.1 million persons.
N = Number of individuals.

Source: Carey, 1988.

Table 16-84. Occupational Tenure for Employed Individuals[a] Grouped by Sex and Employment Status

Employment Status	Median Tenure (years)					
	N	All Individuals	*N*	Men	*N*	Women
Full-Time	93,665	7.2	55,464	8.4	38,201	5.9
Part-Time	15,425	3.1	4,778	2.4	10,647	3.6

[a] Working population = 109.1 million persons.
N = Number of individuals.

Source: Carey, 1988.

Table 16-85. Occupational Tenure of Employed Individuals[a] Grouped by Major Occupational Groups and Age

Occupational Group	Total[b]	Median Tenure (years)					
		Age Group (years)					
		16–24	25–34	35–44	45–54	55–64	65+
Executive, Administrative, and Managerial	8.4	2.4	5.6	10.1	15.1	17.9	26.3
Professional Specialty	9.6	2.0	5.7	12.0	18.2	25.6	36.2
Technicians and Related Support	6.9	2.2	5.7	10.9	17.7	20.8	22.2
Sales Occupations	5.1	1.7	4.7	7.7	10.5	15.5	21.6
Administrative Support, including Clerical	5.4	2.1	5.0	7.6	10.9	14.6	15.4
Service Occupations	4.1	1.7	4.4	6.9	9.0	10.6	10.4
Precision Production, Craft, and Repair	9.3	2.6	7.1	13.5	19.9	25.7	30.1
Operators, Fabricators, and Laborers	5.5	1.7	4.6	9.1	13.7	18.1	14.7
Farming, Forestry, and Fishing	10.4	2.9	7.9	13.5	20.7	30.5	39.8

[a] Working population = 109.1 million persons.
[b] Includes all workers 16 years and older.

Source: Carey, 1988.

Table 16-86. Voluntary Occupational Mobility Rates for Workers[a] Age 16 Years and Older

Age Group (years)	Occupational Mobility Rate[b] (Percent)
16 to 24	12.7
25 to 34	6.6
35 to 44	4.0
45 to 54	1.9
55 to 64	1.0
64 and older	0.3
Total, age 16 and older	5.3

[a] Working population = 100.1 million persons.
[b] Occupational mobility rate = percentage of persons employed in an occupation who had voluntarily entered it from another occupation.

Source: Carey, 1990.

Table 16-87. Descriptive Statistics for Residential Occupancy Period (years)															
			Percentiles											2nd Largest Value	
	N	Mean	5th	10th	25th	50th	75th	90th	95th	98th	99th	99.5th	99.8th	99.9th		Max.
Both sexes	500,000	11.7	2	2	3	9	16	26	33	41	47	51	55	59	75	87
Male only	244,274	11.1	2	2	4	8	15	24	31	39	44	48	53	56	73	73
Female only	255,726	12.3	2	2	5	9	17	28	35	43	49	53	58	61	75	87

= Number of simulated persons.

Source: Johnson and Capel, 1992.

Table 16-88. Descriptive Statistics for Both Sexes by Current Age

Current age, years	Residential Oocupancy Period (years)						
	Mean	Percentiles					
		25	50	75	90	95	99
3	6.5	3	5	8	13	17	22
6	8.0	4	7	10	15	18	22
9	8.9	5	8	12	16	18	22
12	9.3	5	9	13	16	18	23
15	9.1	5	8	12	16	18	23
18	8.2	4	7	11	16	19	23
21	6.0	2	4	8	13	17	23
24	5.2	2	4	6	11	15	25
27	6.0	3	5	8	12	16	27
30	7.3	3	6	9	14	19	32
33	8.7	4	7	11	17	23	39
36	10.4	5	8	13	21	28	47
39	12.0	5	9	15	24	31	48
42	13.5	6	11	18	27	35	49
45	15.3	7	13	20	31	38	52
48	16.6	8	14	22	32	39	52
51	17.4	9	15	24	33	39	50
54	18.3	9	16	25	34	40	50
57	19.1	10	17	26	35	41	51
60	19.7	11	18	27	35	40	51
63	20.2	11	19	27	36	41	51
66	20.7	12	20	28	36	41	50
69	21.2	12	20	29	37	42	50
72	21.6	13	20	29	37	43	53
75	21.5	13	20	29	38	43	53
78	21.4	12	19	29	38	44	53
81	21.2	11	20	29	39	45	55
84	20.3	11	19	28	37	44	56
87	20.6	10	18	29	39	46	57
90	18.9	8	15	27	40	47	56
All ages	11.7	4	9	16	26	33	47

Source: Johnson and Capel, 1992.

Table 16-89. Residence Time of Owner/Renter Occupied Units

Year Household Moved into Unit	Total Occupied Units (number in thousands)
2005–2009	33,543
2000–2004	28,695
1995–1999	15,120
1990–1994	9,631
1985–1989	6,459
1980–1984	3,703
1975–1979	4,412
1970 – 1974	2,979
1960 –1969	3,661
1950–1959	1,892
1940–1949	460
1939 or earlier	137
	Total 110,692

Source: U.S. Census Bureau, 2008a.

Table 16-90. Percent of Householders Living in Houses for Specified Ranges of Time, and Statistics for Years Lived in Current Home

Years Lived in Current Home	Percent of Total Households
0–4	30.3
5–9	25.9
10–14	13.7
15–19	8.7
20–24	5.8
25–29	3.3
30–34	4.0
35–44	2.7
45–54	3.3
55–64	1.7
65–74	0.4
>75	0.1
	Total[a] 99.9

Statistics for Years Lived in Current Home

N	Mean[b]	50th Percentile[b]	90th Percentile[b]	95th Percentile[b]	99th Percentile[b]
110,692	13	8	32	46	62

[a] Total does not equal 100 due to rounding errors.
[b] The mean, 50th and 90th percentiles were calculated for the number of years lived in current house by apportioning the total sample size (110,692 households) to the indicated percentile associated with the applicable range of years lived in the current home, assuming an even distribution.

Source: Adapted from U.S. Census Bureau, 2008a.

Table 16-91. Values and Their Standard Errors for Average Total Residence Time, *T*, for Each Group in Survey[a]

Households	Average Total Residence Time T (years)	SD S_T	Average Current Residence T_{CR} (years)	Households (percent)	
				1985	1987
All households	4.55 ± 0.60	8.68	10.56 ± 0.10	100.0	100.0
Renters	2.35 ± 0.14	4.02	4.62 ± 0.08	36.5	36.0
Owners	11.36 ± 3.87	13.72	13.96 ± 0.12	63.5	64.0
Farms	17.31 ± 13.81	18.69	18.75 ± 0.38	2.1	1.9
Urban	4.19 ± 0.53	8.17	10.07 ± 0.10	74.9	74.5
Rural	7.80 ± 1.17	11.28	12.06 ± 0.23	25.1	25.5
Northeast region	7.37 ± 0.88	11.48	12.64 ± 0.12	21.2	20.9
Midwest region	5.11 ± 0.68	9.37	11.15 ± 0.10	25.0	24.5
South region	3.96 ± 0.47	8.03	10.12 ± 0.08	34.0	34.4
West region	3.49 ± 0.57	6.84	8.44 ± 0.11	19.8	20.2

[a] Values of the average current residence time, T_{CR}, are given for comparison.

Source: Israeli and Nelson, 1992.

Table 16-92. Total Residence Time, *T* (years), Corresponding to Selected Values of *R(t)*[a] by Housing Category

R(t) =	0.05	0.1	0.25	0.5	0.75
All households	23.1	12.9	3.7	1.4	0.5
Renters	8.0	5.2	2.6	1.2	0.5
Owners	41.4	32.0	17.1	5.2	1.4
Farms	58.4	48.3	26.7	10.0	2.4
Urban	21.7	10.9	3.4	1.4	0.5
Rural	32.3	21.7	9.1	3.3	1.2
Northeast region	34.4	22.3	7.5	2.8	1.0
Midwest region	25.7	15.0	4.3	1.6	0.6
South region	20.7	10.8	3.0	1.2	0.4
West region	17.1	8.9	2.9	1.2	0.4

[a] *R(t)* = fraction of households living in the same residence for *T* years or more.

Source: Israeli and Nelson, 1992.

Table 16-93. Summary of Residence Time of Recent Home Buyers (1993)

Number of Years Lived in Previous House	Percent of Respondents
1 year or less	2
2–3	16
4–7	40
8–9	10
10 years or more	32

Source: NAR, 1993.

Table 16–94. Tenure in Previous Home (Percentage Distribution)

	1987	1989	1991	1993
	Percent			
1 year or less	5	8	4	2
2–3 Years	25	15	21	16
4–7 Years	36	22	37	40
8–9 Years	10	11	9	10
10 or More Years	24	34	29	32
Total	100	100	100	100
	Years			
Median	6	6	6	6

Source: NAR, 1993.

Table 16-95. Number of Miles Moved (Percentage Distribution)

Mile	All Buyers	First-Time Buyer	Repeat Buyer	New Home Buyer	Existing Home Buyer
	Percent				
Less than 5 miles	29	33	27	23	31
5–9 miles	20	25	16	18	20
10–19 miles	18	20	17	20	17
20–34 miles	9	11	8	12	9
35–50 miles	2	2	2	2	3
51–100 miles	5	2	6	6	4
Over 100 miles	17	6	24	19	16
Total	100	100	100	100	100
	Miles				
Median	9	8	11	11	8
Mean	200	110	270	230	190

Source: NAR, 1993.

Table 16-96. General Mobility, by Race and Hispanic Origin, Region, Sex, Age, Educational Attainment, Marital Status, Nativity, Tenure, and Poverty Level: 2006 to 2007 (numbers in thousands)

	Total	Mover		Same County		Different County, Same State		Different State, Same Division		Different Division, Same Region		Different Region		Abroad	
Population	*N*	*N*	% (of total)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)
Total 1+ years	292,749	38,681	13%	25,192	65%	7,436	19%	1,446	4%	968	3%	2,448	6%	1,191	3%
Sex															
Male	143,589	19,457	14%	12,579	65%	3,693	19%	771	4%	505	3%	1,220	6%	689	4%
Female	149,160	19,224	13%	12,613	66%	3,743	19%	675	4%	463	2%	1,228	6%	502	3%
Age (years)															
1 to 4 years	16,455	3,217	20%	2,188	68%	577	18%	117	4%	81	3%	184	6%	72	2%
5 to 9 years	19,830	3,161	16%	2,092	66%	614	19%	121	4%	73	2%	179	6%	81	3%
10 to 14 years	20,444	2,517	12%	1,735	69%	441	18%	92	4%	62	2%	139	6%	47	2%
15 to 17 years	13,297	1,465	11%	1,057	72%	224	15%	50	3%	22	2%	75	5%	37	3%
18 to 19 years	7,873	1,330	17%	898	68%	252	19%	40	3%	25	2%	68	5%	47	4%
20 to 24 years	20,532	5,516	27%	3,623	66%	1,069	19%	168	3%	157	3%	320	6%	179	3%
25 to 29 years	20,666	5,316	26%	3,335	63%	1,061	20%	219	4%	136	3%	339	6%	226	4%
30 to 34 years	19,202	3,767	20%	2,374	63%	789	21%	140	4%	106	3%	221	6%	137	4%
35 to 39 years	20,907	2,962	14%	1,877	63%	587	20%	104	4%	84	3%	187	6%	121	4%
40 to 44 years	21,856	2,456	11%	1,567	64%	480	20%	102	4%	60	2%	178	7%	68	3%
45 to 49 years	22,643	1,963	9%	1,362	69%	304	15%	74	4%	42	2%	131	7%	49	2%
50 to 54 years	20,819	1,612	8%	1,119	69%	292	18%	55	3%	42	3%	76	5%	27	2%
55 to 59 years	18,221	1,171	6%	706	60%	258	22%	57	5%	37	3%	86	7%	27	2%
60 to 61 years	6,093	381	6%	212	56%	82	22%	30	8%	9	2%	39	10%	10	3%
62 to 64 years	7,877	386	5%	201	52%	98	25%	19	5%	1	0%	49	13%	18	5%
65 to 69 years	10,629	496	5%	286	58%	110	22%	16	3%	5	1%	63	13%	16	3%
70 to 74 years	8,369	357	4%	179	50%	79	22%	24	7%	17	5%	43	12%	15	4%
75 to 79 years	7,567	233	3%	153	66%	41	18%	4	2%	6	3%	21	9%	7	3%
80 to 84 years	5,513	219	4%	121	55%	53	24%	10	5%	4	2%	26	12%	5	2%
85+ years	3,958	159	4%	108	68%	24	15%	2	1%	-	-	22	14%	3	2%
Educational Attainment															
Not a high school graduate	27,742	3,458	12%	2,431	70%	575	17%	103	3%	33	1%	137	4%	178	5%
High school graduate	61,490	6,435	10%	4,398	68%	1,207	19%	221	3%	145	2%	353	5%	112	2%
Some college or AA degree	49,243	5,534	11%	3,475	63%	1,167	21%	206	4%	145	3%	411	7%	130	2%
Bachelor's degree	36,658	4,062	11%	2,290	56%	910	22%	231	6%	124	3%	336	8%	172	4%
Prof or graduate degree	19,184	1,985	10%	1,004	51%	399	20%	97	5%	102	5%	246	12%	137	7%
Persons age 1 to 24	98,431	17,205	17%	11,593	67%	3,177	18%	589	3%	419	2%	965	6%	462	3%

Table 16-96. General Mobility, by Race and Hispanic Origin, Region, Sex, Age, Educational Attainment, Marital Status, Nativity, Tenure, and Poverty Level: 2006 to 2007 (numbers in thousands) (continued)

	Total	Mover		Same County		Different County, Same State		Different State, Same Division		Different Division, Same Region		Different Region		Abroad	
Population	*N*	*N*	% (of total)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)	*N*	% (of movers)
Marital Status															
Married, spouse present	121,390	10,671	9%	6,434	60%	2,220	21%	502	5%	338	3%	808	8%	369	3%
Married, spouse absent	3,472	805	23%	501	62%	90	11%	31	4%	11	1%	73	9%	98	12%
Widowed	13,920	802	6%	533	66%	136	17%	34	4%	8	1%	68	8%	22	3%
Divorced	22,867	3,483	15%	2,369	68%	702	20%	93	3%	69	2%	200	6%	50	1%
Separated	5,047	1,246	25%	911	73%	213	17%	29	2%	16	1%	57	5%	19	2%
Never married	69,324	12,779	18%	8,429	66%	2,442	19%	427	3%	310	2%	739	6%	433	3%
Persons age 1 to 14	56,730	8,895	16%	6,015	68%	1,632	18%	330	4%	216	2%	502	6%	200	2%
Nativity															
Native	255,501	33,023	13%	21,603	65%	6,671	20%	1,279	4%	904	3%	2,180	7%	387	1%
Foreign born	37,248	5,658	15%	3,589	63%	765	14%	167	3%	64	1%	268	5%	804	14%
Naturalized US citizen	14,525	1,161	8%	768	66%	212	18%	41	4%	31	3%	76	7%	31	3%
Not a US citizen	22,723	4,497	20%	2,821	63%	553	12%	126	3%	33	1%	192	4%	772	17%
Tenure															
Owner-occupied housing unit	207,774	13,760	7%	8,467	62%	2,881	21%	595	4%	408	3%	1,027	7%	381	3%
Renter-occupied housing unit	81,351	24,228	30%	16,353	67%	4,374	18%	806	3%	547	2%	1,371	6%	776	3%
No cash renter-occupied housing unit	3,624	694	19%	372	54%	181	26%	45	6%	13	2%	49	7%	33	5%
Poverty Status															
Below 100% of poverty	35,924	8,777	24%	6,041	69%	1,484	17%	270	3%	166	2%	392	4%	423	5%
100% to 149% of poverty	26,183	4,705	18%	3,312	70%	832	18%	128	3%	84	2%	215	5%	136	3%
150% of poverty and above	230,642	25,199	11%	15,839	63%	5,120	20%	1,048	4%	718	3%	1,841	7%	632	3%

\- Represents 0 or rounds to 0.
N = Number of respondents.

Source: U.S. Census Bureau, 2008b.

Table 16-97. Distance of Intercounty Move[a], by Sex, Age, Race and Hispanic Origin, Educational Attainment, Marital Status, Nativity, Tenure, Poverty Status, Reason for Move, and State of Residence 1 Year Ago: 2006 to 2007 (numbers in thousands)

	Total	Less than 50 miles		50 to 199 miles		200 to 499 miles		500 miles or more	
Population	*N*	*N*	%	*N*	%	*N*	%	*N*	%
Intercounty Movers 1+ years	12,299	5,149	42%	2,582	21%	1,802	15%	2,765	22%
Sex									
Male	6,190	2,554	41%	1,324	21%	894	14%	1,418	23%
Female	6,109	2,595	42%	1,258	21%	909	15%	1,347	22%
Age									
Under 16 years	2,809	1,230	44%	520	19%	455	16%	603	21%
16 to 19 years	629	279	44%	148	24%	82	13%	120	19%
20 to 24 years	1,714	720	42%	436	25%	185	11%	373	22%
25 to 29 years	1,755	792	45%	347	20%	215	12%	400	23%
30 to 44 years	3,040	1,295	43%	618	20%	458	15%	669	22%
45 to 64 years	1,782	633	36%	408	23%	312	18%	429	24%
65 to 74 years	357	128	36%	68	19%	66	18%	95	27%
75+ years	213	71	33%	37	17%	30	14%	76	36%
Race and Hispanic Origin									
White alone	9,730	4,049	42%	2,064	21%	1,382	14%	2,234	23%
Black or African American alone	1,626	729	45%	285	18%	320	20%	293	18%
Asian alone	515	205	40%	120	23%	51	10%	138	27%
All remaining single races and all race combinations[b]	427	166	39%	113	26%	49	11%	99	23%
White alone, not Hispanic or Latino	8,290	3,527	43%	1,697	20%	1,156	14%	1,910	23%
Hispanic or Latino[c]	1,575	578	37%	401	25%	232	15%	364	23%
White alone or in combination with 1 or more other races	9,986	4,161	42%	2,130	21%	1,405	14%	2,290	23%
Black or African American alone or in combination with 1 or more other races	1,733	777	45%	312	18%	329	19%	315	18%
Asian alone or in combination with 1 or more other races	573	223	39%	146	25%	59	10%	144	25%

Table 16-97. Distance of Intercounty Move[a], by Sex, Age, Race and Hispanic Origin, Educational Attainment, Marital Status, Nativity, Tenure, Poverty Status, Reason for Move, and State of Residence 1 Year Ago: 2006 to 2007 (continued) (numbers in thousands)

	Total	Less than 50 miles		50 to 199 miles		200 to 499 miles		500 miles or more	
Population	*N*	*N*	%	*N*	%	*N*	%	*N*	%
Educational Attainment									
Not a high school graduate	848	390	46%	197	23%	126	15%	135	16%
High school graduate	1,926	776	40%	414	21%	351	18%	385	20%
Some college or AA degree	1,929	836	43%	376	19%	254	13%	463	24%
Bachelor's degree	1,601	651	41%	340	21%	210	13%	400	25%
Prof. or graduate degree	844	268	32%	151	18%	140	17%	286	34%
Persons age 1 to 24	5,151	2,229	43%	1,104	21%	721	14%	1,096	21%
Marital Status									
Married, spouse present	3,868	1,500	39%	834	22%	560	14%	975	25%
Married, spouse absent	206	57	28%	44	21%	31	15%	74	36%
Widowed	246	78	32%	60	24%	45	18%	63	26%
Divorced	1,065	493	46%	221	21%	158	15%	193	18%
Separated	316	146	46%	57	18%	66	21%	47	15%
Never married	3,917	1,691	43%	867	22%	517	13%	843	22%
Persons age 1 to 14	2,680	1,184	44%	500	19%	426	16%	570	21%
Nativity									
Native	11,034	4,627	42%	2,299	21%	1,646	15%	2,462	22%
Foreign born	1,265	523	41%	283	22%	156	12%	303	24%
Naturalized U.S. citizen	361	156	43%	63	17%	45	12%	96	27%
Not a US citizen	904	367	41%	220	24%	111	12%	206	23%
Tenure									
Owner-occupied housing unit	4,912	2,083	42%	950	19%	742	15%	1,137	23%
Renter-occupied housing unit	7,099	2,962	42%	1,554	22%	1,019	14%	1,564	22%
No cash renter-occupied housing unit	288	104	36%	78	27%	41	14%	64	22%
Poverty Status									
Below 100% of poverty	2,313	967	42%	576	25%	353	15%	417	18%
100% to 149% of poverty	1,258	625	50%	245	19%	176	14%	212	17%
150% of poverty and above	8,728	3,558	41%	1,761	20%	1,274	15%	2,136	24%

Table 16-97. Distance of Intercounty Move[a], by Sex, Age, Race and Hispanic Origin, Educational Attainment, Marital Status, Nativity, Tenure, Poverty Status, Reason for Move, and State of Residence 1 Year Ago: 2006 to 2007 (continued)
(numbers in thousands)

	Total	Less than 50 miles		50 to 199 miles		200 to 499 miles		500 miles or more	
Population	*N*	*N*	%	*N*	%	*N*	*N*	%	*N*
State of Residence 1 Year Ago									
Same state	7,436	4,741	64%	2,059	28%	627	8%	9	0%
Different state	4,862	408	8%	524	11%	1,175	24%	2,756	57%

[a] The estimated distance in miles of an intercounty move is measured from the county of previous residence's geographic population centroid to the county of current residence's geographic population centroid.
[b] Includes American Indian and Alaska Native alone, Native Hawaiian and Other Pacific Islander alone, and 2 or More Races.
[c] Hispanics or Latinos may be of any race.

Source: U.S. Census Bureau, 2008b.

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17. CONSUMER PRODUCTS

17.1. INTRODUCTION

17.1.1. Background

Consumer products may contain toxic or potentially toxic chemical constituents to which people may be exposed as a result of their use. For example, household cleaners can contain ammonia, alcohols, acids, and/or organic solvents that may pose health concerns. Potential routes of exposure to consumer products or chemicals released from consumer products during use include ingestion, inhalation, and dermal contact. These household consumer products include cleaners, solvents, and paints. Non-users, including children, can be passively exposed to chemicals in these products. Because people spend a large amount of time indoors, the use of household chemicals in the indoor environment can be a principal source of exposure (Franklin, 2008).

Very little information is available about the exact way the different kinds of products are used by consumers, including the many ways in which these products are handled, the frequency and duration of contact, and the measures consumers may take to minimize exposure or risk (Steenbekkers, 2001). In addition, the factors that influence these behaviors are not well studied, but some studies have shown that a large variation exists in behavior between persons (Steenbekkers, 2001).

This chapter presents information on the amount of product used, the frequency of use, and the duration of use for various consumer products typically found in consumer households. All tables that present information for these consumer products are located at the end of this chapter.

Note that this chapter does not provide an exhaustive treatment of all consumer products, but rather, it provides some background and data that can be used in an exposure assessment. Also, the data presented may not capture the information needed to assess the highly exposed population (i.e., consumers who use commercial and industrial strength products at home). The studies presented in the following sections represent readily available surveys for which data were collected on the frequency and duration of use and the amount of use of cleaning products, painting products, household solvent products, cosmetic and other personal care products, household equipment, pesticides, and tobacco. Also note that some of the data in this chapter comes from corporate, consortia, or trade organizations.

17.1.2. Additional Sources of Information

There are several sources of information on data relevant to consumer products.

Table 17-1 provides a list of household consumer products found in some U.S. households (U.S. EPA, 1987). It should be noted, however, that this list was compiled by the U.S. Environmental Protection Agency (EPA) in 1987, and consumer use of some products listed may have changed (e.g., aerosol product use has declined). Therefore, refer to the Household Product Database of the National Library of Medicine database as a source of more current information on the types of products used. This database contains over 7,000 consumer brands including auto products; products used inside the home; pesticides; landscape and yard; personal care; home maintenance, arts, and crafts; pet care; and home office. The information includes chemical ingredients, specific brands that contain those ingredients, and acute and chronic health effects associated with specific ingredients. The database does not contain any information on frequency or amount of product used.

The Soaps and Detergent Association (SDA) developed a peer-reviewed document that presents methodologies and specific exposure information that can be used for screening-level risk assessments from exposures to high production volume chemicals. The document addresses the use of consumer products, including laundry, cleaning, and personal care products. It includes data for daily frequency of use and the amount of product used. The data used were compiled from a number of sources including cosmetic associations and data from the SDA. The document *Exposure and Risk Screening Methods for Consumer Product Ingredients* can be found on the SDA Web site at http://www.cleaning101.com/files/Exposure_and_Risk_Screening_Methods_for_Consumer_Product_Ingredients.pdf.

Another document has been developed by the U.S. EPA Office of Toxic Substances (1986): *Standard Scenarios for Estimating Exposure to Chemical Substances During Use of Consumer Products – Volumes I and II*. This document presents data and supporting information required to assess consumer exposure to constituents in household cleaners and components of adhesives. Its information includes a description of standard scenarios selected to represent upper bound exposures for each product. Values also are presented for parameters needed to estimate exposure for defined exposure routes and pathways assumed for each scenario.

An additional reference is the Simmons Market Research Bureau's (SMRB's) *Simmons Study of Media and Markets*. This document provides an example of available marketing data that may be useful in assessing exposure to selected products. The report is published biannually. Data are collected on the buying habits of the U.S. population during the previous 12 months for more than 1,000 consumer products. Data are presented on frequency of use, total number of buyers in each use category, and selected demographics. The consumer product data are presented according to the buyer and not necessarily according to the user (i.e., actively exposed person). Therefore, it may be necessary to adjust the data to reflect potential uses. The reports are available for purchase from the SMRB. Table 17-2 presents a list of product categories in the *Simmons Study of Media and Markets* for which information is available.

17.2. RECOMMENDATIONS

Because of the large range and variation among consumer products and their exposure pathways, it is not feasible to recommend specific exposure values as has been done in other chapters of this handbook. Refer to the information provided by the references of this chapter to derive appropriate exposure factors. The following sections of this chapter provide summaries of data from surveys involving the use of consumer products.

17.3. CONSUMER PRODUCTS USE STUDIES

17.3.1. CTFA (1983)—Cosmetic, Toiletry, and Fragrance Association, Inc.—Summary of Results of Surveys of the Amount and Frequency of Use of Cosmetic Products by Women

The Cosmetic, Toiletry, and Fragrance Association, Inc. (CTFA, 1983), a major manufacturer and a market research bureau, published three surveys that collected data on the frequency of use of various cosmetic products and selected baby products. In the first survey, CTFA (1983) conducted a 1-week prospective survey of 47 female employees and relatives of employees between ages 13 and 61 years. In the second survey, a cosmetic manufacturer conducted a retrospective survey of 1,129 of its customers. In the third survey, a market research bureau sampled 19,035 female consumers nationwide over a 9½-month period. Of the 19,035 females interviewed, responses from only 9,684 females were tabulated (CTFA, 1983). The respondents in all three surveys were asked to record the number of times they used the various products in a given time period (i.e., a week, a day, a month, or a year). The third survey also was designed to reflect the socio-demographic (e.g., age, income) characteristics of the entire U.S. population.

To obtain the average frequency of use for each cosmetic product, responses were averaged for each product in each survey. Averages were calculated by adding the reported number of uses per given time period for each product, dividing by the total number of respondents in the survey, and then dividing again by the number of days in the given time period (CTFA, 1983). The average frequency of use of cosmetic products was determined for both users and non-users. The frequency of use of baby products was determined among users only. The upper 90^{th} percentile frequency of use values were determined by eliminating the top 10% most extreme frequencies of use. Therefore, the highest remaining frequency of use was recorded as the upper 90^{th} percentile value. Table 17-3 presents the amount of product used per application (grams) and the average and 90^{th} percentile frequency of use per day for various cosmetic products for all the surveys. Note that Table 17-3 reports values provided by cosmetic companies, associations, or market research firms.

An advantage of the frequency data obtained from the third survey (by the market research bureau) is that the sample population was more likely to be representative of the U.S. population. Another advantage of the third data set is that the survey was conducted over a longer period of time when compared with the other two frequency datasets. Also, the study provided empirical data that may be useful in generating more accurate estimates of consumer exposure to cosmetic products. In contrast to the large market research bureau survey, the CTFA employee survey is very small, and both that survey and the cosmetic company survey are likely to be biased toward high-end users. Therefore, data from these two surveys should be used with caution. The limitations of these surveys are that data were not tabulated by age, are more than 20 years old, and are only representative of products used by babies and female consumers. Another limitation is that these data may not be representative of long-term use patterns.

17.3.2. Westat (1987a)—Household Solvent Products: A National Usage Survey

Westat (1987a) conducted a nationwide survey to determine consumer exposure to common household products believed to contain methylene chloride or its substitutes (i.e., carbon tetrachloride, trichloroethane, trichloroethylene, perchloroethylene, and 1,1,1,2,2,2 - trichlorotrifluoroethane). The survey methodology was comprised of two phases. In the first phase, the sample population was generated by using a random digit dialing (RDD) procedure, in which telephone numbers of households nationwide were randomly selected by using an unbiased, equal probability of selection method, known as the Waksberg Method (Westat, 1987a). After the respondents in the selected households (18 years and older) agreed to participate in the survey, questionnaires and product pictures were mailed to each respondent. Finally, telephone follow-up calls were made to those respondents who did not respond to the mailed questionnaire within a 4-week period to administer the same questionnaire. Of the 6,700 individuals contacted for the survey, 4,920 individuals either responded to the mailed questionnaire or to a telephone interview (a response rate of 73%). Survey questions included how often the products were used in the last 12 months, when they were last used, how much time was spent using a product (per occasion or year), how long the respondent remained in the room after use, how much of a product was used per occasion or year, and what protective measures were used (Westat, 1987a).

Thirty-two categories of common household products were included in the survey and are presented in Table 17-4. Tables 17-4, 17-5, 17-6, and 17-7 provide means, medians, and percentile rankings for the following variables: frequency of use, exposure time, amount of use, and time exposed after use.

An advantage of this study is that the RDD procedure (i.e., Waksberg Method) to identify participants enabled a diverse selection of a representative, unbiased sample of the U.S. population (Westat, 1987a). Also, empirical data on consumer household product use are provided. However, a limitation associated with this study is that the data generated were based on recall behavior. Another limitation is that extrapolation of these data to long-term use patterns may be difficult; the data are more than 20 years old and cannot be broken out by age groups.

17.3.3. Westat (1987b)—National Usage Survey of Household Cleaning Products

Westat (1987b) collected usage data from a nationwide survey to assess the magnitude of exposure of consumers to various products used when performing certain household cleaning tasks. The survey was conducted from the middle of November 1985 to the middle of January 1986. Telephone interviews were conducted with 193 households. According to Westat (1987b), the resulting response rate for this survey was 78%. The Waksberg Method discussed in the Westat (1987a) study also was used in randomly selecting telephone numbers employed in this survey. The survey was designed to obtain information on cleaning activities performed in the interior of the home during the previous year. The person who did the majority of the cleaning in the kitchen and bathroom areas of each household was interviewed. Of those respondents, the primary cleaner was female in 160 households (83%) and male in 30 households (16%); the sex of the respondents in the three remaining households was not ascertained (Westat, 1987b). Data obtained from the survey included the frequency of performing 14 different cleaning tasks, the amount of time (duration) spent at each task, the cleaning product most frequently used, the type of product (i.e., liquid, powder, aerosol, or spray pump) used, and the protective measures taken during cleaning, such as wearing rubber gloves or having a window open or an exhaust fan on (Westat, 1987b).

Tables 17-8 through 7-12 present the survey data. Table 17-8 presents the mean and median total exposure time of use for each cleaning task and the product type preferred for each task. Table 17-9 presents the percentile rankings for the total time exposed to the products used for 14 cleaning tasks. Table 17-10 presents the mean and percentile rankings of the frequency in performing each task. Table 17-11 shows the mean and percentile rankings for exposure time per event of performing household tasks. Table 17-12 presents the mean and percentile rankings for total number of hours spent per year using the top 10 product groups.

Westat (1987b) randomly selected a subset of 30 respondents from the original survey and re-interviewed them during the first 2 weeks of March 1986 as a reliability check on the recall data from the original phone survey. Frequency and duration data for 3 of the original 14 cleaning tasks were obtained from the re-interviews. In a second effort to validate the phone survey, 50 respondents of the original phone survey participated in a 4-week diary study (between February and March 1986) of 8 of the 14 cleaning tasks originally studied. The diary approach assessed the validity of using a 1-time telephone survey to determine usual cleaning behavior (Westat, 1987b). The data (i.e., frequency and duration) obtained from the re-interviews and the diary approach were lower than the data from the original telephone survey, but were more consistent with one other. Westat (1987b) attributed the significant differences in the data obtained from these surveys to seasonal changes rather than methodological problems.

A limitation of this survey is evident from the reliability and validity check of the data collected by Westat (1987b). The data obtained from the telephone survey may reflect heavier seasonal cleaning because the survey was conducted during the holidays (November through January). Therefore, usage data obtained in this study may be biased and may represent upper bound estimates. Other limitations of this study include the small size of the sample population, the age of the data set, and that the data cannot be broken out by age groups. An advantage of this survey is that the RDD procedure (Waksberg Method) used provides unbiased results of sample selection and reduces the number of unproductive calls. Another advantage of this study is that it provides empirical data on frequency and duration of consumer use.

17.3.4. Westat (1987c)—National Household Survey of Interior Painters

Westat (1987c) conducted a nationwide study between November 1985 and January 1986 to obtain usage information that estimates the magnitude of exposure of consumers to different types of painting and painting-related products used while painting the interior of the home. The study sampled 777 households to determine whether any household member had painted the interior of the home during the 12 months prior to the survey date. Of the sampled households, 208 households (27%) had a household member who had painted during the past 12 months. Based on the households with primary painters, the response rate was 90% (Westat, 1987c). The person in each household who did most of the interior painting during the past 12 months was interviewed over the telephone. The RDD procedure (Waksberg Method) previously described in Westat (1987a) was used to generate sample blocks of telephone numbers in this survey. Questions were asked about the frequency and time spent for interior painting activities, the amount of paint used, and the protective measures used (i.e., wearing gloves, hats, and masks or keeping a window open) (Westat, 1987c). Fifty-three percent of the primary painters in the households interviewed were male, 46% were female, and the sex of the remaining 1% was not ascertained. Three types of painting products were used in this study: latex paint, oil-based paint, and wood stains and varnishes. Of the respondents, 94.7% used latex paint, 16.8% used oil-based paint, and 20.2% used wood stains and varnishes.

Tables 17-13, 17-14, and 17-15 summarize data generated from this survey. Table 17-13 presents the mean, standard deviation, and percentile rankings for the total exposure time for painting activity by paint type. Table 17-14 presents the mean and median exposure times for each painting activity per occasion for each paint type. A painting occasion is defined as a time period from start to cleanup (Westat, 1987c). Table 17-14 also presents the frequency and percentile rankings of painting occasions per year. Table 17-15 presents the total amount of paint used by interior painters.

In addition, 30 respondents from the original survey were re-interviewed in April 1986 as a reliability check on the recall data. There were no significant differences between the data obtained from the re-interviews and the original painting survey (Westat, 1987c).

An advantage of this survey, based on the reliability check conducted by Westat (1987c), is the stability in the painting data obtained. Another advantage of this survey is that the response rate was high (90%), thus minimizing non-response bias. Also, the Waksberg Method employed provides an unbiased equal probability method of RDD. The limitations of the survey are that the data are based on 12-month recall and may not accurately reflect long-term use patterns and the age of the data set.

17.3.5. Abt (1992)—Methylene Chloride Consumer Use Study Survey Findings

As part of a plan to assess the effectiveness of labeling of consumer products containing methylene chloride, Abt (1992) conducted a nationwide telephone survey of nearly 5,000 households. The survey was conducted in April and May of 1991. Three classes of products were included: (1) paint strippers, (2) non-automotive spray paint, and (3) adhesive removers. The survey paralleled a 1986 consumer use survey conducted by Abt for the U.S. EPA.

The survey was conducted to estimate the percentage of the U.S. adult population using paint remover, adhesive remover, and non-automotive spray paint. In addition, an estimate of the population using these products containing methylene chloride was determined. A survey questionnaire was developed to collect product usage data and demographic data. The survey sample was generated using a RDD technique.

A total of 4,997 product screener interviews were conducted for the product interview sections. The number of respondents was 381 for paint strippers, 58 for adhesive removers, and 791 for non-automotive spray paint. Survey responses were weighted to allow estimation at the level of the total U.S. population (Abt, 1992). A follow-up mail survey also was conducted by using a short questionnaire. Respondents who had used the product in the past year or had purchased the product in the past 2 years and still had the container were asked to respond to the questionnaire (Abt, 1992). Of the 527 mailed questionnaires, 259 were returned. The questionnaire responses included 67 on paint strippers, 6 on adhesive removers, and 186 on non-automotive spray paint. Tables 17-16 through 17-21 (*N*s are unweighted) present the results of the survey. Data are presented for recent users, who were defined as persons who have used the product within the last year of the survey or who have purchased the product in the past 2 years.

Abt (1992) found the following results when comparing the new data to the 1986 findings:

- A significantly smaller proportion of current survey respondents used a paint stripper, spray paint, or adhesive remover.
- The proportion of the population who used the three products recently (within the past year) decreased substantially.
- Those who used the products reported a significantly longer time since their last use. For all three products, the reported amount used per year was significantly higher in the current survey.

An advantage of this survey is that the survey population was large, and the survey responses were weighted to represent the U.S. population. In addition, the survey was designed to collect data for frequency of product use and amount of product used by sex. Limitations of the survey are that the information may be dated, and that the data were generated based on recall behavior. Extrapolation of these data to accurately reflect long-term use patterns may be difficult.

17.3.6. U.S. EPA (1996)—National Human Activity Pattern Survey (NHAPS)

U.S. EPA (1996) collected data on the duration and frequency of selected activities and the time spent in selected microenvironments via 24-hour diaries as part of the National Human Activity Pattern Survey (NHAPS). More than 9,000 individuals from various age groups in 48 contiguous states participated in NHAPS, including 2,000 children. The survey was conducted between October 1992 and September 1994. Individuals were interviewed to categorize their 24-hour routines (diaries) and/or to answer follow-up questions that were related to exposure events. Demographic, including socioeconomic (e.g., sex, age, race, education), geographic (e.g., census region, state), and temporal (i.e., day of week, month, season) data were included in the study. Data were collected for a maximum of 82 possible microenvironments and 91 different activities.

As part of the survey, data also were collected on duration and frequency of use of selected consumer products. Tables 17-22 through 17-30 present data on the number of minutes that survey respondents spent in activities working with or being near certain consumer products, including microwave ovens; freshly applied paints; household cleaning agents such as scouring powders or ammonia; floor wax, furniture wax, or shoe polish; glue; solvents, fumes, or strong-smelling chemicals; stain or spot removers; gasoline, diesel-powered equipment, or automobiles; and pesticides, bug sprays, or bug strips. Tables 17-31 through 17-35 present data on the number of respondents in these age categories that used fragrances, aerosol sprays, humidifiers, and pesticides (professionally-applied and consumer-applied). Because the age categories used by the study authors did not coincide with the standardized age categories recommended in U.S. EPA (2005) and used elsewhere in this handbook, the source data from NHAPS on pesticide use (professionally applied and consumer-applied) were reanalyzed by U.S. EPA to generate data for the standardized age categories. Data for subsets of the 1st year of life (e.g., 1 to 2 months, 3 to 5 months, etc.) were not available.

As discussed in previous chapters that used NHAPS as a data source, the primary advantage is that the data were collected for a large number of individuals, and the survey was designed to be representative of the U.S. general population. However, due to the wording of questions in the survey, precise data were not available for consumers who spent more than 60 or 120 minutes (depending on the activity) using some consumer products. This prevents accurate characterization of the high end of the distribution and also may introduce error into the calculation of the mean. Another limitation is that the adult data were not broken down into finer age categories. These data are also based on 24-hour diaries and may not be representative of long-term use patterns.

17.3.7. Bass et al. (2001)—What's Being Used at Home: A Household Pesticide Survey

Bass et al. (2001) conducted a survey to assess the use of pesticide products in homes with children in March 1999. The study obtained information on what pesticides were used, where they were used, and how frequently they were used. A total of 107 households in Arizona that had a least one child less than 10 years old in the household and had used a pesticide within the last 6 months were surveyed (Bass et al., 2001). The survey population was composed predominantly of Hispanic females and represented a survey response rate of approximately 74%. Study participants were selected by systematic random sampling. Pesticide use was assessed by a one-on-one interview in the home. Survey questions pertained to household pesticides used inside the house for insect control and outside the house for controlling weeds in the garden and repelling animals from the garden. As part of the interview, information was gathered on the pesticides' frequency of use.

Table 17-36 presents information on the type, characteristics, and frequency of pesticide use, as well as information on the demographics of the survey population. A total of 148 pesticide products were used in the 107 households surveyed. Respondents had used pesticides in the kitchen, bathroom, floors, baseboards, and cabinets with dishes or cookware. The frequency of use data showed the following: about 32% of the households used pesticides once per week or more; about 44% used the products once per month or once in 3 months; and about 19% used the products once in 6 months or once per year (Bass et al., 2001).

Although this study was limited to a selected area in Arizona, it provides useful information on the frequency of use of pesticides among households with children. This may be useful for populations in similar geographical locations where site-specific data are not available. However, these data are the result of a community-based survey and are not representative of the U.S. general population.

17.3.8. Weegels and van Veen (2001)—Variation of Consumer Contact with Household Products: A Preliminary Investigation

Weegels and van Veen (2001) conducted a survey to determine consumer exposure to common household products used once a day or every other day. Thirty households participated in the study, including 10 families with children, 10 couples, 9 individuals, and 1 household of 6 adults from the city of Delft in The Netherlands. Households were recruited through the Usability Panel of the School of Industrial Design and through public notices and pamphlets.

Three types of products were studied: dishwashing detergent, all-purpose cleaners, and hair-styling products. Three activities in which these products are commonly used were studied in more detail: dishwashing, toilet cleaning, and styling hair. In-home observations, diaries, and measurement of the amount of product utilized were used to collect data. Subjects were visited in their homes and videotaped performing the activities. After 3 weeks, subjects were again visited in their homes and videotaped performing activities, diaries were collected, and the amount of product used was measured.

Table 17-37 presents the survey data. During toilet cleaning, 22 of 29 subjects observed used at least two different products (e.g., toilet cleaner, all-purpose cleaner, and/or abrasive cleaner). The large variation in duration of toilet cleaning was due to the diverse ways in which toilet cleaner was used: some subjects left the toilet cleaner to soak overnight, some left it in the bowl while cleaning the remainder of the toilet, others flushed the toilet immediately after cleaning. The authors noted that the findings of the study suggest that "…individuals have a consistent way of using a product for a particular activity, but there is a large variety in product usage among consumers, with relations among frequency, durations and amount. If this conclusion is confirmed by future research, it suggests that there will be people who exhibit high-end use of products and will, most likely follow their own routine, which may have consequences for the definition of worst-case use of consumer products."

An advantage of this study is that the empirical data generated provide more accurate calculations of exposure than studies relying on recall data. Limitations of the study are the small study population (30 households) and that The Netherlands may not be representative of U.S. population behaviors. Another limitation is that the short duration (3 weeks) may not accurately reflect long-term or seasonal usage patterns.

17.3.9. Loretz et al. (2005)—Exposure Data for Cosmetic Products: Lipstick, Body Lotion, and Face Cream

Loretz et al. (2005) conducted a nationwide survey to estimate the usage (i.e., frequency of application and amount used per application) of lipstick, body lotion, and face cream. The study was conducted in 2000 and included 360 study subjects recruited in 10 U.S. cities (i.e., Atlanta, GA; Boston, MA; Chicago, IL; Denver, CO; Houston, TX; Minneapolis, MN; St. Louis, MO; San Bernardino, CA; Tampa Bay, FL; and Seattle, WA). The survey participants were women, ages 19 to 65 years, who regularly used the products of interest. Typical cosmetic formulations of the three product types were weighed and provided to the women for use over a 2-week period. Subjects recorded information on product usage (e.g., whether the product was used, number of applications, time of applications) on a daily basis in a diary provided to them. At the end of the 2-week period, unused portions of product were returned and weighed. The amount of product used was estimated as the difference between the weight of product at the beginning and end of the survey period. Of the 360 subjects, 86.4%, 83.3%, and 85.6% completed the study and returned the diaries for lipstick, body lotion, and face cream, respectively (Loretz et al., 2005).

Tables 17-38 and 17-39 present the survey data. Table 17-38 provides the mean, median, and standard deviations for the frequency of use. Table 17-39 provides distribution data for the total amount applied, the average amount applied per use day, and the average amount applied per application.

An advantage of this study is that the survey population covered a diverse geographical area of the United States and that it was not based on recall data. A limitation of the study is that the short duration (2 weeks) may not accurately reflect long-term usage patterns. Another limitation is that the study only included women who already used the products; therefore, the usage patterns are not representative of the entire female population. Also, the data are not presented by age group.

17.3.10. Loretz et al. (2006)—Exposure Data for Personal Care Products: Hairspray, Spray Perfume, Liquid Foundation, Shampoo, Body Wash, and Solid Antiperspirant

Loretz et al. (2006) conducted a nationwide survey to determine the usage (i.e., frequency of use and amount used) of hairspray, spray perfume, liquid foundation, shampoo, body wash, and solid antiperspirant. The survey was similar to that described by Loretz et al. (2005). This study was conducted in 2000 and 2001. A total of 360 women were recruited from 10 U.S. cities (Atlanta, GA; Boston, MA; Chicago, IL; Denver, CO; Houston, TX; Minneapolis, MN; St. Louis, MO; San Bernardino, CA; Tampa Bay, FL; and Seattle, WA). The survey participants were women, ages 19 to 65 years old, who regularly used the test products. Subjects kept daily records on product usage (e.g., whether the product was used, number of applications, time of applications) in a diary. For spray perfume, liquid foundation, and body wash, subjects recorded the body areas where these products were applied. For shampoo, subjects recorded information on their hair type (i.e., length, thickness, oiliness, straight or curly, and color treated or not). At the end of the 2-week period, unused portions of products were returned and weighed. Of the 360 subjects recruited per product, the study was completed by 91% of participants for hairspray, 91% for spray perfume, 94% for liquid foundation, and 94% for shampoo, body wash, and solid antiperspirant.

Tables 17-40 through 17-42 present the survey data. Table 17-40 provides the minimum, maximum, mean, and standard deviations for the frequency of use. Table 17-41 provides percentile values for the amount of product applied per application. Table 17-42 provides distribution data for the amount applied per use day.

An advantage of this study is that the survey population covered a diverse geographical range of the United States and that it did not rely on recall data. A limitation of the study is that the short duration (2 weeks) may not accurately reflect long-term usage patterns. Another limitation is that the study only included women who already used these products; therefore, the usage patterns are not entirely representative of the entire female population. Also, the data are not presented by age group.

17.3.11. Hall et al. (2007)—European Consumer Exposure to Cosmetic Products, a Framework for Conducting Population Exposure Assessments

European cosmetic manufacturers constructed a probabilistic European population model of exposure for six cosmetic products: body lotion, deodorant/antiperspirant, lipstick, facial moisturizer, shampoo, and toothpaste (Hall et al., 2007). Data were collected by using both market information databases and a controlled product use study from 44,100 households and 18,057 individual consumers, creating a sample of the 249 million inhabitants of the 15 countries in the European Union. Tables 17-43 through 17-50 show the amount used in g/day and mg/kg-day. The study found an inverse correlation between frequency of product use and quantity used per application for body lotion, facial moisturizer, toothpaste, and shampoo, and so the authors cautioned against calculating daily exposure to these products by multiplying the maximum frequency value by the maximum quantity per event value.

The advantage of this study is that it included a large sample size. However, behaviors and activities in the European population may not be representative of the U.S. population, and results were not broken out by age groups.

17.3.12. Loretz et al. (2008)—Exposure Data for Cosmetic Products: Facial Cleanser, Hair Conditioner, and Eye Shadow

Loretz et al. (2008) used the data from a study conducted in 2005 to estimate frequency of use and usage amount for facial cleanser, hair conditioner, and eye shadow. The study was conducted in a similar manner as Loretz et al. (2005, 2006). A total of 360 women, ages 18 to 69 years, were recruited by telephone to provide diary records of product use during a 2-week period. The study subjects were representative of four U.S. Census regions (i.e., Northeast, Midwest, South, and West). A total of 295, 297, and 299 women completed the study for facial cleanser, hair conditioner, and eye shadow, respectively.

The participants recorded daily in a diary whether the product was used that day, the number of applications, and the time of applications during a 2-week period. Products were weighed at the start and completion of the study to determine the amount used. A statistical analysis of the data was conducted to provide summary distributions of use patterns, including number of applications, amount used per day, and amount of product used per application for each product. Table 17-51 provides data on the number of applications per use day. Table 17-52 shows the average amounts of product applied per use day, while Table 17-53 shows the average amounts of product applied per application.

The advantages of this study are that it is representative of the U.S. female population for users of the products studied, it provides data for frequency of use and amount used, and it provides distribution data. A limitation of the study is that the data were not provided by age group. In addition, the participants were regular users of the product, so the amount applied and the frequency of use may be higher than for other individuals who may use the products. According to Loretz et al. (2008), "…variability in amount used by the different subjects is high, but consistent with the data from other cosmetic and personal care studies." The authors also noted that it was not clear if the high-end users of products represented true usage. Data were also collected over a 2-week period and may not be representative of long-term usage patterns.

17.3.13. Sathyanarayana et al. (2008)—Baby Care Products; Possible Sources of Infant Phthalate Exposure

Sathyanarayana et al. (2008) investigated dermal exposure to phthalates via the dermal application of personal care products. The study was conducted on 163 infants born between 2000 and 2005. The products studied were baby lotion, baby powder, baby shampoo, diaper cream, and baby wipes. Infants were recruited through Future Families, a multicenter pregnancy cohort study, at prenatal clinics in Los Angeles, CA; Minneapolis, MN; and Columbia, MO. Although the study was designed to assess exposure to phthalates, the authors collected information on the percentage of the total participants who used the baby products. Data were collected from questionnaire responses of the mothers and at study visits. Table 17-54 shows the characteristics and the percentage of the population using the studied baby products. Of the 163 infants studied, 94% of the participants used baby wipes, and 54% used infant shampoo.

The advantages of this study are that it specifically targeted consumer products used by children, it captured the percentage of the study population using these products, and it collected the data from a diverse ethnic population. The limitation is that these data may not be entirely representative of the U.S. population because the study population was from only three states and the sample size was small. Also, this study did not contain any information on amount or frequency of product use.

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Table 17-1. Consumer Products Commonly Found in Some U.S. Households[a]		
Consumer Product Category	Consumer Product	
Cosmetics Hygiene Products	• Adhesive bandages • Bath additives (liquid) • Bath additives (powder) • Cologne/perfume/aftershave • Contact lens solutions • Deodorant/antiperspirant (aerosol) • Deodorant/antiperspirant (wax and liquid) • Depilatories • Facial makeup • Fingernail cosmetics • Hair coloring/tinting products • Hair conditioning products • Hairsprays (aerosol)	• Lip products • Mouthwash/breath freshener • Sanitary napkins and pads • Shampoo • Shaving creams (aerosols) • Skin creams (non-drug) • Skin oils (non-drug) • Soap (toilet bar) • Sunscreen/suntan products • Talc/body powder (non-drug) • Toothpaste • Waterless skin cleaners
Household Furnishings	• Carpeting • Draperies/curtains • Rugs (area)	• Shower curtains • Vinyl upholstery, furniture
Garment Conditioning Products	• Anti-static spray (aerosol) • Leather treatment (liquid and wax) • Shoe polish • Spray starch (aerosol)	• Suede cleaner/polish (liquid and aerosol) • Textile water-proofing (aerosol)
Household Maintenance Products	• Adhesive (general) (liquid) • Bleach (household) (liquid) • Bleach (see laundry) • Candles • Cat box litter • Charcoal briquettes • Charcoal lighter fluid • Drain cleaner (liquid and powder) • Dishwasher detergent (powder) • Dishwashing liquid • Fabric dye (DIY)[b] • Fabric rinse/softener (liquid) • Fabric rinse/softener (powder) • Fertilizer (garden) (liquid) • Fertilizer (garden) (powder) • Fire extinguishers (aerosol) • Floor polish/wax (liquid) • Food packaging and packaged food • Furniture polish (liquid) • Furniture polish (aerosol) • General cleaner/disinfectant (liquid) • General cleaner (powder) • General cleaner/disinfectant (aerosol and pump) • General spot/stain remover (liquid) • General spot/stain remover (aerosol and pump) • Herbicide (garden-patio) (liquid and aerosol) • Insecticide (home and garden) (powder) • Insecticide (home and garden) (aerosol and pump)	• Insect repellent (liquid and aerosol) • Laundry detergent/bleach (liquid) • Laundry detergent (powder) • Laundry prewash/soak (powder) • Laundry prewash/soak (liquid) • Laundry prewash/soak (aerosol and pump) • Lubricant oil (liquid) • Lubricant (aerosol) • Matches • Metal polish • Oven cleaner (aerosol) • Pesticide (home) (solid) • Pesticide (pet dip) (liquid) • Pesticide (pet) (powder) • Pesticide (pet) (aerosol) • Pesticide (pet) (collar) • Petroleum fuels (home) (liquid and aerosol) • Rug cleaner/shampoo (liquid and aerosol) • Rug deodorizer/freshener (powder) • Room deodorizer (solid) • Room deodorizer (aerosol) • Scouring pad • Toilet bowl cleaner • Toiler bowl deodorant (solid) • Water-treating chemicals (swimming pools)

Table 17-1. Consumer Products Commonly Found in Some U.S. Households[a] (continued)

Consumer Product Category	Consumer Product	
Home Building/Improvement Products (DIY)[b]	• Adhesives, specialty (liquid) • Ceiling tile • Caulks/sealers/fillers • Dry wall/wall board • Flooring (vinyl) • House paint (interior) (liquid) • House paint and stain (exterior) (liquid) • Insulation (solid) • Insulation (foam)	• Paint/varnish removers • Paint thinner/brush cleaners • Patching/ceiling plaster • Roofing • Refinishing products (e.g., polyurethane, varnishes) • Spray paints (home) (aerosol) • Wall paneling • Wall paper • Wall paper glue
Automobile-Related Products	• Antifreeze • Car polish/wax • Fuel/lubricant additives • Gasoline/diesel fuel • Interior upholstery/components, synthetic	• Motor oil • Radiator flush/cleaner • Automotive touch-up paint (aerosol) • Windshield washer solvents
Personal Materials	• Clothes/shoes • Diapers/vinyl pants • Jewelry • Printed material (colorprint, newsprint, photographs)	• Sheets/towels • Toys (intended to be placed in mouths)

[a] A subjective listing based on consumer use profiles.
[b] DIY = do it yourself.

Source: U.S. EPA, 1987.

Table 17-2. List of Product Categories in the Simmons Study of Media and Markets

The volumes included in the Media series are as follows:	
M1	Publications: Total Audiences
M2	Publications: Qualitative Measurements and In-Home Audiences
M3	Publications: Duplication of Audiences
M4	Multi-Media Audiences: Adults
M5	Multi-Media Audiences: Males
M6	Multi-Media Audiences: Females and Mothers
M7	Business to Business
M8	Multi-Media Reach and Frequency and Television Attentiveness and Special Events
The following volumes are included in the Product series:	
P1	Automobiles, Cycles, Trucks and Vans
P2	Automotive Products and Services
P3	Travel
P4	Banking, Investments, Insurance, Credit Cards and Contributions, Memberships and Public Activities
P5	Games and Toys, Children's and Babies' Apparel and Specialty Products
P6	Computers, Books, Discs, Records, Tapes, Stereo, Telephones, TV and Video
P7	Appliances, Garden Care, Sewing and Photography
P8	Home Furnishings and Home Improvements
P9	Sports and Leisure
P10	Restaurants, Stores and Grocery Shopping
P11	Direct Mail and Other In-Home Shopping, Yellow Pages, Florist, Telegrams, Faxes and Greeting Cards
P12	Jewelry, Watches, Luggage, Writing Tools and Men's Apparel
P13	Women's Apparel
P14	Distilled Spirits, Mixed Drinks, Malt Beverages, Wine and Tobacco Products
P15	Coffee, Tea, Cocoa, Milk, Soft Drinks, Juices and Bottled Water
P16	Dairy Products, Desserts, Baking and Bread Products
P17	Cereals and Spreads, Rice, Pasta, Pizza, Mexican Foods, Fruits and Vegetables
P18	Soup, Meat, Fish, Poultry, Condiments and Dressings
P19	Chewing Gum, Candy, Cookies and Snacks
P20	Soap, Laundry, Paper Products and Kitchen Wraps
P21	Household Cleaners, Room Deodorizers, Pest Controls and Pet Foods
P22	Health Care Products and Remedies
P23	Oral Hygiene Products, Skin Care, Deodorants and Drug Stores
P24	Hair Care, Shaving Products and Fragrances
P25	Women's Beauty Aids, Cosmetics and Personal Products
P26	Relative Volume of Consumption

Table 17-3. Amount and Frequency of Use of Various Cosmetic and Baby Products							
Product Type	Amount of Product Per Application[a] (grams)	Average Frequency of Use (per day)			Upper 90th Percentile Frequency of Use (per day)		
		Survey Type			Survey Type		
		CTFA	Cosmetic Co.	Market[b] Research Bureau	CTFA	Cosmetic Co.	Market Research Bureau
Baby Lotion - baby use[c]	1.4	0.38	1.0	–	0.57	2.0	–
Baby Lotion - adult use	1.0	0.22	0.19	0.24[d]	0.86	1.0	1.0[d]
Baby Oil - baby use[c]	1.3	0.14	1.2	–	0.14	3.0	–
Baby Oil - adult use	5.0	0.06	0.13	–	0.29	0.57	–
Baby Powder - baby use[c]	0.8	5.36	1.5	0.35[d]	8.43	3.0	1.0[d]
Baby Powder - adult use	0.8	0.13	0.22	–	0.57	1.0	–
Baby Cream - baby use[c]	–	0.43	1.3	–	0.43	3.0	–
Baby Cream - adult use	–	0.07	0.10	–	0.14	0.14[e]	–
Baby Shampoo - baby use[c]	0.5	0.14	–	0.11[f]	0.14	–	0.43[f]
Baby Shampoo - adult use	5.0	0.02	–	–	0.86[e]	–	–
Bath Oils	14.7	0.08	0.19	0.22[g]	0.29	0.86	1.0[g]
Bath Tablets	–	0.003	0.008	–	0.14[e]	0.14[e]	–
Bath Salts	18.9	0.006	0.013	–	0.14[e]	0.14[e]	–
Bubble Baths	11.8	0.088	0.13	–	0.43	0.57	–
Bath Capsules	–	0.018	0.019	–	0.29[e]	0.14[e]	–
Bath Crystals	–	0.006	–	–	0.29[e]	0.14[e]	–
Eyebrow Pencil	–	0.27	0.49	–	1.0	1.0	–
Eyeliner	–	0.42	0.68	0.27	1.43	1.0	1.0
Eye Shadow	–	0.69	0.78	0.40	1.43	1.0	1.0
Eye Lotion	–	0.094	0.34	–	0.43	1.0	–
Eye Makeup Remover	–	0.29	0.45	–	1.0	1.0	–
Mascara	–	0.79	0.87	0.46	1.29	1.0	1.5
Under Eye Cover	–	0.79	–	–	0.29	–	–
Blusher and Rouge	0.011	1.18	1.24	0.55	2.0	1.43	1.5
Face Powders	0.085	0.35	0.67	0.33	1.29	1.0	1.0
Foundations	0.265	0.46	0.78	0.47	1.0	1.0	1.5
Leg and Body Paints	–	0.003	0.011	–	0.14[e]	0.14[e]	–
Lipstick and Lip Gloss	–	1.73	1.23	2.62	4.0	2.86	6.0
Makeup Bases	0.13	0.24	0.64	–	0.86	1.0	–

Table 17-3. Amount and Frequency of Use of Various Cosmetic and Baby Products (continued)

Product Type	Amount of Product Per Application[a] (grams)	Average Frequency of Use (per day)			Upper 90th Percentile Frequency of Use (per day)		
		Survey Type			Survey Type		
		CTFA	Cosmetic Co.	Market[b] Research Bureau	CTFA	Cosmetic Co.	Market Research Bureau
Makeup Fixatives	–	0.052	0.12	–	0.14	1.0	–
Sunscreen	3.18	0.003	–	0.002	0.14[e]	–	0.005
Colognes and Toilet Water	0.65	0.68	0.85	0.56	1.71	1.43	1.5
Perfumes	0.23	0.29	0.26	0.38	0.86	1.0	1.5
Powders	2.01	0.18	0.39	–	1.0	1.0	–
Sachets	0.2	0.0061	0.034	–	0.14[e]	0.14[e]	–
Fragrance Lotion	–	0.0061	–	–	0.29[e]	–	–
Hair Conditioners	12.4	0.4	0.40	0.27	1.0	1.0	0.86
Hair Sprays	–	0.25	0.55	0.32	1.0	1.0	1.0
Hair Rinses	12.7	0.064	0.18	–	0.29	1.0	–
Shampoos	16.4	0.82	0.59	0.48	1.0	1.0	1.0
Tonics and Dressings	2.9	0.073	0.021	–	0.29	0.14[d]	–
Wave Sets	2.6	0.003[h]	0.040	–	–[h]	0.14	–
Dentifrices	–	1.62	0.67	2.12	2.6	2.0	4.0
Mouthwashes	–	0.42	0.62	0.58	1.86	1.14	1.5
Breath Fresheners	–	0.052	0.43	0.46	0.14	1.0	0.57
Nail Basecoats	0.2	0.052	0.13	–	0.29	0.29	–
Cuticle Softeners	0.7	0.040	0.10	–	0.14	0.29	–
Nail Creams and Lotions	0.6	0.070	0.14	–	0.29	0.43	–
Nail Extenders	–	0.003	0.013	–	0.14[e]	0.14[e]	–
Nail Polish and Enamel	0.3	0.16	0.20	0.07	0.71	0.43	1.0
Nail Polish and Enamel Remover	3.1	0.088	0.19	–	0.29	0.43	–
Nail Undercoats	–	0.049	0.12	–	0.14	0.29	–
Bath Soaps	2.6	1.53	0.95	–	3.0	1.43	–
Underarm Deodorants	0.5	1.01	0.80	1.10	1.29	1.29	2.0
Douches	–	0.013	0.089	0.085	0.14[e]	0.29	0.29
Feminine Hygiene Deodorants	–	0.021	0.084	0.05	1.0[e]	0.29	0.14
Cleansing Products (cold creams, cleansing lotions, liquids, and pads)	1.7	0.63	0.80	0.54	1.71	2.0	1.5
Depilatories	–	0.0061	0.051	0.009	0.016	0.14	0.033

Table 17-3. Amount and Frequency of Use of Various Cosmetic and Baby Products (continued)							
Product Type	Amount of Product Per Application[a] (grams)	Average Frequency of Use (per day)			Upper 90th Percentile Frequency of Use (per day)		
		Survey Type			Survey Type		
		CTFA	Cosmetic Co.	Market[b] Research Bureau	CTFA	Cosmetic Co.	Market Research Bureau
Face, Body and Hand Preps (excluding shaving preps)	3.5	0.65	–	1.12	2.0	–	2.14
Foot Powder and Sprays	–	0.061	0.079	–	0.57[e]	0.29	–
Hormones	–	0.012	0.028	–	0.57[e]	0.14[e]	–
Moisturizers	0.5	0.98	0.88	0.63	2.0	1.71	1.5
Night Skin Care Products	1.3	0.18	0.50	–	1.0	1.0	–
Paste Masks (mud packs)	3.7	0.027	0.20	–	0.14	0.43	–
Skin Lighteners	–	–	0.024	–	–[e]	0.14[e]	–
Skin Fresheners and Astringents	2.0	0.33	0.56	–	1.0	1.43	–
Wrinkle Smoothers (removers)	0.4	0.021	0.15	–	1.0[d]	1.0	–
Facial Cream	0.6	0.0061	–	–	0.0061	–	–
Permanent Wave	101	0.003	–	0.001	0.0082	–	0.005
Hair Straighteners	0.2	0.0007	–	–	0.005[e]	–	–
Hair Dye	–	0.001	–	0.005	0.004[e]	–	0.014
Hair Lighteners	–	0.0003	–	–	0.005[e]	–	–
Hair Bleaches	–	0.0005	–	–	0.02[e]	–	–
Hair Tints	–	0.0001	–	–	0.005[e]	–	–
Hair Rinse (coloring)	–	0.0004	–	–	0.02[e]	–	–
Shampoo (coloring)	–	0.0005	–	–	0.02[e]	–	–
Hair Color Spray	–	–	–	–	–[e]	–	–
Shave Cream	1.73	–	–	0.082	–	–	0.36

a Values reported are the averages of the responses reported by the 20 companies interviewed.
b The averages shown for the Market Research Bureau are not true averages - this is due to the fact that in many cases the class of most frequent users is indicated by "1 or more"; also, ranges are used in many cases (i.e., "10-12"). The average, therefore, is underestimated slightly. The "1 or more" designation also skews the 90th percentile figures in many instances. The 90th percentile values may, in actuality, be somewhat higher for many products.
c Average usage among users only for baby products.
d Usage data reflects entire household use for both baby lotion and baby oil.
e Fewer than 10% of individuals surveyed used these products. Value listed is lowest frequency among individuals reporting usage. In the case of wave sets, skin lighteners, and hair color spray, none of the individuals surveyed by the CTFA used this product during the period of the study.
f Usage data reflects entire household use.
g Usage data reflects total bath product usage.
h None of the individuals surveyed reported using this product.
(–) indicate no data available.

Source: CTFA, 1983.

Table 17-4. Frequency of Use for Household Solvent Products (users only)

Products	Mean (use/year)	SD	Percentile Rankings for Frequency of Use/Year										
			Min	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	10.28	20.10	1.00	1.00	1.00	1.00	2.00	4.00	8.00	24.30	52.00	111.26	156.00
Water Repellents/Protectors	3.50	11.70	1.00	1.00	1.00	1.00	1.00	2.00	3.00	6.00	10.00	35.70	300.00
Spot Removers	15.59	43.34	1.00	1.00	1.00	1.00	2.00	3.00	10.00	40.00	52.00	300.00	365.00
Solvent-Type Cleaning Fluids or Degreasers	16.46	44.12	1.00	1.00	1.00	1.00	2.00	4.00	12.00	46.00	52.00	300.00	365.00
Wood Floor and Paneling Cleaners	8.48	20.89	1.00	1.00	1.00	1.00	NA	2.00	6.00	24.00	50.00	56.00	350.00
Typewriter Correction Fluid	40.00	74.78	1.00	1.00	1.00	2.00	4.00	12.00	40.00	100.00	200.00	365.00	520.00
Adhesives	8.89	26.20	1.00	1.00	1.00	1.00	2.00	3.00	6.00	15.00	28.00	100.00	500.00
Adhesive Removers	4.22	12.30	1.00	1.00	1.00	1.00	1.00	1.00	3.00	6.00	16.80	100.00	100.00
Silicone Lubricants	10.32	25.44	1.00	1.00	1.00	1.00	2.00	3.00	10.00	20.00	46.35	150.00	300.00
Other Lubricants (excluding automotive)	10.66	25.46	1.00	1.00	1.00	1.00	2.00	4.00	10.00	20.00	50.00	100.00	420.00
Specialized Electronic Cleaners (e.g., for TVs)	13.41	38.16	1.00	1.00	1.00	1.00	2.00	3.00	10.00	24.00	52.00	224.50	400.00
Latex Paint	3.93	20.81	1.00	1.00	1.00	1.00	1.00	2.00	4.00	6.00	10.00	30.00	800.00
Oil Paint	5.66	23.10	1.00	1.00	1.00	1.00	1.00	1.00	3.00	6.00	12.00	139.20	300.00
Wood Stains, Varnishes, and Finishes	4.21	12.19	1.00	1.00	1.00	1.00	1.00	2.00	4.00	7.00	12.00	50.80	250.00
Paint Removers/Strippers	3.68	9.10	1.00	1.00	1.00	1.00	4.00	2.00	3.00	6.00	11.80	44.56	100.00
Paint Thinners	6.78	22.10	0.03	0.03	0.10	0.23	1.00	2.00	4.00	12.00	23.00	100.00	352.00
Aerosol Spray Paint	4.22	15.59	1.00	1.00	1.00	1.00	1.00	2.00	4.00	6.10	12.00	31.05	365.00
Primers and Special Primers	3.43	8.76	1.00	1.00	1.00	1.00	1.00	1.00	3.00	6.00	10.00	50.06	104.00
Aerosol Rust Removers	6.17	9.82	1.00	1.00	1.00	1.00	1.00	2.00	6.00	15.00	24.45	50.90	80.00
Outdoor Water Repellents (for wood or cement)	2.07	3.71	1.00	1.00	1.00	1.00	1.00	2.00	2.00	3.00	5.90	12.00	52.00
Glass Frostings, Window Tints, and Artificial Snow	2.78	21.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	27.20	365.00
Engine Degreasers	4.18	13.72	1.00	1.00	1.00	1.00	1.00	2.00	3.25	6.70	12.00	41.70	300.00
Carburetor Cleaners	3.77	7.10	1.00	1.00	1.00	1.00	1.00	2.00	3.00	6.00	12.00	47.28	100.00
Aerosol Spray Paints for Cars	4.50	9.71	1.00	1.00	1.00	1.00	1.00	2.00	4.00	10.00	15.00	60.00	100.00
Auto Spray Primers	6.42	33.89	1.00	1.00	1.00	1.00	1.00	2.00	3.75	10.00	15.00	139.00	500.00
Spray Lubricant for Cars	10.31	30.71	1.00	1.00	1.00	1.00	2.00	3.00	6.00	20.00	40.00	105.60	365.00
Transmission Cleaners	2.28	3.55	1.00	NA	1.00	1.00	1.00	1.00	2.00	3.00	9.00	NA	26.00
Battery Terminal Protectors	3.95	24.33	1.00	1.00	1.00	1.00	1.00	2.00	2.00	4.00	6.55	41.30	365.00
Brake Quieters Cleaners	3.00	6.06	1.00	NA	1.00	1.00	1.00	2.00	2.00	6.00	10.40	NA	52.00
Gasket Remover	2.50	4.39	1.00	NA	1.00	1.00	1.00	1.00	2.00	5.00	6.50	NA	30.00
Tire/Hubcap Cleaners	11.18	18.67	1.00	1.00	1.00	1.00	2.00	4.00	12.00	30.00	50.00	77.00	200.00
Ignition and Wire Dryers	3.01	5.71	1.00	1.00	1.00	1.00	1.00	2.00	3.00	5.00	9.70	44.52	60.00

NA = Not available.
SD = Standard deviation.
Min/Max = Minimum/Maximum.

Source: Westat, 1987a.

Table 17-5. Exposure Time of Use for Household Solvent Products (users only)

Products	Mean (minutes)	SD	Percentile Rankings for Duration of Use (minutes)										
			Min	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	7.49	9.60	0.02	0.03	0.25	0.50	2.00	5.00	10.00	18.00	30.00	60.00	60.00
Water Repellents/Protectors	14.46	24.10	0.02	0.08	0.50	1.40	3.00	10.00	15.00	30.00	60.00	120.00	480.00
Spot Removers	10.68	22.36	0.02	0.03	0.08	0.25	2.00	5.00	10.00	30.00	30.00	120.00	360.00
Solvent-Type Cleaning Fluids or Degreasers	29.48	97.49	0.02	0.03	1.00	2.00	5.00	15.00	30.00	60.00	120.00	300.00	1,800.00
Wood Floor and Paneling Cleaners	74.04	128.43	0.02	1.00	5.00	10.00	20.00	30.00	90.00	147.00	240.00	480.00	2,700.00
Typewriter Correction Fluid	7.62	29.66	0.02	0.02	0.03	0.03	0.17	1.00	2.00	10.00	32.00	120.00	480.00
Adhesives	15.58	81.80	0.02	0.03	0.08	0.33	1.00	4.25	10.00	30.00	60.00	180.00	2,880.00
Adhesive Removers	121.20	171.63	0.03	0.03	1.45	3.00	15.00	60.00	120.00	246.00	480.00	960.00	960.00
Silicone Lubricants	10.42	29.47	0.02	0.03	0.08	0.17	0.50	2.00	10.00	20.00	45.00	180.00	360.00
Other Lubricants (excluding automotive)	8.12	32.20	0.02	0.03	0.05	0.08	0.50	2.00	5.00	15.00	30.00	90.00	900.00
Specialized Electronic Cleaners (e.g., for TVs)	9.47	45.35	0.02	0.03	0.08	0.17	0.50	2.00	5.00	20.00	30.00	93.60	900.00
Latex Paint	295.08	476.11	0.02	1.00	22.50	30.00	90.00	180.00	360.00	480.00	810.00	2,880.00	5,760.00
Oil Paint	194.12	345.68	0.02	0.51	15.00	30.00	60.00	12.00	240.00	480.00	579.00	1,702.80	5,760.00
Wood Stains, Varnishes, and Finishes	117.17	193.05	0.02	0.74	5.00	10.00	30.00	60.00	120.00	140.00	360.00	720.00	280.00
Paint Removers/Strippers	125.27	286.59	0.02	0.38	5.00	5.00	20.00	60.00	120.00	240.00	420.00	1,200.00	4,320.00
Paint Thinners	39.43	114.85	0.02	0.08	1.00	2.00	5.00	10.00	30.00	60.00	180.00	480.00	2,400.00
Aerosol Spray Paint	39.54	87.79	0.02	0.17	2.00	5.00	10.00	20.00	45.00	60.00	120.00	300.00	1,800.00
Primers and Special Primers	91.29	175.05	0.05	0.24	3.00	5.00	15.00	30.00	120.00	240.00	360.00	981.60	1,920.00
Aerosol Rust Removers	18.57	48.54	0.02	0.05	0.17	0.25	2.00	5.00	20.00	60.00	60.00	130.20	720.00
Outdoor Water Repellents (for wood or cement)	104.94	115.36	0.02	0.05	5.00	15.00	30.00	60.00	120.00	240.00	300.00	480.00	960.00
Glass Frostings, Window Tints, and Artificial Snow	29.45	48.16	0.03	0.14	2.00	3.00	5.00	15.00	30.00	60.00	96.00	268.80	360.00
Engine Degreasers	29.29	48.14	0.02	0.95	2.00	5.00	10.00	15.00	30.00	60.00	120.00	180.00	900.00
Carburetor Cleaners	13.57	23.00	0.02	0.08	0.33	1.00	3.00	7.00	15.00	30.00	45.00	120.00	300.00
Aerosol Spray Paints for Cars	42.77	71.39	0.03	0.19	1.00	3.00	10.00	20.00	60.00	120.00	145.00	360.00	900.00
Auto Spray Primers	51.45	86.11	0.05	0.22	2.00	5.00	10.00	27.50	60.00	120.00	180.00	529.20	600.00
Spray Lubricant for Cars	9.90	35.62	0.02	0.03	0.08	0.17	1.00	5.00	10.00	15.00	30.00	120.00	720.00
Transmission Cleaners	27.90	61.44	0.17	NA	0.35	1.80	5.00	15.00	30.00	60.00	60.00	NA	450.00
Battery Terminal Protectors	9.61	18.15	0.03	0.04	0.08	0.23	1.00	5.00	10.00	20.00	30.00	120.00	180.00
Brake Quieters/Cleaners	23.38	36.32	0.07	NA	0.50	1.00	5.00	15.00	30.00	49.50	120.00	NA	240.00
Gasket Remover	23.57	27.18	0.33	NA	0.50	2.00	6.25	15.00	30.00	60.00	60.00	NA	180.00
Tire/Hubcap Cleaners	22.66	23.94	0.08	0.71	3.00	5.00	10.00	15.00	30.00	60.00	60.00	120.00	240.00
Ignition and Wire Dryers	7.24	8.48	0.02	0.02	0.08	0.47	1.50	5.00	10.00	15.00	25.50	48.60	60.00

NA = Not available.

SD = Standard deviation.
Min/Max = Minimum/Maximum.

Source: Westat, 1987a.

Table 17-6. Amount of Products Used for Household Solvent Products (users only)

Products	Mean (ounces/year)	SD	Percentile Rankings for Amount of Products Used (ounces/year)										
			Min.	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	9.90	17.90	0.04	0.20	0.63	1.00	2.00	4.50	10.00	24.00	36.00	99.36	180.00
Water Repellents/Protectors	11.38	22.00	0.04	0.47	0.98	1.43	2.75	6.00	12.00	24.00	33.00	121.84	450.00
Spot Removers	26.32	90.10	0.01	0.24	0.60	1.00	2.00	5.50	16.00	48.00	119.20	384.00	1,600.00
Solvent-Type Cleaning Fluids or Degreasers	58.30	226.97	0.04	0.50	2.00	3.00	6.50	16.00	32.00	96.00	192.00	845.00	5,120.00
Wood Floor and Paneling Cleaners	28.41	57.23	0.03	0.80	2.45	3.50	7.00	14.00	30.00	64.00	96.00	204.40	1,144.00
Typewriter Correction Fluid	4.14	13.72	0.01	0.02	0.06	0.12	0.30	0.94	2.40	8.00	18.00	67.44	181.80
Adhesives	7.49	55.90	0.01	0.02	0.05	0.12	0.35	1.00	3.00	8.00	20.00	128.00	1,280.00
Adhesive Removers	34.46	96.60	0.25	0.29	1.22	2.80	6.00	10.88	32.00	64.00	138.70	665.60	1,024.00
Silicone Lubricants	12.50	27.85	0.02	0.20	0.69	1.00	2.25	4.50	12.00	24.00	41.20	192.00	312.00
Other Lubricants (excluding automotive)	9.93	44.18	0.01	0.18	0.30	0.52	1.00	2.25	8.00	18.00	32.00	128.00	1,280.00
Specialized Electronic Cleaners (e.g., for TVs)	9.48	55.26	0.01	0.05	0.13	0.25	0.52	2.00	6.00	12.65	24.00	109.84	1,024.00
Latex Paint	371.27	543.86	0.03	4.00	12.92	32.00	64.00	256.00	384.00	857.60	1,280.00	2,560.00	6,400.00
Oil Paint	168.92	367.82	0.02	0.33	4.00	8.00	25.20	64.00	148.48	384.00	640.00	1,532.16	5,120.00
Wood Stains, Varnishes, and Finishes	65.06	174.01	0.12	1.09	4.00	4.00	8.00	16.00	64.00	128.00	256.00	768.00	3,840.00
Paint Removers/Strippers	63.73	144.33	0.64	1.50	4.00	8.00	16.00	32.00	64.00	128.00	256.00	512.00	2,560.00
Paint Thinners	69.45	190.55	0.03	0.45	3.10	4.00	8.00	20.48	64.00	128.00	256.00	640.00	3,200.00
Aerosol Spray Paint	30.75	52.84	0.02	0.75	2.01	3.25	7.00	13.00	32.00	65.00	104.00	240.00	1,053.00
Primers and Special Primers	68.39	171.21	0.01	0.09	1.30	3.23	8.00	16.00	60.00	128.00	256.00	867.75	1,920.00
Aerosol Rust Removers	18.21	81.37	0.09	0.25	1.00	1.43	2.75	8.00	13.00	32.00	42.60	199.80	1,280.00
Outdoor Water Repellents (for wood or cement)	148.71	280.65	0.01	0.37	3.63	8.00	16.00	64.00	128.00	448.00	640.00	979.20	3,200.00
Glass Frostings, Window Tints, and Artificial Snow	13.82	14.91	1.00	1.40	2.38	3.25	6.00	12.00	14.00	28.00	33.00	98.40	120.00
Engine Degreasers	46.95	135.17	0.04	1.56	4.00	6.00	12.00	16.00	36.00	80.00	160.00	480.00	2,560.00
Carburetor Cleaners	22.00	50.60	0.10	0.50	1.50	3.00	5.22	12.00	16.00	39.00	75.00	212.00	672.00
Aerosol Spray Paints for Cars	44.95	89.78	0.04	0.14	1.50	3.00	6.12	16.00	48.00	100.80	156.00	557.76	900.00
Auto Spray Primers	70.37	274.56	0.12	0.77	3.00	4.00	9.00	16.00	48.00	128.00	222.00	1,167.36	3840.00
Spray Lubricant for Cars	18.63	54.74	0.08	0.40	0.96	1.00	2.75	6.00	15.50	36.00	64.00	240.00	864.00
Transmission Cleaners	35.71	62.93	2.00	NA	3.75	4.00	8.00	15.00	32.00	77.00	140.00	NA	360.00
Battery Terminal Protectors	16.49	87.84	0.12	0.13	0.58	1.00	2.00	4.00	8.00	15.00	24.60	627.00	1,050.00
Brake Quieters/Cleaners	11.72	13.25	0.50	NA	1.00	2.00	3.02	8.00	14.25	32.00	38.60	NA	78.00
Gasket Remover	13.25	22.35	0.50	NA	1.00	1.00	3.75	7.75	16.00	24.00	58.40	NA	160.00
Tire/Hubcap Cleaners	31.58	80.39	0.12	0.50	1.82	3.00	6.00	12.00	28.00	64.00	96.00	443.52	960.00
Ignition and Wire Dryers	9.02	14.59	0.13	0.32	1.09	1.50	3.00	6.00	10.75	16.00	20.55	113.04	120.00

NA = Not available.
SD = Standard deviation.
Min/Max = Minimum/Maximum.

Source: Westat, 1987a.

Table 17-7. Time Exposed After Duration of Use for Household Solvent Products (users only)

Products	Mean (minutes)	SD	Percentile Rankings for Time Exposed After Duration of Use (minutes)										
			Min.	1	5	10	25	50	75	90	95	99	Max
Spray Shoe Polish	31.40	80.50	0.00	0.00	0.00	0.00	0.00	5.00	20.00	120.00	120.00	480.00	720.00
Water Repellents/Protectors	37.95	111.40	0.00	0.00	0.00	0.00	0.00	3.00	20.00	120.00	240.00	480.00	1,800.00
Spot Removers	43.65	106.97	0.00	0.00	0.00	0.00	1.00	5.00	30.00	120.00	240.00	480.00	1,440.00
Solvent-Type Cleaning Fluids or Degreasers	33.29	90.39	0.00	0.00	0.00	0.00	0.00	3.00	28.75	60.00	180.00	480.00	1,440.00
Wood Floor and Paneling Cleaners	96.75	192.88	0.00	0.00	0.00	0.00	5.00	30.00	120.00	240.00	480.00	1,062.00	1,440.00
Typewriter Correction Fluid	124.70	153.46	0.00	0.00	1.00	5.00	30.00	60.00	180.00	360.00	480.00	600.00	1,800.00
Adhesives	68.88	163.72	0.00	0.00	0.00	0.00	1.00	10.00	60.00	180.00	360.00	720.00	2,100.00
Adhesive Removers	94.12	157.69	0.00	0.00	0.00	0.00	1.75	20.00	120.00	360.00	480.00	720.00	720.00
Silicone Lubricants	30.77	107.39	0.00	0.00	0.00	0.00	0.00	0.00	10.00	60.00	180.00	480.00	1,440.00
Other Lubricants (excluding automotive)	47.45	127.11	0.00	0.00	0.00	0.00	0.00	2.00	30.00	120.00	240.00	485.40	1,440.00
Specialized Electronic Cleaners (e.g., for TVs)	117.24	154.38	0.00	0.00	0.00	1.00	10.00	60.00	180.00	300.00	480.00	720.00	1,440.00
Latex Paint	91.38	254.61	0.00	0.00	0.00	0.00	0.00	5.00	60.00	240.00	480.00	1,440.00	2,880.00
Oil Paint	44.56	155.19	0.00	0.00	0.00	0.00	0.00	0.00	30.00	120.00	240.00	480.00	2,880.00
Wood Stains, Varnishes, and Finishes	48.33	156.44	0.00	0.00	0.00	0.00	0.00	1.00	30.00	120.00	240.00	694.00	2,880.00
Paint Removers/Strippers	31.38	103.07	0.00	0.00	0.00	0.00	0.00	0.00	20.00	60.00	180.00	541.20	1,440.00
Paint Thinners	32.86	105.62	0.00	0.00	0.00	0.00	0.00	0.00	15.00	60.00	180.00	480.00	1,440.00
Aerosol Spray Paint	12.70	62.80	0.00	0.00	0.00	0.00	0.00	0.00	1.00	30.00	60.00	260.50	1,440.00
Primers and Special Primers	22.28	65.57	0.00	0.00	0.00	0.00	0.00	0.00	10.00	60.00	120.00	319.20	720.00
Aerosol Rust Removers	15.06	47.58	0.00	0.00	0.00	0.00	0.00	0.00	5.00	60.00	60.00	190.20	600.00
Outdoor Water Repellents (for wood or cement)	8.33	43.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	58.50	309.60	420.00
Glass Frostings, Window Tints, and Artificial Snow	137.87	243.21	0.00	0.00	0.00	0.00	3.00	60.00	180.00	360.00	480.00	1,440.00	1,800.00
Engine Degreasers	4.52	24.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.50	120.00	360.00
Carburetor Cleaners	7.51	68.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	30.00	120.60	1,800.00
Aerosol Spray Paints for Cars	10.71	45.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.50	60.00	282.00	480.00
Auto Spray Primers	11.37	45.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00	77.25	360.00	360.00
Spray Lubricant for Cars	4.54	30.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	15.00	70.20	420.00
Transmission Cleaners	5.29	29.50	0.00	NA	0.00	0.00	0.00	0.00	0.00	5.00	22.50	NA	240.00
Battery Terminal Protectors	3.25	17.27	0.00	NA	0.00	0.00	0.00	0.00	0.00	2.90	15.00	120.00	180.00
Brake Quieters/Cleaners	10.27	30.02	0.00	NA	0.00	0.00	0.00	0.00	0.00	30.00	120.00	NA	120.00
Gasket Remover	27.56	58.54	0.00	NA	0.00	0.00	0.00	0.00	12.50	120.00	180.00	NA	240.00
Tire/Hubcap Cleaners	1.51	20.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	480.00
Ignition and Wire Dryers	6.39	31.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	30.00	216.60	240.00

NA = Not available.
SD = Standard deviation.
Min/Max = Minimum/Maximum.

Source: Westat, 1987a.

Table 17-8. Total Exposure Time of Performing Task and Product Type Used by Task for Household Cleaning Products

Tasks	Mean (hours/year)	Median (hours/year)	Product Type Used	Percent of Preference
Clean Bathroom Sinks and Tubs	44	26	Liquid	29%
			Powder	44%
			Aerosol	16%
			Spray pump	10%
			Other	1%
Clean Kitchen Sinks	41	18	Liquid	31%
			Powder	61%
			Aerosol	2%
			Spray pump	4%
			Other	2%
Clean Inside of Cabinets (e.g., kitchen)	12	5	Liquid	68%
			Powder	12%
			Aerosol	2%
			Spray pump	16%
			Other	2%
Clean Outside of Cabinets	21	6	Liquid	61%
			Powder	8%
			Aerosol	16%
			Spray pump	13%
			Other	2%
Wipe Off Kitchen Counters	92	55	Liquid	67%
			Powder	13%
			Aerosol	2%
			Spray pump	15%
			Other	3%
Thoroughly Clean Counters	24	13	Liquid	56%
			Powder	21%
			Aerosol	5%
			Spray pump	17%
			Other	1%
Clean Bathroom Floors	20	9	Liquid	70%
			Powder	21%
			Aerosol	2%
			Spray pump	4%
			Other	3%
Clean Kitchen Floors	31	14	Liquid	70%
			Powder	27%
			Aerosol	2%
			Spray pump	1%
			Other	-
Clean Bathroom or Other tilted or Ceramic Walls	16	9	Liquid	37%
			Powder	18%
			Aerosol	17%
			Spray pump	25%
			Other	3%

Table 17-8. Total Exposure Time of Performing Task and Product Type Used by Task for Household Cleaning Products (continued)

Tasks	Mean (hours/year)	Median (hours/year)	Product Type Used	Percent of Preference
Clean Outside of Windows	13	6	Liquid	27%
			Powder	2%
			Aerosol	6%
			Spray pump	65%
			Other	-
Clean Inside of Windows	18	6	Liquid	24%
			Powder	1%
			Aerosol	8%
			Spray pump	66%
			Other	2%
Clean Glass Surfaces Such as Mirrors and Tables	34	13	Liquid	13%
			Powder	1%
			Aerosol	8%
			Spray pump	76%
			Other	2%
Clean Outside of Refrigerator and Other Appliances	27	13	Liquid	48%
			Powder	3%
			Aerosol	7%
			Spray pump	38%
			Other	4%
Clean Spots or Dirt on Walls or Doors Finishes	19	8	Liquid	46%
			Powder	15%
			Aerosol	4%
			Spray pump	30%
			Other	4%

- Indicates value is less than 1%.

Source: Westat, 1987b.

Table 17-9. Percentile Rankings for Total Exposure Time in Performing Household Tasks

	Percentile Rankings for Total Exposure Time Performing Task (hours/year)							
Tasks	Min	10th	25th	50th	75th	90th	95th	Max
Clean Bathroom Sinks and Tubs	0.4	5.2	13	26	52	91.3	121.7	365
Clean Kitchen Sinks	0.3	3.5	8.7	18.3	60.8	97.6	121.7	547.5
Clean Inside of Kitchen Cabinets	0.2	1	2	4.8	12	32.5	48	208
Clean Outside of Cabinets	0.1	1	2	6	17.3	36	78.7	780
Wipe Off Kitchen Counters	1.2	12	24.3	54.8	91.5	231.2	456.3	912.5
Thoroughly Clean Counters	0.2	1.8	6	13	26	52	94.4	547.5
Clean Bathroom Floors	0.1	2	4.3	8.7	26	36.8	71.5	365
Clean Kitchen Floors	0.5	4.3	8.7	14	26	52	97	730
Clean Bathroom or Other Tilted or Ceramic Walls	0.2	1	3	8.7	26	36	52	208
Clean Outside of Windows	0.1	1.5	2	6	11.5	24	32.6	468
Clean Inside of Windows	0.2	1.2	3	6	19.5	36	72	273
Clean Glass Surfaces Such as Mirrors and Tables	0.2	1.7	6	13	26	60.8	104	1460
Clean Outside Refrigerator and Other Appliances	0.1	1.8	4.3	13	30.4	91.3	95.3	365
Clean Spots or Dirt on Walls or Doors	0.1	0.6	2	8	24	52	78	312

Min = Minimum.
Max = Maximum.

Source: Westat, 1987b.

Table 17-10. Mean Percentile Rankings for Frequency of Performing Household Tasks

Tasks	Mean	Percentile Rankings							
		Min	10th	25th	50th	75th	90th	95th	Max
Clean Bathroom Sinks and Tubs	3 ×/week	0.2 ×/week	1 ×/week	1 ×/week	2 ×/week	3.5 ×/week	7 ×/week	7 ×/week	42 ×/week
Clean Kitchen Sinks	7 ×/week	0 ×/week	1 ×/week	2 ×/week	7 ×/week	7 ×/week	15 ×/week	21 ×/week	28 ×/week
Clean Inside of Cabinets Such as Those in the Kitchen	9 ×/year	1 ×/year	1 ×/year	1 ×/year	2 ×/year	12 ×/year	12 ×/year	52 ×/year	156 ×/year
Clean Outside of Cabinets	3 ×/month	0.1 ×/month	0.1 ×/month	0.3 ×/month	1 ×/month	4 ×/month	4 ×/month	22 ×/month	30 ×/month
Wipe Off Counters Such as Those in the Kitchen	2 ×/day	0 ×/day	0.4 ×/day	1 ×/day	1 ×/day	3 ×/day	4 ×/day	6 ×/day	16 ×/day
Thoroughly Clean Counters	8 ×/month	0.1 ×/month	0.8 ×/month	1 ×/month	4 ×/month	4 ×/month	30 ×/month	30 ×/month	183 ×/month
Clean Bathroom Floors	6 ×/month	0.2 ×/month	1 ×/month	2 ×/month	4 ×/month	4 ×/month	13 ×/month	30 ×/month	30 ×/month
Clean Kitchen Floors	6 ×/month	0.1 ×/month	1 ×/month	2 ×/month	4 ×/month	4 ×/month	13 ×/month	30 ×/month	30 ×/month
Clean Bathroom or Other Tiled or Ceramic Walls	4 ×/month	0.1 ×/month	0.2 ×/month	1 ×/month	2 ×/month	4 ×/month	9 ×/month	13 ×/month	30 ×/month
Clean Outside of Windows	5 ×/year	1 ×/year	1 ×/year	1 ×/year	2 ×/year	4 ×/year	12 ×/year	12 ×/year	156 ×/year
Clean Inside of Windows	10 ×/year	1 ×/year	1 ×/year	2 ×/year	4 ×/year	12 ×/year	24 ×/year	52 ×/year	156 ×/year
Clean Other Glass Surfaces such as Mirrors and Tables	7 ×/month	0.1 ×/month	1 ×/month	2 ×/month	4 ×/month	4 ×/month	17 ×/month	30 ×/month	61 ×/month
Clean Outside of Refrigerator and Other Appliances	10 ×/month	0.2 ×/month	1 ×/month	2 ×/month	4 ×/month	13 ×/month	30 ×/month	30 ×/month	61 ×/month
Clean Spots or Dirt on Walls or Doors	6 ×/month	0.1 ×/month	0.2 ×/month	0.3 ×/month	1 ×/month	4 ×/month	13 ×/month	30 ×/month	152 ×/month

Min = Minimum.
Max = Maximum.

Source: Westat, 1987b.

Table 17-11. Mean and Percentile Rankings for Exposure Time per Event of Performing Household Tasks

Tasks	Mean (minutes/event)	Percentile Rankings (minutes/event)							
		Min	10th	25th	50th	75th	90th	95th	Max
Clean Bathroom Sinks and Tubs	20	1	5	10	15	30	45	60	90
Clean Kitchen Sinks	10	1	2	3	5	10	15	20	480
Clean Inside of Cabinets Such as Those in the Kitchen	137	5	24	44	120	180	240	360	2,880
Clean Outside of Cabinets	52	1	5	15	30	60	120	180	330
Wipe Off Counters Such as Those in the Kitchen	9	1	2	3	5	10	15	30	120
Thoroughly Clean Counters	25	1	5	10	15	30	60	90	180
Clean Bathroom Floors	16	1	5	10	15	20	30	38	60
Clean Kitchen Floors	30	2	10	15	20	30	60	60	180
Clean Bathroom or Other Tiled or Ceramic Walls	34	1	5	15	30	45	60	120	240
Clean Outside of Windows	180	4	30	60	120	240	420	480	1,200
Clean Inside of Windows	127	4	20	45	90	158	300	381	1,200
Clean Other Glass Surfaces Such as Mirrors and Tables	24	1	5	10	15	30	60	60	180
Clean Outside of Refrigerator and Other Appliances	19	1	4	5	10	20	30	45	240
Clean Spots or Dirt on Walls or Doors	50	1	5	10	20	60	120	216	960

Min = Minimum.
Max = Maximum.
Source: Westat, 1987b.

Table 17-12. Total Exposure Time for Ten Product Groups Most Frequently Used for Household Cleaning[a]

Products	Mean (hours/year)	Percentile Rankings of Total Exposure Time (hours/year)							
		Min	10th	25th	50th	75th	90th	95th	Max
Dish Detergents	107	0.2	6	24	56	134	274	486	941
Glass Cleaners	67	0.4	3	12	29	62	139	260	1,508
Floor Cleaners	52	0.7	4	7	22	52	102	414	449
Furniture Polish	32	0.1	0.3	1	12	36	101	215	243
Bathroom Tile Cleaners	47	0.5	2	8	17	48	115	287	369
Liquid Cleansers	68	0.2	2	9	22	52	122	215	2,381
Scouring Powders	78	0.3	9	17	35	92	165	281	747
Laundry Detergents	66	0.6	8	14	48	103	174	202	202
Rug Cleaners/Shampoos	12	0.3	0.3	0.3	9	26	26	26	26
All Purpose Cleaners	64	0.3	4	9	26	77	174	262	677

[a] The data in Table 17-12 reflect only the 14 tasks included in the survey. Therefore, many of the durations reported in the table underestimate the hours of the use of the product group. For example, use of dish detergents to wash dishes is not included.
Min = Minimum.
Max = Maximum.
Source: Westat, 1987b.

Table 17-13. Total Exposure Time of Painting Activity of Interior Painters (hours)

Types of Paint	Mean (hours)	SD	Percentile Rankings for Duration of Painting Activity (hours)							
			Min	10	25	50	75	90	95	Max
Latex	12.2	11.3	1	3	4	9	15	24	40	248
Oil-Based	10.7	15.6	1	1.6	3	6	10	21.6	65.6	72
Wood Stains and Varnishes	8.6	10.9	1	1	2	4	9.3	24	40	42

SD = Standard deviation.
Min = Minimum.
Max = Maximum.

Source: Westat, 1987c.

Table 17-14. Exposure Time of Interior Painting Activity/Occasion (hours) and Frequency of Occasions Spent Painting per Year

	Duration of Painting/Occasion (hours)		Frequency of Occasions Spent Painting/Year		Percentile Rankings for Frequency of Occasions Spent Painting							
Types of Paint	Mean	Median	Mean	SD	Min	10	25	50	75	90	95	Max
Latex	3.0	3	4.2	5.5	1	1	2	3	4	9	10	62
Oil-Based	2.1	3	5.1	12.0	1	1	1	2	4	8	26	72
Wood Stains and Varnishes	2.2	2	4.0	4.9	1	1	1	2	4	9	20	20

SD = Standard deviation.
Min = Minimum.
Max = Maximum.

Source: Westat, 1987c.

Table 17-15. Amount of Paint Used by Interior Painters

Types of Paint	Median (gallons)	Mean (gallons)	SD	Percentile Rankings for Amount of Paint Used (gallons)							
				Min	10	25	50	75	90	95	Max
Latex	3.0	3.9	4.6	0.1	1	2	3	5	8	10	50
Oil-Based	2.0	2.6	3.0	0.1	0.3	0.5	2	3	7	12	12
Wood Stains and Varnishes	0.8	0.9	0.8	0.1	0.1	0.3	0.8	1	2	2	4.3

SD = Standard deviation.
Min = Minimum.
Max = Maximum.

Source: Westat, 1987c.

Table 17-16. Frequency of Use and Amount of Product Used for Adhesive Removers

	No. of Times Used Within the Last 12 Months *N* = 58	Minutes Using *N* = 52	Minutes in Room After Using[a] *N* = 51	Minutes in Room After Using[b] *N* = 5	Amount Used in Past Year (fluid oz.) *N* = 51	Amount per Use (fluid oz.) *N* = 51
Mean	1.66	172.87	13.79	143.37	96.95	81.84
Standard Deviation	1.67	304.50	67.40	169.31	213.20	210.44
Minimum Value	1.00	5.00	0.00	5.00	13.00	5.20
1st Percentile	1.00	5.00	0.00	5.00	13.00	5.20
5th Percentile	1.00	10.00	0.00	5.00	13.00	6.50
10th Percentile	1.00	15.00	0.00	5.00	16.00	10.67
25th Percentile	1.00	29.50	0.00	20.00	16.00	16.00
Median Value	1.00	120.00	0.00	120.00	32.00	26.00
75th Percentile	2.00	240.00	0.00	420.00	96.00	64.00
90th Percentile	3.00	480.00	0.00	420.00	128.00	128.00
95th Percentile	5.00	1,440.00	120.00	420.00	384.00	192.00
99th Percentile	12.00	1,440.00	420.00	420.00	1,280.00	1,280.00
Maximum Value	12.00	1,440.00	420.00	1,440.00	1,280.00	1,280.00

[a] Includes those who did not spend any time in the room after use.
[b] Includes only those who spent time in the room.

Source: Abt, 1992.

Table 17-17. Adhesive Remover Usage by Sex

	Sex	
	Male *N* = 25	Female *N* = 33
Mean number of months since last time adhesive remover was used – includes all respondents (unweighted *N* = 240).	35.33	43.89
Mean number of uses of product in the past year.	1.94	1.30
Mean number of minutes spent with the product during last use.	127.95	233.43
Mean number of minutes spent in the room after last use of product. (Includes all recent users.)	19.76	0
Mean number of minutes spent in the room after last use of product. (Includes only those who did not leave immediately.)	143.37	0
Mean ounces of product used in the past year.	70.48	139.71
Mean ounces of product used per use in the past year.	48.70	130.36

Source: Abt, 1992.

Table 17-18. Frequency of Use and Amount of Product Used for Spray Paint

	No. of Times Used Within the Last 12 Months *N* = 775	Minutes Using *N* = 786	Minutes in Room After Using[a] *N* = 791	Minutes in Room After Using[b] *N* = 35	Amount Used in Past Year (fluid oz.) *N* = 778	Amount per Use (fluid oz.) *N* = 778
Mean	8.23	40.87	3.55	65.06	83.92	19.04
Standard Deviation	31.98	71.71	22.03	70.02	175.32	25.34
Minimum Value	1.00	1.00	0.00	1.00	13.00	0.36
1st Percentile	1.00	1.00	0.00	1.00	13.00	0.36
5th Percentile	1.00	3.00	0.00	1.00	13.00	3.47
10th Percentile	1.00	5.00	0.00	10.00	13.00	6.50
25th Percentile	1.00	10.00	0.00	15.00	13.00	9.75
Median Value	2.00	20.00	0.00	30.00	26.00	13.00
75th Percentile	4.00	45.00	0.00	60.00	65.00	21.67
90th Percentile	11.00	90.00	0.00	120.00	156.00	36.11
95th Percentile	20.00	120.00	0.00	120.00	260.00	52.00
99th Percentile	104.00	360.00	120.00	300.00	1,170.00	104.00
Maximum Value	365.00	960.00	300.00	300.00	1,664.00	312.00

[a] Includes those who did not spend any time in the room after use.
[b] Includes only those who spent time in the room.

Source: Abt, 1992.

Table 17-19. Spray Paint Usage by Sex

	Sex	
	Male *N* = 405	Female *N* = 386
Mean number of months since last time spray paint was used – includes <u>all</u> respondents (unweighted *N* = 1724).	17.39	26.46
Mean number of uses of product in the past year.	10.45	4.63
Mean number of minutes spent with the product during last use.	40.87	40.88
Mean number of minutes spent in the room after last use of product. (Includes all recent users.)	5.49	0.40
Mean number of minutes spent in the room after last use of product. (Includes only those who did not leave immediately.)	67.76	34.69
Mean ounces of product used in the past year.	103.07	59.99
Mean ounces of product used per use in the past year.	18.50	19.92

Source: Abt, 1992.

Table 17-20. Frequency of Use and Amount of Product Used for Paint Removers/Strippers

	No. of Times Used Within the Last 12 Months *N* = 316	Minutes Using *N* = 390	Minutes in Room After Using[a] *N* = 390	Minutes in Room After Using[b] *N* = 39	Amount Used in Past Year (fluid oz.) *N* = 307	Amount per Use (fluid oz.) *N* = 307
Mean	3.54	144.59	12.96	93.88	142.05	64.84
Standard Deviation	7.32	175.54	85.07	211.71	321.73	157.50
Minimum Value	1.00	2.00	0.00	1.00	15.00	0.35
1st Percentile	1.00	5.00	0.00	1.00	15.00	2.67
5th Percentile	1.00	15.00	0.00	1.00	16.00	8.00
10th Percentile	1.00	20.00	0.00	3.00	16.00	10.67
25th Percentile	1.00	45.00	0.00	10.00	32.00	16.00
Median Value	2.00	120.00	0.00	60.00	64.00	32.00
75th Percentile	3.00	180.00	0.00	120.00	128.00	64.00
90th Percentile	6.00	360.00	10.00	180.00	256.00	128.00
95th Percentile	12.00	480.00	60.00	420.00	384.00	192.00
99th Percentile	50.00	720.00	180.00	1,440.00	1,920.00	320.00
Maximum Value	70.00	1,440.00	1,440.00	1,440.00	3,200.00	2,560.00

a Includes those who did not spend any time in the room after use.
b Includes only those who spent time in the room.

Source: Abt, 1992.

Table 17-21. Paint Stripper Usage by Sex

	Sex	
	Male *N* = 156	Female *N* = 162
Mean number of months since last time paint stripper was used – includes all respondents (unweighted *N* = 1724).	32.07	47.63
Mean number of uses of product in the past year.	3.88	3.01
Mean number of minutes spent with the product during last use.	136.70	156.85
Mean number of minutes spent in the room after last use of product. (Includes all recent users.)	15.07	9.80
Mean number of minutes spent in the room after last use of product. (Includes only those who did not leave immediately.)	101.42	80.15
Mean ounces of product used in the past year.	160.27	114.05
Mean ounces of product used per use in the past year.	74.32	50.29

Source: Abt, 1992.

Table 17-22. Number of Minutes Spent Using Any Microwave Oven (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
5 to 11 years	62	0	0	0	1	1	2	5	10	15	20	30	30
12 to 17 years	141	0	0	0	1	2	3	5	10	15	30	30	60
18 to 64 years	1,686	0	0	1	2	3	5	10	15	25	45	60	121
> 64 years	375	0	0	1	2	3	5	10	20	30	60	60	70

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-23. Number of Minutes Spent in Activities Working With or Near Freshly Applied Paints (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	7	3	3	3	3	5	15	121	121	121	121	121	121
5 to 11 years	12	5	5	5	15	20	45	120	120	121	121	121	121
12 to 17 years	20	0	0	0.5	3	8	45	75	121	121	121	121	121
18 to 64 years	212	0	0	1	2	11	60	121	121	121	121	121	121
> 64 years	20	0	0	0	3	18	90	121	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-24. Number of Minutes Spent in Activities Working With or Near Household Cleaning Agents Such as Scouring Powders or Ammonia (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	21	0	0	0	0	5	10	15	20	30	121	121	121
5 to 11 years	26	1	1	2	2	3	5	15	30	30	30	30	30
12 to 17 years	41	0	0	0	0	2	5	10	40	60	60	60	60
18 to 64 years	672	0	0	1	2	5	10	20	60	121	121	121	121
> 64 years	127	0	0	0	1	3	5	15	30	60	120	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-25. Number of Minutes Spent in Activities (at home or elsewhere) Working with or Near Floorwax, Furniture Wax, or Shoe Polish (minutes/day)													
Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	13	0	0	0	5	10	15	20	60	121	121	121	121
5 to 11 years	21	0	0	2	2	3	5	10	35	60	120	120	120
12 to 17 years	15	0	0	0	1	2	10	25	45	121	121	121	121
18 to 64 years	238	0	0	2	3	5	15	30	120	121	121	121	121
> 64 years	34	0	0	0	2	5	10	20	35	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-26. Number of Minutes Spent in Activities Working with or Near Glue (minutes/day)													
Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	6	0	0	0	0	30	30	30	50	50	50	50	50
5 to 11 years	36	2	2	3	5	5	12.5	25	30	60	120	120	120
12 to 17 years	34	0	0	1	2	5	10	30	30	60	120	120	120
18 to 64 years	207	0	0	0	1	5	20	90	121	121	121	121	121
> 64 years	10	0	0	0	0	0	4	60	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-27. Number of Minutes Spent in Activities Working with or Near Solvents, Fumes, or Strong Smelling Chemicals (minutes/day)													
Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	7	0	0	0	0	1	5	60	121	121	121	121	121
5 to 11 years	16	0	0	0	2	5	5	17.5	45	70	70	70	70
12 to 17 years	38	0	0	0	0	5	10	60	121	121	121	121	121
18 to 64 years	407	0	0	1	2	5	30	121	121	121	121	121	121
> 64 years	21	0	0	0	0	2	5	15	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-28. Number of Minutes Spent in Activities Working with or Near Stain or Spot Removers (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	3	0	0	0	0	0	0	3	3	3	3	3	3
5 to 11 years	3	3	3	3	3	3	5	5	5	5	5	5	5
12 to 17 years	7	0	0	0	0	5	15	35	60	60	60	60	60
18 to 64 years	87	0	0	0	0	2	5	15	60	121	121	121	121
> 64 years	9	0	0	0	0	2	3	15	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-29. Number of Minutes Spent in Activities Working with or Near Gasoline or Diesel-Powered Equipment, Besides Automobiles (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	14	0	0	0	1	5	22.5	120	121	121	121	121	121
5 to 11 years	12	1	1	1	3	7.5	25	50	60	60	60	60	60
12 to 17 years	25	2	2	5	5	13	35	120	121	121	121	121	121
18 to 64 years	312	0	0	1	3	15	60	121	121	121	121	121	121
> 64 years	26	2	2	2	3	10	25	90	121	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; *percentiles* are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-30. Number of Minutes Spent in Activities Working with or Near Pesticides, Including Bug Sprays or Bug Strips (minutes/day)

Age Group	Percentiles												
	N	1	2	5	10	25	50	75	90	95	98	99	Max
1 to 4 years	6	1	1	1	1	3	10	15	20	20	20	20	20
5 to 11 years	16	0	0	0	0	1.5	7.5	30	121	121	121	121	121
12 to 17 years	10	0	0	0	0	2	2.5	40	121	121	121	121	121
18 to 64 years	190	0	0	0	1	2	10	88	121	121	121	121	121
> 64 years	764	31	0	0	0	02	5	15	60	121	121	121	121

Note: A value of "121" for number of minutes signifies that more than 120 minutes were spent; *N* = doer sample size; percentiles are the percentage of doers below or equal to a given number of minutes.

Source: U.S. EPA, 1996.

Table 17-31. Number of Respondents Using Cologne, Perfume, Aftershave, or Other Fragrances at Specified Daily Frequencies						
Age Group	Total *N*	Number of Times Used in a Day				
		1 to 2	3 to 5	6 to 9	10+	Do Not Know
5 to 11 years	26	24	2	*	*	*
12 to 17 years	144	133	9	*	1	1
18 to 64 years	1,735	1,635	93	3	1	3
> 64 years	285	277	8	0	0	0

* = Missing data.
N = Number of respondents.

Source: U.S. EPA, 1996.

Table 17-32. Number of Respondents Using Any Aerosol Spray Product or Personal Care Item Such as Deodorant or Hair Spray at Specified Daily Frequencies											
Age Group	Total *N*	Number of Times Used in a Day									
		1	2	3	4	5	6	7	10	10+	Don't Know
1 to 4 years	40	30	9	0	0	1	0	0	0	0	0
5 to 11 years	75	57	14	1	1	1	1	0	0	0	0
12 to 17 years	103	53	31	12	4	1	0	0	1	1	0
18 to 64 years	1,071	724	263	39	15	13	1	1	2	8	5
> 64 years	175	141	27	4	0	0	0	0	0	1	2

N = Number of respondents.

Source: U.S. EPA, 1996.

Table 17-33. Number of Respondents Using a Humidifier at Home						
Age Group	Total *N*	Frequency				
		Almost Every Day	3–5 Times a Week	1−2 Times a Week	1−2 Times a Month	Don't Know
1 to 4 years	111	33	16	7	53	2
5 to 11 years	88	18	10	12	46	2
12 to 17 years	83	21	7	5	49	1
18 to 64 years	629	183	77	70	287	12
> 64 years	120	42	10	10	53	5

N = Number of respondents.

Source: U.S. EPA, 1996.

Table 17-34. Number of Respondents Indicating Pesticides Were Applied by a Professional at Home to Eradicate Insects, Rodents, or Other Pests at Specified Frequencies

Age Group	Total *N*	Frequency (number of times over a 6-month period that pesticides were applied by a professional)					
		None	1 to 2	3 to 5	6 to 9	10+	Don't Know
<1 year	15	9	4	1	1	0	0
1 to <2 years	23	13	5	3	1	1	0
2 to <3 years	32	9	15	5	3	0	0
3 to <6 years	80	51	22	5	2	0	0
6 to <11 years	106	59	22	7	17	1	0
11 to <16 years	115	68	35	4	6	0	2
16 to <21 years	87	40	36	2	5	1	3
18 to 64 years	1,264	660	387	89	97	15	16
> 64 years	243	146	55	15	19	3	5

N = Number of respondents.

Source: U.S. EPA reanalysis of NHAPS (U.S. EPA, 1996) data.

Table 17-35. Number of Respondents Reporting Pesticides Applied by the Consumer at Home to Eradicate Insects, Rodents, or Other Pests at Specified Frequencies

Age Group	Total *N*	Frequency (number of times over a 6-month period that pesticides were applied by a resident)					
		None	1 to 2	3 to 5	6 to 9	10+	Don't Know
<1 year	15	4	8	2	0	1	0
1 to <2 years	23	11	10	1	0	1	0
2 to <3 years	32	18	9	2	2	1	0
3 to <6 years	80	26	35	18	1	0	0
6 to <11 years	106	37	49	14	1	4	1
11 to <16 years	115	37	50	18	4	6	0
16 to <21 years	87	36	33	9	4	4	1
18 to 64 years	1,264	473	477	192	48	55	19
> 64 years	243	94	85	31	15	9	9

N = Number of respondents.

Source: U.S. EPA reanalysis of NHAPS (U.S. EPA, 1996) data.

Table 17-36. Household Demographics and Pesticide Types, Characteristics, and Frequency of Pesticide Use

	Number[a]	Percent[a]
Survey Population Demographics		
Sex		
Female	90	84.1
Male	17	15.9
Language of Interview		
Spanish	72	67.3
English	35	32.7
Reading Skills		
Able to read English	71	66.4
Able to read Spanish	95	88.8
Number in Household		
2 to 3 people	25	23.3
4 to 5 people	59	55.1
6 to 8 people	23	21.4
Children under 10 years		
1 child	37	34.6
2 children	45	42.1
3 to 5 children	25	23.3
Type of Home		
Single family detached	75	70.1
Multi-family	9	8.4
Trailer/mobile home	9	8.4
Single-family attached	8	7.5
Apartment/other	4	3.7
Pets		
Pets kept in household	55	51.4
Pesticides used on pets	22	40.0
Pesticide Use		
Type of Pesticide		
Insecticide	135	91.2
Rodenticide	10	6.8
Herbicide	3	2.0
Storage of Pesticide		
Kitchen	67	45.3
Garage/shed	30	20.3
Laundry/washroom	14	9.4
Other, inside home	11	7.4
Other, outside home	7	4.7
Bathroom	7	4.7
Basement	4	2.7
Closet	4	2.7
Storage Precautions		
Child-resistant container	83	56.1
Pesticide locked away	55	37.2
Storage Risks		
< 4 feet from ground	72	48.6
Kept near food	5	3.4
Kept near dishes/cookware	5	3.4
Disposal		
Throw it away	132	89.2
Wrap in separate container, throw away	10	6.8
Other	5	3.4
Frequency of Use		
More than once/week	20	13.5
Once/week	27	18.2
Once/month	42	28.4
Once every 3 months	23	15.5
Once every 6 months	16	10.8
Once/year	13	8.8
Time Stored in Home		
< 6 months	75	50.7
6 to 12 months	24	15.2
12 to 24 months	17	11.5
> 24 months	16	10.8

[a] Totals may not add up to 107 participants or 148 products, and percentages may not add up to 100 because of some non-responses to survey questions.

Source: Bass et al., 2001.

Table 17-37. Amount and Frequency of Use of Household Products

Product Type	Overall						Per Subject	
	Mean	SD	Min	Max	Subjects	Events	Min	Max
Dishwashing Liquid								
Frequency of use per day	0.63	0.79	0	5	45	596	0.05	2.29
Duration of contact (minutes)	11	5	1	60	45	596	2	35
Amount used per contact (grams)	5	3	1	16	13	163	2	10
All-Purpose Cleaner								
Frequency of use per day	0.35	0.70	0	4	28	218	0.050	1.82
Duration of contact (minutes)	20	22	1	135	28	204	5	60
Amount used per contact (grams)	27	30	1	123	12	105	2	74
Toilet Cleaner								
Frequency of use per day	0.28	0.55	0	2	18	105	0.05	1.67
Duration of contact (minutes)	74	204	1	1,209	28	101	2[a]	24[a]
Amount used per contact (grams)	-	-	-	-	-	-	9	153
Hair Spray								
Frequency of use per day	0.76	0.68	0	3	9	143	0.29	1.76
Amount used per contact (grams)	-	-	-	-	-	-	1.0	11.6
Duration of release (seconds)	11	6	5	25	12	-	-	-
Duration of contact with nebula (seconds)	23	11	5	41	12	-	-	-
Duration of contact with nebula × gram released (seconds × grams)	48	48	5	150	10	-	-	-

[a] Excludes durations over 30 minutes.
\- Indicates insufficient sample size to estimate average use.

Source: Weegels and van Veen, 2001.

Table 17-38. Frequency of Use of Cosmetic Products				
Product Type	*N*	Number of Applications per Day		
		Mean	Median	SD
Lipstick	311	2.35	2	1.80
Body lotion, hands	308	2.12	2	1.59
Body lotion, arms	308	1.52	1	1.30
Body lotion, feet	308	0.95	1	1.01
Body lotion, legs	308	1.11	1	0.98
Body lotion, neck and throat	308	0.43	0	0.82
Body lotion, back	308	0.26	0	0.63
Body lotion, other	308	0.40	0	0.76
Face cream	300	1.77	2	1.16

N = Number of subjects (women, ages 19 to 65 years).
SD = Standard deviation.

Source: Loretz et al., 2005.

Table 17-39. Amount of Test Product Used (grams) for Lipstick, Body Lotion, and Face Cream

Summary Statistics	Total Amount Applied	Average[a] Amount Applied per Use Day	Average[b] Amount Applied per Application
Lipstick			
Minimum	0.001	0.000	0.000
Maximum	2.666	0.214	0.214
Mean	0.272	0.024	0.010
SD	0.408	0.034	0.018
Percentiles			
10th	0.026	0.003	0.001
20th	0.063	0.005	0.003
30th	0.082	0.008	0.004
40th	0.110	0.010	0.004
50th	0.147	0.013	0.005
60th	0.186	0.016	0.006
70th	0.242	0.021	0.009
80th	0.326	0.029	0.011
90th	0.655	0.055	0.024
95th	0.986	0.087	0.037
99th	2.427	0.191	0.089
Best Fit Distributions and Parameters[c]	Lognormal Distribution GM = 0.14 GSD = 3.56 *p*-value (Gof) = 0.01	Lognormal Distribution GM = 0.01 GSD = 3.45 *p*-value (Gof) <0.01	Lognormal Distribution GM = 0.01 GSD = 3.29 *p*-value (Gof) <0.01
Body Lotion			
Minimum	0.67	0.05	0.05
Maximum	217.66	36.31	36.31
Mean	103.21	8.69	4.42
SD	53.40	5.09	4.19
Percentiles			
10th	36.74	3.33	1.30
20th	51.99	4.68	1.73
30th	68.43	5.71	2.32
40th	82.75	6.74	2.76
50th	96.41	7.63	3.45
60th	110.85	9.25	4.22
70th	134.20	10.90	4.93
80th	160.26	12.36	6.14

Table 17-39. Amount of Test Product used (grams) for Lipstick, Body Lotion and Face Cream (continued)			
Summary Statistics	Total Amount Applied	Average[a] Amount Applied per Use Day	Average[b] Amount Applied per Application
90th	182.67	14.39	8.05
95th	190.13	16.83	10.22
99th	208.50	27.91	21.71
Best Fit Distributions and Parameters[c]	Beta Distribution[c] Alpha = 1.53 Beta = 1.77 Scale = 222.01 *p*-value (GoF) = 0.06	Gamma Distribution Location = -0.86 Scale = 2.53 Shape = 3.77 *p*-value (GoF) = 0.37	Lognormal Distribution GM = 3.26 GSD = 2.25 *p*-value (GoF) = 0.63
Face Cream			
Minimum	0.04	0.00	0.00
Maximum	55.85	42.01	21.01
Mean	22.36	2.05	1.22
SD	14.01	2.90	1.76
Percentiles			
10th	5.75	0.47	0.28
20th	9.35	0.70	0.40
30th	12.83	1.03	0.53
40th	16.15	1.26	0.67
50th	19.86	1.53	0.84
60th	23.79	1.88	1.04
70th	29.31	2.23	1.22
80th	36.12	2.90	1.55
90th	44.58	3.50	2.11
95th	48.89	3.99	2.97
99th	51.29	12.54	10.44
Best Fit Distributions and Parameters[c]	Triangle Distribution Minimum = -1.09 Maximum = 58.71 Likeliest = 7.53 *p*-value (GoF) = 0.27	Lognormal Distribution[c] GM = 1.39 GSD = 2.58 *p*-value (GoF) <0.01	Lognormal Distribution[c] GM = 0.80 GSD = 2.55 *p*-value (GoF) = 0.02

[a] Derived as the ratio of the total amount used to the number of use days.
[b] Derived as the ratio of the total amount used to the total number of applications during the survey.
[c] None of the tested distributions provided a good fit.
GM = Geometric mean.
GSD = Geometric standard deviation.
GoF = Goodness of fit.
Note: Data are for women, ages 19 to 65 years.

Source: Loretz et al., 2005.

Table 17-40. Frequency of Use of Personal Care Products

Product Type	*N*	Average Number of Applications per Use Day[a]			
		Mean	SD	Min	Max
Hairspray (aerosol)	165[b]	1.49	0.63	1.00	5.36
Hairspray (pump)	162	1.51	0.64	1.00	4.22
Liquid Foundation	326	1.24	0.32	1.00	2.00
Spray Perfume	326	1.67	1.10	1.00	11.64
Body Wash	340	1.37	0.58	1.00	6.36
Shampoo	340	1.11	0.24	1.00	2.14
Solid Antiperspirant	340	1.30	0.40	1.00	4.00

[a] Derived as the ratio of the number of applications to the number of use days.
[b] Subjects who completed the study but did not report their number of applications were excluded.
N = Number of subjects (women, ages 18 to 65 years).
SD = Standard deviation.

Source: Loretz et al., 2006.

Table 17-41. Average Amount of Product Applied per Application[a] (grams)

Summary Statistics	Hairspray (aerosol)	Hairspray (pump)	Spray Perfume	Liquid Foundation	Shampoo	Body Wash	Solid Antiperspirant
N	163[b]	161[b]	310[b]	321[b]	340	340	340
Mean	2.58	3.64	0.33	0.54	11.76	11.3	0.61
SD	2.26	3.50	0.41	0.52	8.77	6.9	0.56
Minimum	0.05	0.00	0.00	0.00	0.39	1.1	0.00
Maximum	14.08	21.44	5.08	2.65	67.89	58.2	5.55
Percentiles							
10th	0.66	0.70	0.06	0.08	3.90	4.6	0.14
20th	0.94	1.01	0.10	0.14	5.50	5.8	0.22
30th	1.26	1.59	0.13	0.19	6.78	7.1	0.30
40th	1.56	2.14	0.18	0.26	8.27	8.5	0.37
50th	1.83	2.66	0.23	0.36	9.56	9.5	0.45
60th	2.38	3.43	0.28	0.48	11.32	11.4	0.55
70th	2.87	3.84	0.36	0.63	13.29	13.4	0.69
80th	3.55	5.16	0.49	0.86	16.07	16.0	0.89
90th	5.33	7.81	0.68	1.23	22.59	21.1	1.25
95th	7.42	10.95	0.94	1.70	27.95	24.3	1.67
97.5th	8.77	14.68	1.25	2.07	35.65	28.4	2.15
99th [c]	11.30	15.52	1.73	2.36	51.12	35.1	2.52
Best Fit Distributions and Parameters	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal	Gamma	Lognormal Distribution
	GM = 1.84 GSD = 2.40	GM = 2.44 GSD = 2.67	GM = 0.21 GSD = 3.01	GM = 0.33 GSD = 2.99	GM = 9.32 GSD = 2.02	Location = 0.51 Scale = 3.92 Shape = 2.76	GM = 0.43 GSD = 2.37
p-value (Kolmogorov-Smirnov)	0.06	0.07	0.077	0.041	0.1328	0.486	0.339

[a] Derived as the ratio of the total amount used to the total number of applications.

[b] Subjects who completed the study, but did not report their number of applications, or who did not return the unused portion of the product, were excluded.

[c] Estimate does not meet the minimum sample size criteria (*N* = 800) as set by the National Center for Health Statistics. For upper percentile (>75), the minimum sample size (*N*) satisfies the following rule: $n[8/(1-p)]$. http://www.cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.

N = Number of subjects (women, ages 19 to 65 years).
SD = Standard deviation.
GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Loretz et al., 2006.

Table 17-42. Average Amount of Product Applied per Use Day[a] (grams)

Summary Statistics	Hairspray (aerosol)	Hairspray (pump)	Spray Perfume	Liquid Foundation	Shampoo	Body Wash	Solid Antiperspirant
N	163[b]	161[b]	310[b]	321[b]	340	340	340
Mean	3.57	5.18	0.53	0.67	12.80	14.5	0.79
SD	3.09	4.83	0.57	0.65	9.11	8.5	0.78
Minimum	0.05	0.00	0.00	0.00	0.55	1.3	0.00
Maximum	18.25	24.12	5.08	3.00	67.89	63.4	5.55
Percentiles							
10th	0.84	0.91	0.08	0.10	4.12	5.7	0.17
20th	1.35	1.48	0.12	0.16	5.80	7.6	0.29
30th	1.65	2.33	0.19	0.23	7.32	9.3	0.38
40th	2.23	2.66	0.26	0.30	9.09	10.9	0.46
50th	2.71	3.74	0.34	0.45	10.75	12.9	0.59
60th	3.30	4.71	0.45	0.58	12.82	14.8	0.70
70th	3.89	5.67	0.61	0.76	14.73	17.4	0.86
80th	4.86	7.38	0.81	1.04	17.61	20.7	1.08
90th	7.73	12.22	1.45	1.76	23.63	25.5	1.70
95th	9.89	15.62	1.77	2.18	29.08	29.1	2.32
97.5th	13.34	19.41	1.86	2.40	36.46	35.6	3.33
99th [c]	15.05	23.98	2.01	2.70	51.12	43.5	4.42
Best fit distributions and parameters	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal	Gamma	Lognormal Distribution
	GM = 2.57 GSD = 2.37	GM = 3.45 GSD = 2.70	GM = 0.30 GSD = 3.36	GM = 0.40 GSD = 3.10	Location = 0.38 Scale = 5.79 Shape = 2.15	Location = 0.67 Scale = 4.89 Shape = 2.84	GM = 0.56 GSD = 2.41
p-value (Kolmogorov-Smirnov)	0.05	0.05	0.075	0.047	0.8208	0.760	0.293

[a] Derived as the ratio of the total amount used to the total number of applications.

[b] Subjects who completed the study, but did not report their number of applications, or who did not return the unused portion of the product, were excluded.

[c] Estimate does not meet the minimum sample size criteria (*N* = 800) as set by the National Center for Health Statistics. For upper percentile (>75), the minimum sample size (*N*) satisfies the following rule: *n*[8/(1-*p*)]. http://www.cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.

N = Number of subjects (women, ages 19 to 65 years).
SD = Standard deviation.
GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Loretz et al., 2006.

Table 17-43. Body Lotion Exposure for Consumers Only (male and female)				
Distribution Parameter	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	4.543	0.012	67.869	0.228
Standard Deviation	2.707	0.013	43.866	0.307
Median	4.556	0.023	64.265	0.369
Minimum	0.005	0.000	0.043	0.003
Maximum	21.081	1.264	401.371	46.215
Percentile				
*p*01	0.005	0.000	0.079	0.003
*p*02.5	0.017	0.000	0.250	0.011
*p*05	0.556	0.008	8.066	0.191
*p*10	1.129	0.006	15.055	0.293
*p*20	1.948	0.018	27.535	0.330
*p*30	2.907	0.024	40.763	0.359
*p*40	3.737	0.027	53.072	0.357
*p*50	4.556	0.023	64.265	0.369
*p*60	5.246	0.023	75.114	0.374
*p*70	5.898	0.021	86.751	0.404
*p*80	6.645	0.024	101.024	0.495
*p*90	7.822	0.033	123.227	0.715
*p*92	8.183	0.038	130.177	0.868
*p*94	8.651	0.042	139.085	0.968
*p*95	8.951	0.047	144.797	1.072
*p*96	9.326	0.054	151.892	1.211
*p*97.5	10.191	0.081	167.036	1.559
*p*98	10.655	0.096	174.414	1.768
*p*99	12.261	0.155	198.018	2.888
*p*99.5	13.893	0.221	222.667	4.420
*p*99.9	16.991	0.413	282.959	10.304

Source: Hall et al., 2007.

Table 17-44. Deodorant/Antiperspirant Spray Exposure for Consumers Only (male and female)—Under Arms Only

Value	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	3.478	0.007	49.07	0.13
Standard Deviation	2.051	0.009	31.00	0.22
Median	3.153	0.012	43.52	0.19
Minimum	0.045	0.005	0.59	0.10
Maximum	23.663	1.724	379.03	63.23
Percentile				
*p*01	0.228	0.012	3.08	0.13
*p*02.5	0.373	0.008	5.08	0.12
*p*05	0.598	0.011	8.23	0.16
*p*10	1.135	0.014	15.31	0.20
*p*20	1.951	0.012	25.75	0.17
*p*30	2.425	0.010	32.38	0.17
*p*40	2.796	0.011	37.96	0.17
*p*50	3.153	0.012	43.52	0.19
*p*60	3.548	0.013	49.73	0.22
*p*70	4.049	0.015	57.50	0.27
*p*80	4.804	0.019	68.59	0.32
*p*90	6.095	0.029	87.79	0.49
*p*92	6.477	0.031	93.94	0.58
*p*94	6.955	0.037	101.93	0.71
*p*95	7.262	0.040	107.01	0.81
*p*96	7.645	0.047	113.29	0.91
*p*97.5	8.537	0.064	126.91	1.24
*p*98	9.005	0.076	133.46	1.40
*p*99	10.451	0.107	154.31	1.98
*p*99.5	11.628	0.132	175.01	2.80
*p*99.9	13.843	0.277	222.53	7.29

Source: Hall et al., 2007.

Table 17-45. Deodorant/Antiperspirant Spray Exposure for Consumers Only (male and female) Using Product Over Torso and Under Arms

Value	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	3.732	0.008	52.47	0.14
Standard Deviation	2.213	0.010	32.94	0.23
Median	3.383	0.012	46.66	0.20
Minimum	0.044	0.005	0.59	0.10
Maximum	24.662	2.057	389.12	66.91
Percentile				
*p*01	0.239	0.014	3.19	0.14
*p*02.5	0.384	0.009	5.30	0.15
*p*05	0.639	0.015	8.80	0.18
*p*10	1.214	0.015	16.47	0.23
*p*20	2.078	0.013	27.71	0.18
*p*30	2.580	0.012	34.76	0.17
*p*40	2.986	0.011	40.73	0.18
*p*50	3.383	0.012	46.66	0.20
*p*60	3.819	0.014	53.26	0.21
*p*70	4.364	0.016	61.50	0.27
*p*80	5.156	0.021	73.25	0.35
*p*90	6.543	0.030	93.70	0.53
*p*92	6.969	0.036	100.24	0.60
*p*94	7.505	0.042	108.70	0.73
*p*95	7.839	0.048	114.08	0.81
*p*96	8.263	0.053	120.73	0.92
*p*97.5	9.213	0.069	135.17	1.24
*p*98	9.711	0.080	142.13	1.42
*p*99	11.263	0.117	164.14	2.31
*p*99.5	12.544	0.157	186.13	3.14
*p*99.9	14.898	0.300	235.47	7.01

Source: Hall et al., 2007.

Table 17-46. Deodorant/Antiperspirant Non-Spray for Consumers Only (male and female)

Value	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	0.898	0.002	12.95	0.04
Standard Deviation	0.494	0.002	7.34	0.05
Median	0.820	0.003	11.77	0.05
Minimum	0.000	0.000	0.00	0.00
Maximum	4.528	0.300	73.91	7.48
Percentile				
*p*01	0.064	0.002	0.90	0.04
*p*02.5	0.123	0.004	1.75	0.05
*p*05	0.221	0.004	3.12	0.06
*p*10	0.363	0.003	5.08	0.05
*p*20	0.509	0.003	7.26	0.05
*p*30	0.617	0.003	8.85	0.05
*p*40	0.718	0.003	10.30	0.05
*p*50	0.820	0.003	11.77	0.05
*p*60	0.934	0.004	13.36	0.05
*p*70	1.068	0.004	15.25	0.07
*p*80	1.238	0.005	17.77	0.08
*p*90	1.509	0.007	22.08	0.12
*p*92	1.598	0.008	23.51	0.14
*p*94	1.722	0.010	25.37	0.17
*p*95	1.806	0.011	26.57	0.19
*p*96	1.912	0.013	28.05	0.21
*p*97.5	2.134	0.016	31.18	0.28
*p*98	2.233	0.017	32.67	0.32
*p*99	2.515	0.025	37.25	0.48
*p*99.5	2.771	0.033	41.93	0.72
*p*99.9	3.426	0.088	52.79	1.63

Source: Hall et al., 2007.

Table 17-47. Lipstick Exposure for Consumers Only (female)				
Value	Amount (mg/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	24.61	0.17	0.39	0.00
Standard Deviation	24.05	0.25	0.40	0.01
Median	17.11	0.18	0.26	0.00
Minimum	0.13	0.04	0.00	0.00
Maximum	217.53	26.01	3.88	0.55
Percentile				
*p*01	0.57	0.04	0.01	0.00
*p*02.5	1.00	0.07	0.02	0.00
*p*05	1.68	0.07	0.03	0.00
*p*10	2.95	0.07	0.04	0.00
*p*20	5.69	0.11	0.09	0.00
*p*30	9.20	0.14	0.14	0.00
*p*40	12.93	0.15	0.20	0.00
*p*50	17.11	0.18	0.26	0.00
*p*60	22.37	0.24	0.34	0.00
*p*70	29.43	0.33	0.46	0.01
*p*80	39.70	0.47	0.62	0.01
*p*90	56.53	0.66	0.90	0.01
*p*92	61.66	0.72	0.98	0.01
*p*94	68.29	0.86	1.10	0.02
*p*95	72.51	0.95	1.17	0.02
*p*96	77.78	1.08	1.26	0.02
*p*97.5	89.08	1.34	1.46	0.03
*p*98	94.46	1.52	1.55	0.03
*p*99	110.98	2.06	1.84	0.04
*p*99.5	126.71	2.93	2.13	0.06
*p*99.9	160.06	6.33	2.78	0.14
Source: Hall et al., 2007.				

Table 17-48. Facial Moisturizer Exposure for Consumers Only (male and female)

Value	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	0.906	0.003	13.62	0.05
Standard Deviation	0.533	0.004	8.63	0.08
Median	0.851	0.004	12.42	0.06
Minimum	0.001	0.000	0.02	0.00
Maximum	4.751	0.380	92.75	11.80
Percentile				
*p*01	0.055	0.002	0.73	0.04
*p*02.5	0.079	0.004	1.13	0.03
*p*05	0.138	0.001	1.89	0.04
*p*10	0.261	0.004	3.67	0.06
*p*20	0.472	0.004	6.63	0.05
*p*30	0.603	0.003	8.66	0.05
*p*40	0.721	0.003	10.51	0.06
*p*50	0.851	0.004	12.42	0.06
*p*60	0.990	0.004	14.47	0.07
*p*70	1.131	0.004	16.78	0.07
*p*80	1.289	0.005	19.65	0.10
*p*90	1.536	0.007	24.14	0.14
*p*92	1.617	0.008	25.57	0.17
*p*94	1.727	0.010	27.46	0.19
*p*95	1.801	0.012	28.68	0.22
*p*96	1.897	0.014	30.23	0.25
*p*97.5	2.129	0.022	33.73	0.35
*p*98	2.251	0.027	35.52	0.43
*p*99	2.653	0.043	41.63	0.71
*p*99.5	3.040	0.057	48.23	1.08
*p*99.9	3.714	0.108	63.35	2.62

Source: Hall et al., 2007.

Table 17-49. Shampoo Exposure for Consumers Only (male and female)

Value	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	6.034	0.014	85.888	0.223
Standard Deviation	3.296	0.015	48.992	0.278
Median	5.503	0.020	77.895	0.294
Minimum	0.344	0.036	3.826	0.461
Maximum	29.607	0.669	528.361	65.887
Percentile				
*p*01	1.071	0.000	12.781	0.148
*p*02.5	1.268	0.023	16.367	0.181
*p*05	1.482	0.024	21.059	0.182
*p*10	2.178	0.019	29.737	0.269
*p*20	3.236	0.016	44.415	0.242
*p*30	3.843	0.019	55.58	0.253
*p*40	4.777	0.023	66.502	0.27
*p*50	5.503	0.020	77.895	0.294
*p*60	6.416	0.022	90.255	0.332
*p*70	7.390	0.026	104.537	0.373
*p*80	8.597	0.028	122.6	0.461
*p*90	10.456	0.039	150.488	0.642
*p*92	11.013	0.054	159.046	0.73
*p*94	11.721	0.041	169.939	0.846
*p*95	12.181	0.063	176.768	0.922
*p*96	12.705	0.064	185.092	1.08
*p*97.5	13.765	0.073	202.349	1.396
*p*98	14.194	0.091	210.49	1.551
*p*99	15.637	0.110	235.613	2.142
*p*99.5	16.992	0.149	260.624	3.009
*p*99.9	20.397	0.443	320.47	6.689

Source: Hall et al., 2007.

Table 17-50. Toothpaste Exposure for Consumers Only (male and female)

Value	Amount (g/day)	Parameter SD	Amount (mg/kg-day)	Parameter SD
Mean	2.092	0.001	29.85	0.04
Standard Deviation	0.577	0.001	10.34	0.05
Median	2.101	0.003	28.67	0.06
Minimum	0.069	0.012	0.93	0.18
Maximum	4.969	0.159	98.77	8.19
Percentile				
*p*01	0.777	0.011	10.14	0.14
*p*02.5	1.049	0.006	13.34	0.08
*p*05	1.204	0.004	15.47	0.06
*p*10	1.370	0.003	17.96	0.06
*p*20	1.591	0.003	21.29	0.05
*p*30	1.790	0.003	23.94	0.05
*p*40	1.958	0.003	26.32	0.06
*p*50	2.101	0.003	28.67	0.06
*p*60	2.237	0.003	31.15	0.06
*p*70	2.383	0.003	34.00	0.07
*p*80	2.551	0.003	37.62	0.08
*p*90	2.749	0.003	43.29	0.12
*p*92	2.809	0.004	45.03	0.14
*p*94	2.895	0.005	47.23	0.16
*p*95	2.960	0.006	48.61	0.17
*p*96	3.052	0.008	50.27	0.20
*p*97.5	3.323	0.010	53.70	0.25
*p*98	3.447	0.015	55.28	0.26
*p*99	3.760	0.006	60.12	0.39
*p*99.5	3.956	0.026	64.77	0.52
*p*99.9	4.303	0.049	74.84	1.10

Source: Hall et al., 2007.

Table 17-51. Average Number of Applications per Use Day[a]			
Summary Statistics	Facial Cleanser (lathering and non-lathering)	Hair Conditioner	Eye Shadow
N	295	297	299
Mean	1.6	1.1	1.2
SD	0.52	0.19	0.33
Minimum	1.0	1.0	1.0
Maximum	3.2	2.4	2.7
Percentiles			
10th	1.0	1.0	1.0
20th	1.0	1.0	1.0
30th	1.2	1.0	1.0
40th	1.4	1.0	1.1
50th	1.7	1.0	1.1
60th	1.9	1.0	1.1
70th	2.0	1.0	1.2
80th	2.0	1.1	1.4
90th	2.2	1.2	1.7
95th	2.4	1.4	2.0
97.5th	2.9[b]	1.8[b]	2.2[b]
99th [b]	3.1[b]	2.1[b]	2.5[b]

[a] Derived as the ratio of the number of applications to the number of use days.

[b] Estimate does not meet the minimum sample size criteria (*n* = 800) as set by the National Center for Health Statistics. For upper percentile (>0.75), the minimum sample size (*n*) satisfies the following rule: *n* [8/(1-*p*.] See http://www/cdc/gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.

N = Number of subjects (women, ages 18 to 69 years).

SD = Standard deviation.

Source: Loretz et al., 2008.

Table 17-52. Average Amount of Product Applied per Use Day (grams)[a]					
Summary Statistics	Facial Cleanser (lathering and non-lathering)	Facial Cleanser (lathering)	Facial Cleanser (non-lathering)	Hair Conditioner	Eye Shadow
N	295	174	121	297	299
Mean	4.06	4.07	4.05	13.77	0.04
SD	2.78	2.87	2.67	11.50	0.11
Minimum	0.33	0.33	0.83	0.84	0.001
Maximum	16.70	15.32	16.70	87.86	0.74
Percentiles					
10^{th}	1.41	1.23	1.50	3.71	0.003
20^{th}	1.79	1.72	1.94	5.54	0.005
30^{th}	2.18	2.15	2.22	6.95	0.007
40^{th}	2.66	2.64	2.80	8.73	0.009
50^{th}	3.25	3.19	3.33	10.62	0.010
60^{th}	3.86	3.84	3.88	12.61	0.013
70^{th}	4.62	4.71	4.59	15.54	0.017
80^{th}	6.24	6.33	5.92	20.63	0.025
90^{th}	8.28	8.24	8.40	28.20	0.052
95^{th}	9.93	10.50	9.37[b]	33.19	0.096
97.5^{th}	10.71[b]	11.47[b]	10.26[b]	45.68[b]	0.525[b]
99^{th} [b]	12.44[b]	13.07[b]	15.29[b]	60.20[b]	0.673[b]
Best Fit Distributions and Parameters	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution	Lognormal Distribution
	GM = 3.26	GM = 3.21	GM = 3.35	GM = 10.28	GM = 0.01
	GSD = 1.12	GSD = 2.03	GSD = 1.86	GSD = 2.20	GSD = 3.61
p-value (chi-square test)	0.1251	0.4429	0.4064	0.8595	<0.0001

[a] Derived as the ratio of the total amount used to the number of use days.
[b] Estimate does not meet the minimum sample size criteria (n = 800) as set by the National Center for Health Statistics. For upper percentile (>0.75), the minimum sample size (n) satisfies the following rule: n [8/(1-p)]. See http://www.cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.
N = Number of subjects (women, ages 18 to 69 years).
SD = Standard deviation.
GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Loretz et al., 2008.

Table 17-53. Average Amount of Product Applied per Application (grams)[a]					
Summary Statistics	Facial Cleanser (lathering and non-lathering)	Facial Cleanser (lathering)	Facial Cleanser (non-lathering)	Hair Conditioner	Eye Shadow
N	295	174	121	297	299
Mean	2.57	2.56	2.58	13.13	0.03
SD	1.78	1.78	1.77	11.22	0.10
Minimum	0.33	0.33	0.57	0.84	0.0004
Maximum	14.61	10.67	14.61	87.86	0.69
Percentiles					
10th	0.92	0.83	1.10	3.48	0.003
20th	1.32	1.26	1.35	5.34	0.004
30th	1.57	1.55	1.59	6.71	0.006
40th	1.85	1.84	1.89	8.26	0.007
50th	2.11	2.11	2.15	10.21	0.009
60th	2.50	2.50	2.51	12.24	0.011
70th	2.94	2.96	2.96	14.54	0.015
80th	3.47	3.56	3.40	18.88	0.022
90th	4.81	5.10	4.52	27.32	0.041
95th	5.89	6.37	5.11[b]	32.43	0.096
97.5th	7.16[b]	7.77[b]	6.29[b]	45.68[b]	0.488[b]
99th[b]	9.44[b]	9.61[b]	15.46[b]	60.20[b]	0.562[b]
Best Fit Distributions and Parameters	Extreme Value	Gamma	Extreme Value	Lognormal Distribution	Lognormal Distribution
	Mode = 1.86	Loc = 0.28	Mode = 1.92	GM = 9.78	GM = 0.01
	Scale = 1.12	Scale = 1.29	Scale = 1.03	GSD = 2.20	GSD = 3.59
p-value (chi-square test)	0.0464	0.6123	0.5219	0.9501	<0.0001

[a] Derived as the ratio of the total amount used to the total number of applications.

[b] Estimate does not meet the minimum sample size criteria (n = 800) as set by the National Center for Health Statistics. For upper percentile (>0.75), the minimum sample size (n) satisfies the following rule: n [8/(1-p)]. http://www.cdc.gov/nchs/about/major/nhanes/nhanes3/nh3gui.pdf.

N = Number of subjects (women, ages 18 to 69 years).

SD = Standard deviation.

GM = Geometric mean.

GSD = Geometric standard deviation.

Source: Loretz et al., 2008.

Table 17-54. Characteristics of the Study Population and the Percentage Using Selected Baby Care Products

Characteristic	Sample Number (%)
Number of Participants	
Los Angeles, CA	43 (26)
Minneapolis, MN	77 (47)
Columbia, MO	43 (26)
Sex	
Male	84 (52)
Female	79 (48)
Age (months)	
2 to 8	42 (26)
9 to 16	82 (50)
17 to 24	30 (18)
24 to 28	9 (6)
Infant Weight (kg)	
≤10	84 (52)
>10	79 (48)
Race	
White	131 (80)
Hispanic/Latino	17 (10)
Native American	3 (2)
Asian	8 (5)
Black	4 (3)
Product Use	% Using
Baby Lotion	36
Baby Shampoo	54
Baby Powder	14
Diaper Cream	33
Baby Wipes	94

Source: Sathyanarayana et al., 2008.

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18. LIFETIME

18.1. INTRODUCTION

The length of an individual's life is an important factor to consider when evaluating cancer risk because the dose estimate is averaged over an individual's lifetime. The recommendations for life expectancy are provided in the next section, along with a summary of the confidence rating for this recommendation. Because the averaging time is found in the denominator of the dose equation, a shorter lifetime would result in a higher potential risk estimate, and, conversely, a longer life expectancy would produce a lower potential risk estimate.

The recommended values are based on one key study identified by the U.S. Environmental Protection Agency (EPA) for this factor. Following the recommendations, the key study is summarized.

18.2. RECOMMENDATIONS

Current data suggest that 78 years would be an appropriate value to reflect the average life expectancy of the general population and is the recommended value. If sex is a factor considered in the assessment, note that the average life expectancy value for females is higher than that for males. It is recommended that the assessor use the appropriate value of 75 years for males and 80 years for females, based on life expectancy data from 2007 (Xu et al., 2010). If race is a consideration in assessing exposure for individuals, note that the life expectancy is longer for Whites than for Blacks. Therefore, assessors are encouraged to use values that most reflect the exposed population. Tables 18-1 and 18-2 present the recommendations and confidence ratings for life expectancy, respectively.

This recommended value is different than the 70 years commonly assumed for the general population in U.S. EPA risk assessments. The Integrated Risk Information System does not use a 70-year lifetime assumption in the derivation of reference concentration and reference dose, cancer slope factors, or unit risks. Therefore, using a value different than 70 years will not result in an inconsistency with the toxicity data.

Table 18-1. Recommended Values for Expectation of Life at Birth: 2007

Population	Life Expectancy (years)	Source
Total	78	Xu et al., 2010
Males	75	
Females	80	

Table 18-2. Confidence in Lifetime Expectancy Recommendations

Considerations	Rationale	Rating
Soundness		High
Adequacy of Approach	Recommendations are based on data from death certificates filed in the 50 states in the United States and District of Columbia.	
Minimal (or defined) Bias	There are no apparent biases.	
Applicability and Utility		High
Exposure Factor of Interest	Death certificate data were used to calculate life expectancy for various population groups born between 1940 and 2007.	
Representativeness	The data are representative of the U.S. population.	
Currency	The study was published in 2010 based on data collected in 2007.	
Data Collection Period	Data were collected in 2007.	
Clarity and Completeness		High
Accessibility	The key study is widely available to the public.	
Reproducibility	Results can be reproduced by analyzing death certificate data.	
Quality Assurance	Information on ensuring data quality are available publicly.	
Variability and Uncertainty		Medium
Variability in Population	Data were averaged by sex and race—but only for Blacks and Whites; no other nationalities were represented within the study.	
Uncertainty	Data were based on death certificates filed in the 50 states in the United States and District of Columbia.	
Evaluation and Review		High
Peer Review	Data are published and have been peer reviewed.	
Number and Agreement of Studies	Recommendations for expectation of life at birth were based on only one study.	
Overall Rating		**High**

18.3. KEY LIFETIME STUDY

18.3.1. Xu et al. (2010)—Deaths: Final Data for 2007

Xu et al. (2010) used information compiled from death certificates filed in the 50 states of the United States and District of Columbia and calculated life expectancy for various population groups born between 1940 and 2007. "Life expectancy at birth represents the average number of years that a group of infants would live if the group was to experience throughout life the age-specific death rates present in the year of birth" (Xu et al., 2010).

Table 18-3 shows life expectancy data by sex, age, and race (i.e., Whites and Blacks). Although data for other ethnic groups were collected, they were not considered as reliable because of inconsistencies between the race reported in the death certificates and in the censuses and surveys. Data for 2007 show that the life expectancy for an average person born in the United States is 77.9 years (Xu et al., 2010). The average life expectancy for males in 2007 was 75.4 years and 80.4 years for females. Whereas the gap between males and females was about 7 years in 1970, it has now narrowed to about 5 years. Table 18-3 also indicates that life expectancy for White males and females is consistently longer than for Black males and females. Table 18-4 presents data for the expectation of life for persons at a specific age in year 2007 (Xu et al., 2010). The advantages of this study are that it is representative of the United States and provides life expectancy data based on death certificates and calculations of death rates. A disadvantage is that the data were averaged by sex and race—but only for Blacks and Whites. \

18.4. RELEVANT LIFETIME STUDY

18.4.1. U.S. Census Bureau (2008)—U.S. Population Projections: Projected Life Expectancy at Birth by Sex, Race, and Hispanic Origin for the United States: 2010 to 2050

Statistical data on life expectancy are published annually by the U.S. Department of Commerce in the publication, *Statistical Abstract of the United States*. Data are collected for the 50 states and the District of Columbia. The *Statistical Abstract of the United States* has been published by the U.S. Census Bureau since 1878 (U.S. Census Bureau, 2010). The U.S. Census Bureau (2008) computed life expectancy projections for 2010 through 2050, by decade. This analysis uses historical mortality trend data collected by the National Center for Health Statistics and applies forecast models to estimate projected life expectancy at birth. These data are provided, by sex and race in Table 18-5.

The advantage of this survey is that it is representative of the United States, and it provides projections by sex and race. A disadvantage is that life expectancy estimates are based on future projections.

18.5. REFERENCES FOR CHAPTER 18

U.S. Census Bureau. (2008) U.S. population projections: projected life expectancy at birth by sex, race, and Hispanic origin for the United States: 2010 to 2050. Released 2008 (based on Census 2000). Available online at http://www.census.gov/population/www/projections/summarytables.html.

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Xu, J; Kochanek, K; Murphy, S; Tejada-Vera, B. (2010) Deaths: final data for 2007. Nat Vital Stat Reports 58(19)1–135. Available online at http://www.cdc.gov/nchs/data/nvsr/nvsr58/nvsr58_19.pdf.

Table 18-3. Expectation of Life at Birth, 1970 to 2007 (years)[a]

Year[b]	Total			White			Black		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
1970	70.8	67.1	74.7	71.7	68.0	75.6	64.1	60.0	68.3
1975	72.6	68.8	76.6	73.4	69.5	77.3	66.8	62.4	71.3
1980	73.7	70.0	77.4	74.4	70.7	78.1	68.1	63.8	72.5
1982	74.5	70.8	78.1	75.1	71.5	78.7	69.4	65.1	73.6
1983	74.6	71.0	78.1	75.2	71.6	78.7	69.4	65.2	73.5
1984	74.7	71.1	78.2	75.3	71.8	78.7	69.5	65.3	73.6
1985	74.7	71.1	78.2	75.3	71.8	78.7	69.3	65.0	73.4
1986	74.7	71.2	78.2	75.4	71.9	78.8	69.1	64.8	73.4
1987	74.9	71.4	78.3	75.6	72.1	78.9	69.1	64.7	73.4
1988	74.9	71.4	78.3	75.6	72.2	78.9	68.9	64.4	73.2
1989	75.1	71.7	78.5	75.9	72.5	79.2	68.8	64.3	73.3
1990	75.4	71.8	78.8	76.1	72.7	79.4	69.1	64.5	73.6
1991	75.5	72.0	78.9	76.3	72.9	79.6	69.3	64.6	73.8
1992	75.8	72.3	79.1	76.5	73.2	79.8	69.6	65.0	73.9
1993	75.5	72.2	78.8	76.3	73.1	79.5	69.2	64.6	73.7
1994	75.7	72.4	79.0	76.5	73.3	79.6	69.5	64.9	73.9
1995	75.8	72.5	78.9	76.5	73.4	79.6	69.6	65.2	73.9
1996	76.1	73.1	79.1	76.8	73.9	79.7	70.2	66.1	74.2
1997	76.5	73.6	79.4	77.2	74.3	79.9	71.1	67.2	74.7
1998	76.7	73.8	79.5	77.3	74.5	80.0	71.3	67.6	74.8
1999	76.7	73.9	79.4	77.3	74.6	79.9	71.4	67.8	74.7
2000	76.8	74.1	79.3	77.3	74.7	79.9	71.8	68.2	75.1
2001	76.9	74.2	79.4	77.4	74.8	79.9	72.0	68.4	75.2
2002	76.9	74.3	79.5	77.4	74.9	79.9	72.1	68.6	75.4
2003	77.1	74.5	79.6	77.6	75.0	80.0	72.3	68.8	75.6
2004	77.5	74.9	79.9	77.9	75.4	80.4	72.8	69.3	76.0
2005	77.4	74.9	79.9	77.9	75.4	80.4	72.8	69.3	76.1
2006	77.7	75.1	80.2	78.2	75.7	80.6	73.2	69.7	76.5
2007	77.9	75.4	80.4	78.4	75.9	80.8	73.6	70.0	76.8

[a] Based on middle mortality assumptions; for details, source: U.S. Census Bureau (2008).

[b] Life expectancies for 2000–2007 were calculated using a revised methodology and may differ from those previously published; see Xu et al. (2010).

Source: Xu et al., 2010.

Table 18-4. Expectation of Life by Race, Sex, and Age: 2007

Exact age in years	All Races[a]			White			Black		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
0	77.9	75.4	80.4	78.4	75.9	80.8	73.6	70.0	76.8
1	77.5	74.9	79.9	77.8	75.4	80.2	73.6	70.1	76.8
5	73.6	71.0	76.0	73.9	71.4	76.3	69.7	66.2	72.9
10	68.6	66.1	71.0	68.9	66.5	71.3	64.7	61.3	67.9
15	63.7	61.1	66.1	64.0	61.6	66.3	59.8	56.3	63.0
20	58.8	56.4	61.2	59.2	56.8	61.5	55.1	51.7	58.1
25	54.1	51.8	56.3	54.4	52.2	56.6	50.4	47.2	53.3
30	49.4	47.1	51.5	49.7	47.5	51.7	45.8	42.7	48.5
35	44.6	42.5	46.7	44.9	42.8	46.9	41.2	38.2	43.8
40	39.9	37.8	41.9	40.2	38.1	42.1	36.7	33.8	39.1
45	35.4	33.3	37.2	35.6	33.6	37.4	32.3	29.5	34.7
50	30.9	29.0	32.7	31.1	29.2	32.8	28.1	25.4	30.4
55	26.7	24.9	28.2	26.8	25.1	28.4	24.2	21.7	26.3
60	22.5	20.9	23.9	22.6	21.0	24.0	20.6	18.3	22.4
65	18.6	17.2	19.9	18.7	17.3	19.9	17.2	15.2	18.7
70	15.0	13.7	16.0	15.0	13.8	16.0	14.1	12.4	15.2
75	11.7	10.6	12.5	11.7	10.6	12.4	11.2	9.9	12.1
80	8.8	7.9	9.4	8.8	7.9	9.3	8.7	7.7	9.4
85	6.5	5.8	6.8	6.4	5.7	6.8	6.7	6.0	7.1
90	4.6	4.1	4.8	4.6	4.1	4.8	5.1	4.6	5.3
95	3.2	2.9	3.3	3.2	2.9	3.3	3.8	3.5	3.9
100	2.3	2.1	2.3	2.2	2.0	2.2	2.8	2.6	2.8

[a] Includes races other than White and Black.

Source: Xu et al., 2010.

Table 18-5. Projected Life Expectancy at Birth by Sex, Race, and Hispanic Origin for the United States: 2010 to 2050

Sex, Race, and Hispanic Origin	2010	2020	2030	2040	2050
Male and Female Combined					
Total Population	78.3	79.5	80.7	81.9	83.1
White	78.9	80.0	81.1	82.2	83.3
Black	73.8	76.1	78.1	80.0	81.8
American Indian and Alaskan Native	79.1	80.2	81.3	82.3	83.4
Asian	78.8	80.0	81.1	82.2	83.3
Native Hawaii or Pacific Islander	79.2	80.2	81.2	82.4	83.4
Two or more races	79.4	80.5	81.5	82.4	83.4
Non-Hispanic White alone	78.7	79.8	80.9	82.0	83.1
Hispanic[a]	81.1	81.8	82.6	83.3	84.1
Males					
Total Population	75.7	77.1	78.4	79.6	80.9
White	76.5	77.7	78.9	80.0	81.2
Black	70.2	72.6	74.9	77.1	79.1
American Indian and Alaskan Native	76.6	77.8	79.0	80.1	81.2
Asian	76.3	77.5	78.7	79.8	81.0
Native Hawaii or Pacific Islander	76.8	77.8	79.0	80.1	81.2
Two or more races	77.0	78.1	79.1	80.2	81.2
Non-Hispanic White alone	76.3	77.5	78.7	79.8	81.0
Hispanic[a]	78.4	79.3	80.2	81.0	81.8
Females					
Total Population	80.8	81.9	83.1	84.2	85.3
White	81.3	82.4	83.4	84.5	85.5
Black	77.2	79.2	81.0	82.7	84.3
American Indian and Alaskan Native	81.5	82.5	83.6	84.5	85.5
Asian	81.1	82.2	83.2	84.2	85.3
Native Hawaii or Pacific Islander	81.6	82.6	83.5	84.5	85.5
Two or more races	81.7	82.7	83.6	84.6	85.5
Non-Hispanic White alone	81.1	82.1	83.2	84.2	85.2
Hispanic[a]	83.7	84.4	85.0	85.6	86.3

[a] Hispanics may be of any race.

Source: U.S. Census Bureau, 2008.

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19. BUILDING CHARACTERISTICS

19.1. INTRODUCTION

Unlike previous chapters in this handbook, which focus on human behavior or characteristics that affect exposure, this chapter focuses on building characteristics. Assessment of exposure in indoor settings requires information on the availability of the chemical(s) of concern at the point of exposure, characteristics of the structure and microenvironment that affect exposure, and human presence within the building. The purpose of this chapter is to provide data that are available on building characteristics that affect exposure in an indoor environment. This chapter addresses residential and non-residential building characteristics (volumes, surface areas, mechanical systems, and types of foundations), transport phenomena that affect chemical transport within a building (airflow, chemical-specific deposition and filtration, and soil tracking), and information on various types of indoor building-related sources associated with airborne exposure and soil/house dust sources. Source-receptor relationships in indoor exposure scenarios can be complex due to interactions among sources, and transport/transformation processes that result from chemical-specific and building-specific factors.

There are many factors that affect indoor air exposures. Indoor air models generally require data on several parameters. This chapter provides recommendations on two parameters, volume and air exchange rates. Other factors that affect indoor air quality are furnishings, siting, weather, ventilation and infiltration, environmental control systems, material durability, operation and maintenance, occupants and their activities, and building structure. Available relevant information on some of these other factors is provided in this chapter, but specific recommendations are not provided, as site-specific parameters are preferred.

Figure 19-1 illustrates the complex factors that must be considered when conducting exposure assessments in an indoor setting. In addition to sources within the building, chemicals of concern may enter the indoor environment from outdoor air, soil, gas, water supply, tracked-in soil, and industrial work clothes worn by the residents. Indoor concentrations are affected by loss mechanisms, also illustrated in Figure 19-1, involving chemical reactions, deposition to and re-emission from surfaces, and transport out of the building. Particle-bound chemicals can enter indoor air through resuspension. Indoor air concentrations of gas-phase organic chemicals are affected by the presence of reversible sinks formed by a wide range of indoor materials. In addition, the activity of human receptors greatly affects their exposure as they move from room to room, entering and leaving the exposure scene.

Inhalation exposure assessments in indoor settings are modeled by considering the building as an assemblage of one or more well-mixed zones. A zone is defined as one room, a group of interconnected rooms, or an entire building. At this macroscopic level, well-mixed assumptions form the basis for interpretation of measurement data as well as simulation of hypothetical scenarios. Exposure assessment models on a macroscopic level incorporate important physical factors and processes. These well-mixed, macroscopic models have been used to perform indoor air quality simulations (Axley, 1989), as well as indoor air exposure assessments (McKone, 1989; Ryan, 1991). Nazaroff and Cass (1986) and Wilkes et al. (1992) have used computer programs featuring finite difference or finite element numerical techniques to model mass balance. A simplified approach using desktop spreadsheet programs has been used by Jennings et al. (1985). U.S. Environmental Protection Agency (EPA) has created two useful indoor air quality models: the (I-BEAM) (http://www.epa.gov/iaq/largebldgs/i-beam/index.html), which estimates indoor air quality in commercial buildings and the *Multi-Chamber Concentration and Exposure Model* (MCCEM) (http://www.epa.gov/opptintr/exposure/pubs/mccem.htm), which estimates average and peak indoor air concentrations of chemicals released from residences.

Major air transport pathways for airborne substances in buildings include the following:

- Air exchange—Air leakage through windows, doorways, intakes and exhausts, and "adventitious openings" (i.e., cracks and seams) that combine to form the leakage configuration of the building envelope plus natural and mechanical ventilation;
- Interzonal airflows—Transport through doorways, ductwork, and service chaseways that interconnect rooms or zones within a building; and
- Local circulation—Convective and advective air circulation and mixing within a room or within a zone.

The air exchange rate is generally expressed in terms of air changes per hour (ACH), with units of (hour^{-1}). It is defined as the ratio of the airflow (m^3 hour^{-1}) to the volume (m^3). The distribution of airflows across the building envelope that contributes to air exchange and the interzonal airflows along interior flowpaths is determined by the interior pressure distribution. The forces causing the airflows are temperature differences, the actions of wind, and mechanical ventilation systems. Basic concepts on distributions and airflows have been reviewed by the American Society of Heating Refrigerating & Air Conditioning Engineers (ASHRAE, 1993). Indoor-outdoor and room-to-room temperature differences create density differences that help determine basic patterns of air motion. During the heating season, warmer indoor air tends to rise to exit the building at upper levels by stack action. Exiting air is replaced at lower levels by an influx of colder outdoor air. During the cooling season, this pattern is reversed: stack forces during the cooling season are generally not as strong as in the heating season because the indoor-outdoor temperature differences are not as pronounced.

The position of the neutral pressure level (i.e., the point where indoor-outdoor pressures are equal) depends on the leakage configuration of the building envelope. The stack effect arising from indoor-outdoor temperature differences is also influenced by the partitioning of the building interior. When there is free communication between floors or stories, the building behaves as a single volume affected by a generally rising current during the heating season and a generally falling current during the cooling season. When vertical communication is restricted, each level essentially becomes an independent zone. As the wind flows past a building, regions of positive and negative pressure (relative to indoors) are created within the building; positive pressures induce an influx of air, whereas negative pressures induce an outflow. Wind effects and stack effects combine to determine a net inflow or outflow.

The final element of indoor transport involves the actions of mechanical ventilation systems that circulate indoor air through the use of fans. Mechanical ventilation systems may be connected to heating/cooling systems that, depending on the type of building, recirculate thermally treated indoor air or a mixture of fresh air and recirculated air. Mechanical systems also may be solely dedicated to exhausting air from a designated area, as with some kitchen range hoods and bath exhausts, or to recirculating air in designated areas as with a room fan. Local air circulation also is influenced by the movement of people and the operation of local heat sources.

19.2. RECOMMENDATIONS

Table 19-1 presents the recommendations for residential building volumes and air exchange rates. Table 19-2 presents the confidence ratings for the recommended residential building volumes. The U.S. EPA 2010 analysis of the 2005 Residential Energy Consumption Survey (RECS) data indicates a 492 m^3 average living space (U.S. DOE, 2008a). However, these values vary depending on the type of housing (see Section 19.3.1.1). The recommended lower end of housing volume is 154 m^3. Other percentiles are available in Section 19.3.1.1. Residential air exchange rates vary by region of the country. The recommended median air exchange rate for all regions combined is 0.45 ACH. The arithmetic mean is not preferred because it is influenced fairly heavily by extreme values at the upper tail of the distribution. This value was derived by Koontz and Rector (1995) using the perflourocarbon tracer (PFT) database. Section 19.5.1.1.1 presents distributions for the various regions of the country. For a conservative value, the 10th percentile for the PFT database (0.18 ACH) is recommended (see Section 19.5.1.1.1).

Table 19-3 presents the recommended values for non-residential building volumes and air exchange rates. Volumes of non-residential buildings vary with type of building (e.g., office space, malls). They range from 1,889 m^3 for food services to 287,978 m^3 for enclosed malls. The mean for all buildings combined is 5,575 m^3. These data come from the Commercial Buildings Energy Consumption Survey (CBECS) (U.S. DOE, 2008b). The last CBECS for which data are publicly available was conducted in 2003. Table 19-4 presents the confidence ratings for the non-residential building volume recommendations. The mean air exchange rate for all non-residential buildings combined is 1.5 ACH. The 10th percentile air exchange rate for all buildings combined is 0.60 ACH. These data come from Turk et al. (1987).

Table 19-5 presents the confidence ratings for the air exchange rate recommendations for both residential and non-residential buildings. Air exchange rate data presented in the studies are extremely limited. Therefore, the recommended values have been assigned a "low" overall confidence rating, and these values should be used with caution.

Volume and air exchange rates can be used by exposure assessors in modeling indoor-air concentrations as one of the inputs to exposure estimation. Other inputs to the modeling effort include rates of indoor pollutant generation and losses to (and, in some cases, re-emissions from) indoor sinks. Other things being equal (i.e., holding constant the pollutant generation rate and effect of indoor sinks), lower values for either the indoor volume or the air exchange rate will result in higher indoor-air concentrations. Thus, values near the lower end of the distribution (e.g., 10th percentile) for either parameter are appropriate in developing conservative estimates of exposure.

There are some uncertainties in, or limitations on, the distribution for volumes and air exchange rates that are presented in this chapter. For example, the RECS contains information on floor area rather than total volume. The PFT database did not base its measurements on a sample that was statistically representative of the national housing stock. PFT has been found to underpredict seasonal average air exchange by 20 to 30% Sherman (1989). Using PFT to determine air exchange can produce significant errors when conditions during the measurements greatly deviate from idealizations calling for constant, well-mixed conditions. Principal concerns focus on the effects of naturally varying air exchange and the effects of temperature in the permeation source. Some researchers have found that failing to use a time-weighted average temperature can greatly affect air exchange rate estimates (Leaderer et al., 1985). A final difficulty in estimating air exchange rates for any particular zone results from interconnectedness of multi-zone models and the effect of neighboring zones as demonstrated by Sinden (1978) and Sandberg (1984).

Table 19-1. Summary of Recommended Values for Residential Building Parameters

	Mean	10th Percentile	Source
Volume of Residence[a]	492 m^3 (central estimate)[b]	154 m^3 (lower percentile)[c]	U.S. EPA 2010 analysis of U.S. DOE, 2008a
Air Exchange Rate	0.45 ACH (central estimate)[d]	0.18 ACH (lower percentile)[e]	Koontz and Rector, 1995

a Volumes vary with type of housing. For specific housing type volumes, see Table 19-6.
b Mean value presented in Table 19-6 recommended for use as a central estimate for all single family homes, including mobile homes and multifamily units.
c 10th percentile value from Table 19-8 recommended to be used as a lower percentile estimate.
d Median value recommended to be used as a central estimate based across all U.S. census regions (see Table 19-24).
e 10th percentile value across all U.S. census regions recommended to be used as a lower percentile value (see Table 19-24).
ACH = Air changes per hour.

Table 19-2. Confidence in Residential Volume Recommendations		
General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	The study was based on primary data. Volumes were estimated assuming an 8-foot ceiling height. The effect of this assumption has been tested by Murray (1996) and found to be insignificant.	
Minimal (or defined) Bias	Selection of residences was random.	
Applicability and Utility		Medium
Exposure Factor of Interest	The focus of the studies was on estimating house volume as well as other factors.	
Representativeness	Residences in the United States were the focus of the study. The sample size was fairly large and representative of the entire United States. Samples were selected at random.	
Currency	The most recent RECS survey was conducted in 2005.	
Data Collection Period	Data were collected in 2005.	
Clarity and Completeness		High
Accessibility	The RECS database is publicly available.	
Reproducibility	Direct measurements were made.	
Quality Assurance	Not applicable.	
Variability and Uncertainty		Medium
Variability in Population	Distributions are presented by housing type and regions, but some subcategory sample sizes were small.	
Uncertainty	Although residence volumes were estimated using the assumption of 8-foot ceiling height, Murray (1996) found this assumption to have minimal impact.	
Evaluation and Review		Medium
Peer Review	The RECS database is publicly available. Some data analysis was conducted by U.S. EPA.	
Number and Agreement of Studies	Only one study was used to derive recommendations. Other relevant studies provide supporting evidence.	
Overall Rating	.	**Medium**

Table 19-3. Summary of Recommended Values for Non-Residential Building Parameters			
	Mean[a]	10th Percentile[b]	Source
Volume of Building (m^3)[c]			
Vacant	4,789	408	U.S. EPA analysis of U.S. DOE, 2008b
Office	5,036	510	
Laboratory	24,681	2,039	
Non-refrigerated warehouse	9,298	1,019	
Food sales	1,889	476	
Public order and safety	5,253	816	
Outpatient healthcare	3,537	680	
Refrigerated warehouse	19,716	1,133	
Religious worship	3,443	612	
Public assembly	4,839	595	
Education	8,694	527	
Food service	1,889	442	
Inpatient healthcare	82,034	17,330	
Nursing	15,522	1,546	
Lodging	11,559	527	
Strip shopping mall	7,891	1,359	
Enclosed mall	287,978	35,679	
Retail other than mall	3,310	510	
Service	2,213	459	
Other	5,236	425	
All Buildings[d]	5,575	527	
Air Exchange Rate[e]	Mean (SD)1.5 (0.87) ACH Range 0.3–4.1 ACH	0.60 ACH	Turk et al., 1987

[a] Mean values are recommended as central estimates for non-residential buildings (see Table 19-20).
[b] 10th percentile values are recommended as lower estimates for non-residential buildings (see Table 19-20).
[c] Volumes were calculated assuming a ceiling height of 20 feet for warehouses and enclosed malls and 12 feet for other structures (see Table 19-20).
[d] Weighted average assuming a ceiling height of 20 feet for warehouses and enclosed malls and 12 feet for other structures (see Table 19-20).
[e] Air exchange rates for commercial buildings (see Table 19-27).
SD = Standard deviation.
ACH = Air changes per hour.

Table 19-4. Confidence in Non-Residential Volume Recommendations

General Assessment Factors	Rationale	Rating
Soundness		Medium
Adequacy of Approach	All non-residential data were based on one study: CBECS (U.S. DOE, 2008b). Volumes were estimated assuming a 20-foot ceiling height assumption for warehouses and a 12-foot height assumption for all other non-residential buildings based on scant anecdotal information. Although Murray (1996) found that the impact of an 8-foot ceiling assumption was insignificant for residential structures, the impact of these ceiling height assumptions for non-residential buildings is unknown.	
Minimal (or defined) Bias	Selection of residences was random for CBECS.	
Applicability and Utility		High
Exposure Factor of Interest	CBECS (U.S. DOE, 2008b) contained ample building size data, which were used as the basis provided for volume estimates.	
Representativeness	CBECS (U.S. DOE, 2008b) was a nationwide study that generated weighted nationwide data based upon a large random sample.	
Currency, Data Collection Period	The data were collected in 2003.	
Clarity and Completeness		High
Accessibility	The data are available online in both summary tables and raw data. http://www.eia.doe.gov/emeu/cbecs/contents.html	
Reproducibility	Direct measurements were made.	
Quality Assurance	Not applicable.	
Variability and Uncertainty		Medium
Variability in Population	Distributions are presented by building type, heating and cooling system type, and employment, but a few subcategory sample sizes were small.	
Uncertainty	Volumes were calculated using speculative assumptions for building height. The impact of such assumptions may or may not be significant.	
Evaluation and Review		Low
Peer Review	There are no studies from the peer-reviewed literature.	
Number and Agreement of Studies	All data are based upon one study: CBECS (U.S. DOE, 2008b).	
Overall Rating	.	**Medium**

Table 19-5. Confidence in Air Exchange Rate Recommendations for Residential and Non-Residential Buildings		
General Assessment Factors	Rationale	Rating
Soundness		Low
Adequacy of Approach	The studies were based on primary data; however, most approaches contained major limitations, such as assuming uniform mixing, and residences were typically not selected at random.	
Minimal (or defined) Bias	Bias may result because the selection of residences and buildings was not random. The commercial building study (Turk et al., 1987) was conducted only on buildings in the northwest United States.	
Applicability and Utility		Low
Exposure Factor of Interest	The focus of the studies was on estimating air exchange rates as well as other factors.	
Representativeness	Study residences were typically in the United States, but only RECS (U.S. DOE, 2008a) selected residences randomly. PFT residences were not representative of the United States. Distributions are presented by housing type and regions; although some of the sample sizes for the subcategories were small. The commercial building study (Turk et al., 1987) was conducted only on buildings in the northwest United States.	
Currency	Measurements in the PFT database were taken between 1982–1987. The Turk et al. (1987) study was conducted in the mid-1980s.	
Data Collection Period	Only short-term data were collected; some residences were measured during different seasons; however, long-term air exchange rates are not well characterized. Individual commercial buildings were measured during one season.	
Clarity and Completeness		Medium
Accessibility	Papers are widely available from government reports and peer-reviewed journals.	
Reproducibility	Precision across repeat analyses has been documented to be acceptable.	
Quality Assurance	Not applicable.	
Variability and Uncertainty		Medium
Variability in Population	For the residential estimates, distributions are presented by U.S. regions, seasons, and climatic regions, but some of the sample sizes for the subcategories were small. The commercial estimate comes from buildings in the northwest U.S. representing two climate zones, and measurements were taken in three seasons (spring, summer, and winter).	
Uncertainty	Some measurement error may exist. Additionally, PFT has been found to underpredict seasonal average air exchange by 20–30% (Sherman, 1989). Turk et al. (1987) estimates a 10–20% measurement error for the technique used to measure ventilation in commercial buildings.	

Table 19-5. Confidence in Air Exchange Rate Recommendations for Residential and Non-Residential Buildings (continued)

General Assessment Factors	Rationale	Rating
Evaluation and Review		Low
Peer Review	The studies appear in peer-reviewed literature.	
Number and Agreement of Studies	Three residential studies are based on the same PFT database. The database contains results of 20 projects of varying scope. The commercial building rate is based on one study.	
Overall Rating		**Low**

19.3. RESIDENTIAL BUILDING CHARACTERISTICS STUDIES

19.3.1. Key Study of Volumes of Residences

19.3.1.1. *U.S. DOE (2008a)—Residential Energy Consumption Survey (RECS)*

Measurement surveys have not been conducted to directly characterize the range and distribution of volumes for a random sample of U.S. residences. Related data, however, are regularly collected through the U.S. Department of Energy's (DOE) RECS. In addition to collecting information on energy use, this triennial survey collects data on housing characteristics including direct measurements of total and heated floor space for buildings visited by survey specialists. For the most recent survey done in 2005, a multistage probability sample of 4,381 residences was surveyed, representing 111 million housing units nationwide. The 2005 survey response rate was 77.1%. Volumes were estimated from the RECS measurements by multiplying the heated floor space area by an assumed ceiling height of 8 feet. The data and data tables were released to the public in 2008.

In 2010, the U.S. EPA conducted an analysis of the RECS 2005 survey data. Tables 19-6 and 19-7 present results for residential volume distributions by type of residence, ownership, and year of construction from the 2005 RECS. Table 19-6 provides information on average estimated residential volumes according to housing type and ownership. The predominant housing type—single-family detached homes—also had the largest average volume. Multifamily units and mobile homes had volumes averaging about half that of single-family detached homes, with single-family attached homes about halfway between these extremes. Within each category of housing type, owner-occupied residences averaged about 50% greater volume than rental units. Data on the relationship of residential volume to year of construction are provided in Table 19-7 and indicate a slight decrease in residential volumes between 1950 and 1979, followed by an increasing trend. A ceiling height of 8 feet was assumed in estimating the average volumes, whereas there may have been some time-related trends in ceiling height. Table 19-8 presents distributions of residential volumes for all house types and all units. The average house volume for all types of units for all years was estimated to be 492 m^3.

It is important to note that in 2005, the RECS changed the way it calculated total square footage. The total average square footage per housing unit for the 2001 RECS was reported as 1,975 ft^2. This figure excluded unheated garages, and for most housing units, living space in attics. The average total square footage for housing units in the 2005 RECS was 2,171 ft^2 (i.e., 492 m^3 converted to ft^3 and assuming an 8-foot ceiling; see Table 19-7), which includes attic living space for all housing units. The only available figures that permit comparison of total square footage for both survey years would exclude all garage floorspace and attic floorspace in all housing units—for 2001, the average total square footage was 2,005, and for 2005, the average total was 2,029 ft^2.

The advantages of this study were that the sample size was large, and it was representative of houses in the United States. Also, it included various housing types. A limitation of this analysis is that volumes were estimated assuming a ceiling height of 8 feet. Volumes of individual rooms in the house cannot be estimated.

19.3.2. Relevant Studies of Volumes of Residences

19.3.2.1. *Versar (1990)—Database on Perfluorocarbon Tracer (PFT) Ventilation Measurements*

Versar (1990) compiled a database of time-averaged air exchange and interzonal airflow measurements in more than 4,000 residences. These data were collected between 1982 and 1987. The residences that appear in this database are not a random sample of U.S. homes. However, they represent a compilation of homes visited in about 100 different field studies, some of which involved random sampling. In each study, the house volumes were directly measured or estimated. The collective homes visited in these field projects are not geographically balanced. A large fraction of these homes are located in southern California. Statistical weighting techniques were applied in developing estimates of nationwide distributions to compensate for the geographic imbalance. The Versar (1990) PFT database found a mean value of 369 m^3 (see Table 19-9).

The advantage of this study is that it provides a distribution of house volumes. However, more up-to-date data are available from RECS 2005 (U.S. DOE, 2008a).

19.3.2.2. *Murray (1996)—Analysis of RECS and PFT Databases*

Using a database from the 1993 RECS and an assumed ceiling height of 8 feet, Murray (1996) estimated a mean residential volume of 382 m^3 using

RECS estimates of heated floor space. This estimate is slightly different from the mean of 369 m^3 given in Table 19-9. Murray's (1996) sensitivity analysis indicated that when a fixed ceiling height of 8 feet was replaced with a randomly varying height with a mean of 8 feet, there was little effect on the standard deviation of the estimated distribution. From a separate analysis of the PFT database, based on 1,751 individual household measurements, Murray (1996) estimated an average volume of 369 m^3, the same as previously given in Table 19-9. In performing this analysis, the author carefully reviewed the PFT database in an effort to use each residence only once, for those residences thought to have multiple PFT measurements.

Murray (1996) analyzed the distribution of selected residential zones (i.e., a series of connected rooms) using the PFT database. The author analyzed the "kitchen zone" and the "bedroom zone" for houses in the Los Angeles area that were labeled in this manner by field researchers, and "basement," "first floor," and "second floor" zones for houses outside of Los Angeles for which the researchers labeled individual floors as zones. The kitchen zone contained the kitchen in addition to any of the following associated spaces: utility room, dining room, living room, and family room. The bedroom zone contained all the bedrooms plus any bathrooms and hallways associated with the bedrooms. The following summary statistics (mean ± standard deviation) were reported by Murray (1996) for the volumes of the zones described above: 199 ± 115 m^3 for the kitchen zone, 128 ± 67 m^3 for the bedroom zone, 205 ± 64 m^3 for the basement, 233 ± 72 m^3 for the first floor, and 233 ± 111 m^3 for the second floor.

The advantage of this study is that the data are representative of homes in the United States. However, more up-to-date data are available from the RECS 2005 (U.S. DOE, 2008a).

19.3.2.3. *U.S. Census Bureau (2010)—American Housing Survey for the United States: 2009*

The American Housing Survey (AHS) is conducted by the Census Bureau for the Department of Housing and Urban Development. It collects data on the Nation's housing, including apartments, single-family homes, mobile homes, vacant housing units, household characteristics, housing quality, foundation type, drinking water source, equipment and fuels, and housing unit size. National data are collected in odd-numbered years, and data for each of 47 selected Metropolitan Areas are collected about every 6 years. The national sample includes about 55,000 housing units. Each metropolitan area samples 4,100 or more housing units. The AHS returns to the same housing units year after year to gather data. The U.S. Census Bureau (2010) lists the number of residential single detached and manufactured/mobile homes in the United States within various categories including seasonal, year-round occupied, and new in the last 4 years, based on the AHS (see Table 19-10). Assuming an 8-foot ceiling, these units have a median size of 385 m^3; however, these values do not include multifamily units. It should be mentioned that 8 feet is the most common ceiling height, and Murray (1996) has shown that the effect of the 8-foot ceiling height assumption is not significant.

The advantage of this study is that it was a large national sample and, therefore, representative of the United States. The limitations of these data are that distributions were not provided by the authors, and the analysis did not include multifamily units.

19.3.3. Other Factors

19.3.3.1. *Surface Area and Room Volumes*

The surface areas of floors are commonly considered in relation to the room or house volume, and their relative loadings are expressed as a surface area-to-volume, or loading ratio. Table 19-11 provides the basis for calculating loading ratios for typical-sized rooms. Constant features in the examples are a room width of 12 feet and a ceiling height of 8 feet (typical for residential buildings), or a ceiling height of 12 feet (typical for some types of commercial buildings).

Volumes of individual rooms are dependent on the building size and configuration, but summary data are not readily available. The exposure assessor is advised to define specific rooms, or assemblies of rooms, that best fit the scenario of interest. Most models for predicting indoor air concentrations specify airflows in m^3 per hour and, correspondingly, express volumes in m^3. A measurement in ft^3 can be converted to m^3 by multiplying the value in ft^3 by 0.0283 m^3/ft^3. For example, a bedroom that is 9 feet wide by 12 feet long by 8 feet high has a volume of 864 ft^3 or 24.5 m^3. Similarly, a living room with dimensions of 12 feet wide by 20 feet long by 8 feet high has a volume of 1,920 ft^3 or 54.3 m^3, and a bathroom with dimensions of 5 feet by 12 feet by 8 feet has a volume of 480 ft^3 or 13.6 m^3.

19.3.3.2. *Products and Materials*

Table 19-12 presents examples of assumed amounts of selected products and materials used in constructing or finishing residential surfaces (Tucker, 1991). Products used for floor surfaces include adhesive, varnish, and wood stain; and materials used for walls include paneling, painted gypsum board, and wallpaper. Particleboard and chipboard are commonly used for interior furnishings such as shelves or cabinets but could also be used for decking or underlayment. It should be noted that numbers presented in the table for surface area are based on typical values for residences, and they are presented as examples. In contrast to the concept of loading ratios presented above (as a surface area), the numbers in the table also are not scaled to any particular residential volume. In some cases, it may be preferable for the exposure assessor to use professional judgment in combination with the loading ratios given above. For example, if the exposure scenario involves residential carpeting, either as an indoor source or as an indoor sink, then the American Society for Testing and Materials (ASTM) loading ratio of 0.43 m^2m^{-3} for floor materials could be multiplied by an assumed residential volume and assumed fractional coverage of carpeting to derive an estimate of the surface area. More specifically, a residence with a volume of 300 m^3, a loading ratio of 0.43 m^2m^{-3}, and coverage of 80%, would have 103 m^2 of carpeting. The estimates discussed here relate to macroscopic surfaces; the true surface area for carpeting, for example, would be considerably larger because of the nature of its fibrous material.

19.3.3.3. *Loading Ratios*

The loading ratios for the 8-foot ceiling height range from 0.98 m^2m^{-3} to 2.18 m^2m^{-3} for wall areas and from 0.36 m^2m^{-3} to 0.44 m^2m^{-3} for floor area. In comparison, ASTM Standard E 1333 (ASTM, 1990), for large-chamber testing of formaldehyde levels from wood products, specifies the following loading ratios: (1) 0.95 m^2m^{-3} for testing plywood (assumes plywood or paneling on all four walls of a typical size room); and (2) 0.43 m^2m^{-3} for testing particleboard (assumes that particleboard decking or underlayment would be used as a substrate for the entire floor of a structure).

19.3.3.4. *Mechanical System Configurations*

Mechanical systems for air movement in residences can affect the migration and mixing of pollutants released indoors and the rate of pollutant removal. Three types of mechanical systems are (1) systems associated with heating, ventilating, and air conditioning (HVAC); (2) systems whose primary function is providing localized exhaust; and (3) systems intended to increase the overall air exchange rate of the residence.

Portable space heaters intended to serve a single room, or a series of adjacent rooms, may or may not be equipped with blowers that promote air movement and mixing. Without a blower, these heaters still have the ability to induce mixing through convective heat transfer. If the heater is a source of combustion pollutants, as with unvented gas or kerosene space heaters, then the combination of convective heat transfer and thermal buoyancy of combustion products will result in fairly rapid dispersal of such pollutants. The pollutants will disperse throughout the floor where the heater is located and to floors above the heater, but will not disperse to floors below.

Central forced-air HVAC systems are common in many residences. Such systems, through a network of supply/return ducts and registers, can achieve fairly complete mixing within 20 to 30 minutes (Koontz et al., 1988). The air handler for such systems is commonly equipped with a filter (see Figure 19-2) that can remove particle-phase contaminants. Further removal of particles, via deposition on various room surfaces (see Section 19.5.5), is accomplished through increased air movement when the air handler is operating.

Figure 19-2 also distinguishes forced-air HVAC systems by the return layout in relation to supply registers. The return layout shown in the upper portion of the figure is the type most commonly found in residential settings. On any floor of the residence, it is typical to find one or more supply registers to individual rooms, with one or two centralized return registers. With this layout, supply/return imbalances can often occur in individual rooms, particularly if the interior doors to rooms are closed. In comparison, the supply/return layout shown in the lower portion of the figure by design tends to achieve a balance in individual rooms or zones. Airflow imbalances can also be caused by inadvertent duct leakage to unconditioned spaces such as attics, basements, and crawl spaces. Such imbalances usually depressurize the house, thereby increasing the likelihood of contaminant entry via soil-gas transport or through spillage of combustion products from vented fossil-fuel appliances such as fireplaces and gas/oil furnaces.

Mechanical devices such as kitchen fans, bathroom fans, and clothes dryers are intended primarily to provide localized removal of unwanted heat, moisture, or odors. Operation of these devices tends to increase the air exchange rate between the indoors and outdoors. Because local exhaust devices are designed to be near certain indoor sources, their effective removal rate for locally generated pollutants is greater than would be expected from the dilution effect of increased air exchange. Operation of these devices also tends to depressurize the house, because replacement air usually is not provided to balance the exhausted air.

An alternative approach to pollutant removal is one which relies on an increase in air exchange to dilute pollutants generated indoors. This approach can be accomplished using heat recovery ventilators (HRVs) or energy recovery ventilators (ERVs). Both types of ventilators are designed to provide balanced supply and exhaust airflows and are intended to recover most of the energy that normally is lost when additional outdoor air is introduced. Although ventilators can provide for more rapid dilution of internally generated pollutants, they also increase the rate at which outdoor pollutants are brought into the house. A distinguishing feature of the two types is that ERVs provide for recovery of latent heat (moisture) in addition to sensible heat. Moreover, ERVs typically recover latent heat using a moisture-transfer device such as a desiccant wheel. It has been observed in some studies that the transfer of moisture between outbound and inbound air streams can result in some re-entrainment of indoor pollutants that otherwise would have been exhausted from the house (Andersson et al., 1993). Inadvertent air communication between the supply and exhaust air streams can have a similar effect.

Studies quantifying the effect of mechanical devices on air exchange using tracer-gas measurements are uncommon and typically provide only anecdotal data. The common approach is for the expected increment in the air exchange rate to be estimated from the rated airflow capacity of the device(s). For example, if a device with a rated capacity of 100 ft^3 per minute, or 170 m^3 per hour, is operated continuously in a house with a volume of 400 m^3, then the expected increment in the air exchange rate of the house would be 170 m^3 $hour^{-1}$/400 m^3, or approximately 0.4 ACH.

U.S. DOE RECS contains data on residential heating characteristics. The data show that most homes in the United States have some kind of heating and air conditioning system (U.S. DOE, 2008a). The types of system vary regionally within the United States. Table 19-13 shows the type of primary and secondary heating systems found in U.S. residences. The predominant primary heating system in the Midwest is natural gas (used by 72% of homes there) while most homes in the South (54%) primarily heat with electricity. Nationwide, 31% of residences have a secondary heating source, typically an electric source.

Table 19-14 shows the type of heating systems found in the United States by urban/rural location. It is noteworthy that 56% of suburban residences use central heating compared to 16% in rural areas. Another difference is that only 25% of residences in cities used a secondary heating system, which used typically electric, compared to 48% in rural areas, typically electric or wood.

Table 19-15 shows that 84% of U.S. residences have some type of cooling system: 59% have central air while 26% use window units. Like heating systems, cooling system type varies regionally as well. In the South, 97% of residences have either central or room air conditioning units whereas only 57% of residences in the Western United States have air conditioning. Frequency of use varies regionally as well. About 61% of residences in the South use their air conditioner all summer long, but only 15% do so in the Northeast.

19.3.3.5. *Type of Foundation*

The type of foundation of a residence is of interest in residential exposure assessment. It provides some indication of the number of stories and house configuration, as well as an indication of the relative potential for soil−gas transport. For example, such transport can occur readily in homes with enclosed crawl spaces. Homes with basements provide some resistance, but still have numerous pathways for soil−gas entry. By comparison, homes with crawl spaces open to the outside have significant opportunities for dilution of soil gases prior to transport into the house. Using data from the 2009 AHS, of total housing units in the United States, 33% have a basement under the entire building, 10% have a basement under part of the building, 23% have a crawl space, and 32% are on a concrete slab (U.S. Census Bureau, 2010).

19.3.3.5.1. Lucas et al. (1992)—National Residential Radon Survey

The estimated percentage of homes with a full or partial basement according to the National Residential Radon Survey of 5,700 households nationwide was 45% (see Table 19-16) (Lucas et al., 1992). The National Residential Radon Survey provides data for more refined geographical areas, with a breakdown by the 10 U.S. EPA Regions. The New England region (i.e., U.S. EPA Region 1), which includes Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont, had the highest prevalence of basements (93%). The lowest prevalence (4%) was for the South Central region (i.e., U.S. EPA Region 6), which includes Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. Section 19.3.3.5.2 presents the States associated with each census region and U.S. EPA region.

19.3.3.5.2. U.S. DOE (2008a)—Residential Energy Consumption Survey (RECS)

The most recent RECS (described in Section 19.3.1.1) was administered in 2005 to over 4,381 households (U.S. DOE, 2008a). The type of information requested by the survey questionnaire included the type of foundation for the residence (i.e., basement, enclosed crawl space, crawl space open to outside, or concrete slab). This information was not obtained for multifamily structures with five or more dwelling units or for mobile homes. U.S. EPA analyzed the RECS 2005 data (U.S. DOE, 2008a) to estimate the percentage of residences with basements and different foundation types by census region and by U.S. EPA region. Table 19-17 presents these estimates. Table 19-18 shows the states associated with each U.S. EPA region and census region. Table 19-19 presents estimates of the percentage of residences with each foundation type, by census region, and for the entire United States. The percentages can add up to more than 100% because some residences have more than one type of foundation; for example, many split-level structures have a partial basement combined with some crawlspace that typically is enclosed. The data in Table 19-19 indicate that 40.6% of residences nationwide have a basement. It also shows that a large fraction of homes have concrete slabs (46%). There are also variations by census region. For example, around 73% and 68% of the residences in the Northeast and Midwest regions, respectively, have basements. In the South and West regions, the predominant foundation type is concrete slab.

The advantage of this study is that it had a large sample size, and it was representative of houses in the United States. Also, it included various housing types. A limitation of this analysis is that homes have multiple foundation types, and the analysis does not provide estimates of square footage for each type of foundation.

19.4. NON-RESIDENTIAL BUILDING CHARACTERISTICS STUDIES

19.4.1. U.S. DOE (2008b)—Non-Residential Building Characteristics—Commercial Buildings Energy Consumption Survey (CBECS)

The U.S. Department of Energy conducts the CBECS to collect data on the characteristics and energy use of commercial buildings. The survey is conducted every 4 years. The latest survey for which data are available (released in 2008) is the 2003 CBECS. CBECS defines “Commercial” buildings as all buildings in which at least half of the floorspace is used for a purpose that is not residential, industrial, or agricultural, so they include building types that might not traditionally be considered commercial, such as schools, correctional institutions, and buildings used for religious worship.

CBECS is a national survey of U.S. buildings that DOE first conducted in 1979. The 2003 CBECS provided nationwide estimates for the United States based upon a weighted statistical sample of 5,215 buildings. DOE releases a data set about the sample buildings for public use. The 2003 CBECS Public Use Microdata set includes data for 4,820 non-mall commercial buildings (U.S. DOE, 2008b). A second data set available that includes information on malls, lacks building characteristics data. Building characteristics data provided by CBECS includes floor area, number of floors, census division, heating and cooling design, principal building activity, number of employees, and weighting factors. The 2003 CBECS data survey provides the best statistical characterization of the commercial sector available for the United States. A 2007 CBECS was conducted, but the data were not publicly available at the time this handbook was published.

In 2010, U.S. EPA conducted an analysis of the U.S. DOE CBECS 2003 data, released in 2008. Table 19-20 shows that non-residential buildings vary greatly in volumes. The table shows average volume for a numbers of structures including offices (5,036 m^3), restaurants (food services) (1,889 m^3), schools (education) (8,694 m^3), hotels (lodging) (11,559 m^3), and enclosed shopping malls (287,978 m^3). Each of these structures varies considerably in size as well. The large shopping malls are over 500,000 m^3 (90^{th} percentile). The most numerous of the non-residential buildings are office buildings (18%), non-food service buildings (13%), and warehouses (13%).

Table 19-21 presents data on the number of hours various types of non-residential buildings are open for business and the number of employees that work in such buildings. In general, places of worship have the most limited hours. The average place of worship is open 32 hours per week. On the other extreme are healthcare facilities, which are open 168 hours a week (24 hours per day, 7 days per week). The average restaurant is open 86 hours per week. Hours vary considerably by building type. Some offices, labs, warehouses, restaurants, police stations, and hotels are also open 24 hours per day, 7 days per week, as reflected by the 90th percentiles. Table 19-21 also presents the number of employees typically employed in such buildings during the main shift. Overall, the average building houses 16 workers during its primary shift, but some facilities employ many more. The average hospital employs 471 workers during its main shift, although those in the 10th percentile employ only 175, and those in the 90th employ 2,250.

CBECS data on heating and cooling sources were tabulated by the U.S. Energy Information Administration of the U.S. DOE and released to the public (along with the data) in 2008 (U.S. DOE, 2008b). Tables 19-22 and 19-23 present these data. Table 19-22 indicates that electricity and natural gas are the heating sources used by a majority of non-residential buildings. Of those buildings heated by fuel oil, most are older buildings.

Table 19-23 describes non-residential building cooling characteristics. About 78% (i.e., 3,625/4,645) of non-residential buildings have air conditioning, but this varies regionally from 14% in the Northeast to 41% in the South. Nationwide, 77% (i.e., 3,589/4,645) of non-residential buildings use electricity for air conditioning. The remaining fraction use natural gas or chilled water.

It should be noted, however, that there are many critical exposure assessment elements not addressed by CBECS. These include a number of elements discussed in more detail in the Residential Building Characteristics Studies section (i.e., Section 19.3). Data to characterize the room volume, products and materials, loading ratios, and foundation type for non-residential buildings were not available in CBECS.

Another characteristic of non-residential buildings needed in ventilation and air exchange calculations is ceiling height. In the residential section of this chapter, ceiling height was assumed to be 8 feet, a figure often assumed for residential buildings. For non-residential buildings, U.S. EPA has assumed a 20 foot ceiling height for warehouses and enclosed shopping malls and a 12-foot average ceiling height for other structures. These assumptions are based on professional judgment. Murray (1996) found that the impact of assuming an 8-foot ceiling height for residences was insignificant, but non-residential ceiling height varies more greatly and may or may not have a significant impact on calculations.

19.5. TRANSPORT RATE STUDIES

19.5.1. Air Exchange Rates

Air exchange is the balanced flow into and out of a building and is composed of three processes: (1) infiltration—air leakage through random cracks, interstices, and other unintentional openings in the building envelope; (2) natural ventilation—airflows through open windows, doors, and other designed openings in the building envelope; and (3) forced or mechanical ventilation—controlled air movement driven by fans. For nearly all indoor exposure scenarios, air exchange is treated as the principal means of diluting indoor concentrations. The air exchange rate is generally expressed in terms of ACH (with units of hours^{-1}). It is defined as the ratio of the airflow (m^3 hours^{-1}) to the volume (m^3). Thus, ACH and building size and volume are negatively correlated.

No measurement surveys have been conducted to directly evaluate the range and distribution of building air exchange rates. Although a significant number of air exchange measurements have been carried out over the years, there has been a diversity of protocols and study objectives. Since the early 1980s, however, an inexpensive PFT technique has been used to measure time-averaged air exchange and interzonal airflows in thousands of occupied residences using essentially similar protocols (Dietz et al., 1986). The PFT technique utilizes miniature permeation tubes as tracer emitters and passive samplers to collect the tracers. The passive samplers are returned to the laboratory for analysis by gas chromatography. These measurement results have been compiled to allow various researchers to access the data (Versar, 1990).

With regard to residential air exchange, an attached garage can negatively impact indoor air quality. In addition to automobile exhaust, people often store gasoline, oil, paints, lacquers, and yard and garden supplies in garages. Appliances such as furnaces, heaters, hot water heaters, dryers, gasoline-powered appliances, and wood stoves may also impact indoor air quality. Garages can be a source of volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, *m*,*p*-xylene, and *o*-xylene. Emmerich et al. (2003) conducted a literature review on indoor air quality and the transport of pollutants from attached garages to residential living spaces. The authors found the body of literature on the subject was limited and contained little data with regard to airtightness and geometry of the house-garage interface, and the impact of heating and cooling equipment. They concluded, however, that there is substantial evidence that the transport of contaminants from garages has the potential to negatively impact residences.

19.5.1.1. *Key Study of Residential Air Exchange Rates*

19.5.1.1.1. Koontz and Rector (1995)—Estimation of Distributions for Residential Air Exchange Rates

In analyzing the composite data from various projects (2,971 measurements), Koontz and Rector (1995) assigned weights to the results from each state to compensate for the geographic imbalance in locations where PFT measurements were taken. The results were weighted in such a way that the resultant number of cases would represent each state in proportion to its share of occupied housing units, as determined from the 1990 U.S. Census of Population and Housing.

Table 19-24 shows summary statistics from the Koontz and Rector (1995) analysis, for the country as a whole and by census regions. Based on the statistics for all regions combined, the authors suggested that a 10^{th} percentile value of 0.18 ACH would be appropriate as a conservative estimator for air exchange in residential settings, and that the 50^{th} percentile value of 0.45 ACH would be appropriate as a typical air exchange rate. In applying conservative or typical values of air exchange rates, it is important to realize the limitations of the underlying database. Although the estimates are based on thousands of measurements, the residences represented in the database are not a random sample of the U.S. housing stock. Also, the sample population is not balanced in terms of geography or time of year, although statistical techniques were applied to compensate for some of these imbalances. In addition, PFT measurements of air exchange rates assume uniform mixing of the tracer within the building. This is not always so easily achieved. Furthermore, the degree of mixing can vary from day to day and house to house because of the nature of the factors controlling mixing (e.g., convective air monitoring driven by weather, and type and operation of the heating system). The relative placement of the PFT source and the sampler can also cause variability and uncertainty. It should be noted that sampling is typically done in a single location in a house that may not represent the average from that house. In addition, very high and very low values of air exchange rates based on PFT measurements have greater uncertainties than those in the middle of the distribution. Despite such limitations, the estimates in Table 19-24 are believed to represent the best available information on the distribution of air exchange rates across U.S. residences throughout the year.

19.5.1.2. *Relevant Studies of Residential Air Exchange Rates*

19.5.1.2.1. Nazaroff et al. (1988)—Radon Entry via Potable Water

Nazaroff et al. (1988) aggregated the data from two studies conducted earlier using tracer-gas decay. At the time these studies were conducted, they were the largest U.S. studies to include air exchange measurements. The first (Grot and Clark, 1981) was conducted in 255 dwellings occupied by low-income families in 14 different cities. The geometric mean ± standard deviation for the air exchange measurements in these homes, with a median house age of 45 years, was 0.90 ± 2.13 ACH. The second study (Grimsrud et al., 1983) involved 312 newer residences, with a median age of less than 10 years. Based on measurements taken during the heating season, the geometric mean ± standard deviation for these homes was 0.53 ± 1.71 ACH. Based on an aggregation of the two distributions with proportional weighting by the respective number of houses studied, Nazaroff et al. (1988) developed an overall distribution with a geometric mean of 0.68 ACH and a geometric standard deviation of 2.01.

19.5.1.2.2. Versar (1990)—Database of PFT Ventilation Measurements

The residences included in the PFT database do not constitute a random sample across the United States. They represent a compilation of homes visited in the course of about 100 separate field-research projects by various organizations, some of which involved random sampling, and some of which involved judgmental or fortuitous sampling. Table 19-25 summarizes the larger projects in the PFT database, in terms of the number of measurements (samples), states where samples were taken, months when samples were taken, and summary statistics for their respective distributions of measured air exchange rates. For selected projects (Lawrence Berkeley Laboratory, Research Triangle Institute, Southern California—SOCAL), multiple measurements were taken for the same house, usually during different seasons. A large majority of the measurements are from the SOCAL project that was conducted in Southern California. The means of the respective studies generally range from 0.2 to 1.0 ACH, with the exception of two California projects—RTI2 and SOCAL2. Both projects involved measurements in Southern California during a time of year (July) when windows would likely be opened by many occupants.

The limitation of this study is that the PFT database did not base its measurements on a sample that was statistically representative of the national housing stock. PFT has been found to underpredict seasonal average air exchange by 20 to 30% (Sherman, 1989). Using PFT to determine air exchange can produce significant errors when conditions in the measurement scene greatly deviate from idealizations calling for constant, well-mixed conditions.

19.5.1.2.3. Murray and Burmaster (1995)—Residential Air Exchange Rates in the United States: Empirical and Estimated Parametric Distributions by Season and Climatic Region

Murray and Burmaster (1995) analyzed the PFT database using 2,844 measurements (essentially the same cases as analyzed by Koontz and Rector (1995), but without the compensating weights). These authors summarized distributions for subsets of the data defined by climate region and season. The months of December, January, and February were defined as winter; March, April, and May were defined as spring; and so on. Table 19-26 summarizes the results of Murray and Burmaster (1995) Neglecting the summer results in the colder regions, which have only a few observations, the results indicate that the highest air exchange rates occur in the warmest climate region during the summer. As noted earlier, many of the measurements in the warmer climate region were from field studies conducted in Southern California during a time of year (July) when windows would tend to be open in that area. Data for this region in particular should be used with caution because other areas within this region tend to have very hot summers, and residences use air conditioners, resulting in lower air exchange rates. The lowest rates generally occur in the colder regions during the fall.

19.5.1.2.4. Diamond et al. (1996)—Ventilation and Infiltration in High-Rise Apartment Buildings

Diamond et al. (1996) studied air flow in a 13-story apartment building and concluded that "the ventilation to the individual units varies considerably." With the ventilation system disabled, units at the lower level of the building had adequate ventilation only on days with high temperature differences, while units on higher floors had no ventilation at all. At times, units facing the windward side were over-ventilated. With the mechanical ventilation system operating, they found wide variation in the air flows to individual apartments. Diamond et al. (1996) also conducted a literature review and concluded there were little published data on air exchange in multifamily buildings, and that there was a general problem measuring, modeling, and designing ventilation systems for high-rise multifamily buildings. Air flow was dependent upon building type, occupation behavior, unit location, and meteorological conditions.

19.5.1.2.5. Graham et al. (2004)—Contribution of Vehicle Emissions from an Attached Garage to Residential Indoor Air Pollution Levels

There have been several studies of vehicle emission seepage into homes from attached garages, which examined a single home. Graham et al. (2004) conducted a study of vehicle emission seepage of 16 homes with attached garages. On average, 11% of total house leakage was attributed to the house/garage interface (equivalent to an opening of 124 cm^2), but this varied from 0.6 to 29.6%. The amount of in-house chemical concentrations attributed to vehicle emissions from the garage varied widely between homes from 9 to 85%. Greater leakage tended to occur in houses where the garage attached to the house on more than one side. The home's age was not an important factor. Whether the engine was warm or cold when it was started was important because cold-start emissions are dominated by the by-products of incomplete combustion. Cold-start tail pipe emissions were 32 times greater for carbon monoxide (CO), 10 times greater for nitrogen oxide ($NO_{x)}$, and 18 times greater for total hydrocarbon emissions than hot-start tailpipe emissions.

19.5.1.2.6. Price et al. (2006)—Indoor-Outdoor Air Leakage of Apartments and Commercial Buildings

Price et al. (2006) compiled air exchange rate data from 14 different studies on apartment buildings in the United States and Canada. The authors found that indoor-outdoor air exchange rates seem to be twice as high for apartments as for single-family houses. The observed apartment air exchange rates ranged from 0.5 to 2 ACH.

19.5.1.2.7. Yamamoto et al. (2010)—Residential Air Exchange Rates in Three U.S. Metropolitan Areas: Results from the Relationship Among Indoor, Outdoor, and Personal Air Study 1999-2001

Between 1999 and 2001, Yamamoto et al. (2010) conducted approximately 500 indoor-outdoor air exchange rate (AER) calculations based on residences in metropolitan Elizabeth, NJ; Houston, TX; and Los Angeles, CA. The median AER across these urban areas was 0.71 ACH; 0.87 in CA, 0.88 in NJ, and 0.47 in TX. In Texas, the measured AERs were lower in the summer cooling season (median = 0.37 ACH) than in the winter heating season (median = 0.63 ACH), likely because of the reported use of room air conditioners. The measured AERs in California were higher in summer (median = 1.13 ACH) than in winter (median = 0.61 ACH) because summers in Los Angeles County are less humid than NJ or TX, and residents are more likely to utilize natural ventilation through open windows and screened doors. In New Jersey, air exchange rates in the heating and cooling seasons were similar.

19.5.1.3. Key Study of Non-Residential Air Exchange Rates

19.5.1.3.1. Turk et al. (1987)—Commercial Building Ventilation Rates and Particle Concentrations

Few air exchange rates for commercial buildings are provided in the literature. Turk et al. (1987) conducted indoor air quality measurements, including air exchange rates, in 38 commercial buildings. The buildings ranged in age from 0.5 to 90 years old. One test was conducted in 36 buildings, and two tests were conducted in 2 buildings. Each building was monitored for 10 working days over a 2-week period yielding a minimum sampling time of 75 hours per building. Researchers found an average ventilation measurement of 1.5 ACH, which ranged from 0.3 to 4.1 ACH with a standard deviation of 0.87. Table 19-27 presents the results by building type.

19.5.2. Indoor Air Models

Achieving adequate indoor air quality in a non-residential building can be challenging. There are many factors that affect indoor air quality in buildings (e.g., building materials, outdoor environment, ventilation systems, operation and maintenance, occupants and their activities). Indoor air models are typically used to study, identify, and solve problems involving indoor air quality in buildings, as well as to assess efficiency of energy use. Indoor air quality models generally are not software products that can be purchased as "off-the-shelf" items. Most existing software models are research tools that have been developed for specific purposes and are being continuously refined by researchers. Leading examples of indoor air models implemented as software products are as follows:

- CONTAM 3.0—CONTAM was developed at the National Institute of Standards and Technology (NIST) with support from U.S. EPA and the U.S. DOE. Version 3.0 was sponsored by the Naval Surface Warfare Center Dahlgren Division. (Axley, 1988; Walton and Dols, 2010; Wang et al., 2010).
- IAQX—The Indoor Air Quality and Inhalation Exposure model is a Windows-based simulation software package developed by U.S. EPA (Guo, 2000).
- CPIEM—The California Population Indoor Exposure Model was developed for the California Air Resources Board (Rosenbaum et al., 2002).
- TEM—The Total Exposure Model was developed with support from U.S. EPA and the U.S. Air Force (Wilkes, 1998; Wilkes and Nuckols, 2000).
- RISK—RISK was developed by the Indoor Environment Management Branch of the U.S. EPA National Risk Management Research Laboratory (Sparks, 1997).
- TRIM—The Total Risk Integrated Methodology is an ongoing modeling project of U.S. EPA's Office of Air Quality Planning and Standards (Efroymson and Murphy, 2001; Palma, 1999).
- TOXLT/TOXST—The Toxic Modeling System Long-Term was developed along with the release of the new version of the U.S. EPA's Industrial Source Complex Dispersion Models (U.S. EPA, 1995).
- MIAQ—The Multi-Chamber Indoor Air Quality Model was developed for the California Institute of Technology and Lawrence Berkeley National Laboratory. Documentation last updated in 2002. (Nazaroff and Cass, 1986; Nazzaroff and Cass, 1989a).
- MCCEM—the Multi-Chamber Consumer Exposure Model was developed for U.S. EPA Office of Pollution Prevention and

Toxics (EPA/OPPT) (GEOMET, 1989; Koontz and Nagda, 1991).

Price (2001) is an evaluation of the use of many of the above products (TOXLT/TOXST, MCCEM, IAQX, CONTAM, CPIEM, TEM, TRIM, and RISK) in a tiered approach to assessing exposures and risks to children. The information provided is also applicable to adults.

19.5.3. Infiltration Models

A variety of mathematical models exist for prediction of air infiltration rates in individual buildings. A number of these models have been reviewed, for example, by Liddament and Allen (1983), and by Persily and Linteris (1984). Basic principles are concisely summarized in the ASHRAE Handbook of Fundamentals (ASHRAE, 1993). These models have a similar theoretical basis; all address indoor-outdoor pressure differences that are maintained by the actions of wind and stack (temperature difference) effects. The models generally incorporate a network of airflows where nodes representing regions of different pressure are interconnected by leakage paths. Individual models differ in details such as the number of nodes they can treat or the specifics of leakage paths (e.g., individual components such as cracks around doors or windows versus a combination of components such as an entire section of a building). Such models are not easily applied by exposure assessors, however, because the required inputs (e.g., inferred leakage areas, crack lengths) for the model are not easy to gather.

Another approach for estimating air infiltration rates is developing empirical models. Such models generally rely on the collection of infiltration measurements in a specific building under a variety of weather conditions. The relationship between the infiltration rate and weather conditions can then be estimated through regression analysis and is usually stated in the following form:

$$A = a + b\left|T_i - T_0\right| + cU^n \qquad \text{(Eqn. 19-1)}$$

where:

A = air infiltration rate (hours^{-1}),
T_i = indoor temperature (°C),
T_o = outdoor temperature (°C),
U = windspeed (m/second),
n is an exponent with a value typically between 1 and 2, and
a, b and c are parameters to be estimated.

Relatively good predictive accuracy usually can be obtained for individual buildings through this approach. However, exposure assessors often do not have the information resources required to develop parameter estimates for making such predictions.

A reasonable compromise between the theoretical and empirical approaches has been developed in the model specified by Dietz et al. (1986). The model, drawn from correlation analysis of environmental measurements and air infiltration data, is formulated as follows:

$$A = L\left(0.006\Delta T\,\frac{0.03}{C}U^{1.5}\right) \qquad \text{(Eqn. 19-2)}$$

where:

A = average ACH or infiltration rate, hours^{-1},
L = generalized house leakiness factor ($1 < L < 5$),
C = terrain sheltering factor ($1 < C < 10$),
ΔT = indoor-outdoor temperature difference (°C), and
U = windspeed (m/second).

The value of L is greater as house leakiness increases, and the value of C is greater as terrain sheltering (reflects shielding of nearby wind barrier) increases. Although the above model has not been extensively validated, it has intuitive appeal, and it is possible for the user to develop reasonable estimates for L and C with limited guidance. Historical data from various U.S. airports are available for estimation of the temperature and windspeed parameters. As an example application, consider a house that has central values of 3 and 5 for L and C, respectively. Under conditions where the indoor temperature is 20°C (68°F), the outdoor temperature is 0°C (32°F), and the windspeed is 5 m/second, the predicted infiltration rate for that house would be 3 (0.006 × 20 + 0.03/5 × 51.5), or 0.56 ACH. This prediction applies under the condition that exterior doors and windows are closed and does not include the contributions, if any, from mechanical systems (see Section 19.3.3.4). Occupant behavior, such as opening windows, can, of course, overwhelm the idealized effects of temperature and wind speed.

Chan et al. (2005) analyzed the U.S. Residential Air Leakage database at Lawrence Berkley National Laboratory (LBNL) containing 73,000 air leakage measurements from 30 states (predominantly Ohio, Alaska, and Wisconsin). They present the following equation for estimating ACH:

$$ACH = 48\left(\frac{2.5}{H}\right)^{0.3} \frac{NL}{HF}\left[h^{-1}\right] \qquad \text{(Eqn. 19-3)}$$

where:

ACH	= air changes per hour,
H	= building height (meters),
NL	= normalized leakage (unitless),
F	= scaling factor (unitless), and
h	= hours.

Chan et al. (2005) found that "older and smaller homes are more likely to have higher normalized leakage areas than newer and larger ones." Table 19-28 summarizes the normalized leakage distributions in the United States.

It should be noted that newer homes were generally built tighter until about 1997 when the construction trend leveled off. Sherman and Matson (2002) also examined LBNL's U.S. Residential Air Leakage database and found that average normalized leakage for 22,000 houses already in the database was 1.18 *NL* (total leakage cm^2 normalized for dwelling size m^2), but leakage among the 8,700 newer homes averaged 0.30 *NL*.

19.5.4. Vapor Intrusion

In 1998, concerns about subsurface contamination of soil or ground water impacting indoor air quality led the U.S. EPA to develop a series of models for estimating health risks from subsurface vapor intrusion into buildings based on the analytical solutions of Johnson and Ettinger (1991). Since that time, the models have been revised, and new models have been added. The 3-phase soil contamination models theoretically partition the contamination into three discrete phases: (1) in solution with water, (2) sorbed to the soil organic carbon, and (3) in vapor phase within the air-filled pores of the soil. Two new models have been added, allowing the user to estimate vapor intrusion into buildings from measured soil gas data. When Non-Aqueous Phase Liquid (NAPL) is present in soils, the contamination includes a fourth or residual phase. In such cases, the new NAPL models can be used to estimate the rate of vapor intrusion into buildings and the associated health risks. The new NAPL models use a numerical approach for simultaneously solving the time-averaged soil and building vapor concentration for each of up to 10 soil contaminants. This involves a series of iterative calculations for each contaminant. These models are available online from U.S. EPA at http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm.

19.5.5. Deposition and Filtration

Deposition refers to the removal of airborne substances to available surfaces that occurs as a result of gravitational settling and diffusion, as well as electrophoresis and thermophoresis. Filtration is driven by similar processes but is confined to material through which air passes. Filtration is usually a matter of design, whereas deposition is a matter of fact.

19.5.5.1. *Deposition*

The deposition of particulate matter and reactive gas-phase pollutants to indoor surfaces is often stated in terms of a characteristic deposition velocity ($m\ hour^{-1}$) allied to the surface-to-volume ratio ($m^2\ m^{-3}$) of the building or room interior, forming a first order loss rate ($hour^{-1}$) similar to that of air exchange. Theoretical considerations specific to indoor environments have been summarized in comprehensive reviews by Nazaroff and Cass (1989b) and Nazaroff et al. (1993).

For airborne particles, deposition rates depend on aerosol properties (size, shape, density) as well as room factors (thermal gradients, turbulence, surface geometry). The motions of larger particles are dominated by gravitational settling; the motions of smaller particles are subject to convection and diffusion. Consequently, larger particles tend to accumulate more rapidly on floors and up-facing surfaces while smaller particles may accumulate on surfaces facing in any direction. Figure 19-3 illustrates the general trend for particle deposition across the size range of general concern for inhalation exposure (<10 µm). The current thought is that theoretical calculations of deposition rates are likely to provide unsatisfactory results due to knowledge gaps relating to near-surface air motions and other sources of inhomogeneity (Nazaroff et al., 1993).

19.5.5.1.1. Thatcher and Layton (1995)—Deposition, Resuspension, and Penetration of Particles within a Residence

Thatcher and Layton (1995) evaluated removal rates for indoor particles in four size ranges (1–5, 5-10, 10–25, and >25 µm) in a study of one house occupied by a family of four. Table 19-29 lists these values. In a subsequent evaluation of data collected in 100 Dutch residences, Layton and Thatcher (1995) estimated settling velocities of 2.7 m $hour^{-1}$ for lead-bearing particles captured in total suspended particulate matter samples.

19.5.5.1.2. Wallace (1996)—Indoor Particles: A Review

In a major review of indoor particles, Wallace (1996) cited overall particle deposition per hour ($hour^{-1}$) for respirable ($PM_{2.5}$), inhalable (PM_{10}), and coarse (difference between PM_{10} and $PM_{2.5}$) size fractions determined from U.S. EPA's Particle Total Exposure Assessment Methodological Study (PTEAM) study. These values, listed in Table 19-30, were derived from measurements conducted in nearly 200 residences.

19.5.5.1.3. Thatcher et al. (2002)—Effects of Room Furnishings and Air Speed on Particle Deposition Rates Indoors

Thatcher et al. (2002) measured deposition loss rate coefficients for particles of different median diameters (0.55 to 8.66 mm) with fans off and on at various airspeeds in three types of experimental rooms: (1) bare (unfurnished with metal floor), (2) carpeted and unfurnished, and (3) fully furnished. They concluded that large particles (over 25 µm) settle eight times faster than small particles (1–5 µm). Table 19-31 summarizes the results.

19.5.5.1.4. He et al. (2005)—Particle Deposition Rates in Residential Houses

He et al. (2005) investigated particle deposition rates for particles ranging in size from 0.015 to 6 µm. The lowest deposition rates were found for particles between 0.2 and 0.3 µm for both minimum (air exchange rate: 0.61 ± 0.45 $hour^{-1}$) and normal (air exchange rate: 3.00 ± 1.23 $hour^{-1}$) conditions. Thus, air exchange rate was an important factor affecting deposition rates for particles between 0.08 and 1.0 µm, but not for particles smaller than 0.08 µm or larger than 1.0 µm.

19.5.5.2. *Filtration*

A variety of air cleaning techniques have been applied to residential settings. Basic principles related to residential-scale air cleaning technologies have been summarized in conjunction with reporting early test results (Offerman et al., 1984). General engineering principles are summarized in ASHRAE (1988). In addition to fibrous filters integrated into central heating and air conditioning systems, extended surface filters and High Efficiency Particle Arrest filters, as well as electrostatic systems, are available to increase removal efficiency. Free-standing air cleaners (portable and/or console) are also being used. Product-by-product test results reported by Hanley et al. (1994); Shaughnessy et al. (1994); and Offerman et al. (1984) exhibit considerable variability across systems, ranging from ineffectual (<1% efficiency) to nearly complete removal.

19.5.6. Interzonal Airflows

Residential structures consist of a number of rooms that may be connected horizontally, vertically, or both horizontally and vertically. Before considering residential structures as a detailed network of rooms, it is convenient to divide them into one or more zones. At a minimum, each floor is typically defined as a separate zone. For indoor air exposure assessments, further divisions are sometimes made within a floor, depending on (1) locations of specific contaminant sources and (2) the presumed degree of air communication among areas with and without sources.

Defining the airflow balance for a multiple-zone exposure scenario rapidly increases the information requirements as rooms or zones are added. As shown in Figure 19-4, a single-zone system (considering the entire building as a single well-mixed volume) requires only two airflows to define air exchange. Further, because air exchange is balanced flow (air does not "pile up" in the building, nor is a vacuum formed), only one number (the air exchange rate) is needed. With two zones, six airflows are needed to accommodate interzonal airflows plus air exchange; with three zones, 12 airflows are required. In some cases, the complexity can be reduced using judicious (if not convenient) assumptions. Interzonal airflows connecting non-adjacent rooms can be set to zero, for example, if flow pathways do not exist. Symmetry also can be applied to the system by assuming that each flow pair is balanced.

Examples of interzonal airflow models include CONTAM (developed by NIST) and COMIS (Feustel and Raynor-Hoosen, 1990).

19.5.7. House Dust and Soil Loadings

House dust is a complex mixture of biologically derived material (animal dander, fungal spores, etc.), particulate matter deposited from the indoor aerosol, and soil particles brought in by foot traffic. House dust may contain VOCs (Wolkoff and Wilkins, 1994; Hirvonen et al., 1995), pesticides from imported soil particles as well as from direct applications indoors (Roberts et al., 1991), and trace metals derived from outdoor sources (Layton and Thatcher, 1995). The indoor abundance of house dust depends on the interplay of deposition from the airborne state, resuspension due to various activities, direct accumulation, and infiltration.

In the absence of indoor sources, indoor concentrations of particulate matter are significantly lower than outdoor levels. For some time, this observation supported the idea that a significant fraction of the outdoor aerosol is filtered out by the building envelope. More recent data, however, have shown that deposition (incompletely addressed in earlier studies) accounts for the indoor-outdoor contrast, and outdoor particles smaller than 10-µm aerodynamic diameter penetrate the building envelope as completely as non-reactive gases (Wallace, 1996).

It should be noted that carpet dust loadings may be higher than previously believed. This is important because embedded dust is a reservoir for organic compounds. Fortune et al. (2000) compared the mass of dust in carpets removed using conventional vacuuming to that removed by vacuuming with a beater-bar to remove deeply embedded dust. The amount removed was 10 times that removed by conventional vacuuming.

19.5.7.1. *Roberts et al. (1991)—Development and Field Testing of a High-Volume Sampler for Pesticides and Toxics in Dust*

Dust loadings, reported by Roberts et al. (1991), were measured in conjunction with the Non-Occupational Pesticide Exposure Study (NOPES). In this study, house dust was sampled from a representative grid using a specially constructed high-volume surface sampler. The surface sampler collection efficiency was verified in conformance with ASTM F608 (ASTM, 1989). Table 19-32 summarizes data collected from carpeted areas in volunteer households in Florida encountered during the course of NOPES. Seven of the nine sites were single-family detached homes, and two were mobile homes. The authors noted that the two houses exhibiting the highest dust loadings were only those homes where a vacuum cleaner was not used for housekeeping.

19.5.7.2. *Thatcher and Layton (1995)—Deposition, Resuspension, and Penetration of Particles within a Residence*

Relatively few studies have been conducted at the level of detail needed to clarify the dynamics of indoor aerosols. One intensive study of a California residence (Thatcher and Layton, 1995), however, provides instructive results. Using a model-based analysis for data collected under controlled circumstances, the investigators verified penetration of the outdoor aerosol and estimated rates for particle deposition and resuspension (see Table 19-33). The investigators stressed that normal household activities are a significant source of airborne particles larger than 5 µm. During the study, they observed that just walking into and out of a room could momentarily double the concentration. The airborne abundance of submicrometer particles, on the other hand, was unaffected by either cleaning or walking.

Mass loading of floor surfaces (see Table 19-34) was measured in the study of Thatcher and Layton (1995) by thoroughly cleaning the house and sampling accumulated dust, after 1 week of normal habitation and no vacuuming. The methodology, validated under ASTM F608 (ASTM, 1989), showed fine dust recovery efficiencies of 50% with new carpet and 72% for linoleum. Tracked areas showed consistently higher accumulations than untracked areas, confirming the importance of tracked-in material. Differences between tracked areas upstairs and downstairs show that tracked-in material is not readily transported upstairs. The consistency of untracked carpeted areas throughout the house, suggests that, in the absence of tracking, particle transport processes are similar on both floors.

19.6. CHARACTERIZING INDOOR SOURCES

Product- and chemical-specific mechanisms for indoor sources can be described using simple emission factors to represent instantaneous releases, as well as constant releases over defined time periods; more complex formulations may be required for time-varying sources. Guidance documents for characterizing indoor sources within the context of the exposure assessment process are limited (see, for example, Jennings et al., 1987; Wolkoff, 1995). Fairly extensive guidance exists in the technical literature, however, provided that the exposure assessor has the means to define (or estimate) key mechanisms and chemical-specific parameters. Basic concepts are summarized below for the broad source categories that relate to airborne contaminants, waterborne contaminants, and for soil/house dust indoor sources.

19.6.1. Source Descriptions for Airborne Contaminants

Table 19-35 summarizes simplified indoor source descriptions for airborne chemicals for direct emission sources (e.g., combustion, pressurized propellant products), as well as emanation sources (e.g., evaporation from "wet" films, diffusion from porous media), and transport-related sources (e.g., infiltration of outdoor air contaminants, soil gas entry).

Direct-emission sources can be approximated using simple formulas that relate pollutant mass released to characteristic process rates. Combustion sources, for example, may be stated in terms of an emission factor, fuel content (or heating value), and fuel consumption (or carrier delivery) rate. Emission factors for combustion products of general concern (e.g., CO, NO_x) have been measured for a number of combustion appliances using room-sized chambers (see, for example, Relwani et al., 1986). Other direct-emission sources would include volatiles released from water use and from pressurized consumer products. Resuspension of house dust (see Section 19.5.5.1) would take on a similar form by combining an activity-specific rate constant with an applicable dust mass.

Diffusion-limited sources (e.g., carpet backing, furniture, flooring, dried paint) represent probably the greatest challenge in source characterization for indoor air quality. Vapor-phase organics dominate this group, offering great complexity because (1) there is a fairly long list of chemicals that could be of concern, (2) ubiquitous consumer products, building materials, coatings, and furnishings contain varying amounts of different chemicals, (3) source dynamics may include non-linear mechanisms, and (4) for many of the chemicals, emitting as well as non-emitting materials evident in realistic settings may promote reversible and irreversible sink effects. Very detailed descriptions for diffusion-limited sources can be constructed to link specific properties of the chemical, the source material, and the receiving environment to calculate expected behavior (see, for example, Schwope et al., 1992; Cussler, 1984). Validation to actual circumstances, however, suffers practical shortfalls because many parameters simply cannot be measured directly.

The exponential formulation listed in Table 19-35 was derived based on a series of papers generated during the development of chamber testing methodology by U.S. EPA (Dunn, 1987; Dunn and Tichenor, 1988; Dunn and Chen, 1993). This framework represents an empirical alternative that works best when the results of chamber tests are available. Estimates for the initial emission rate (E_o) and decay factor (k_s) can be developed for hypothetical sources from information on pollutant mass available for release (M) and supporting assumptions.

Assuming that a critical time period (t_c) coincides with reduction of the emission rate to a critical level (E_c) or with the release of a critical fraction of the total mass (M_c), the decay factor can be estimated by solving either of these relationships:

$$\frac{E_c}{E_0} = e^{-k_s t_c} \qquad \text{(Eqn. 19-4)}$$

where:

E_c = emission rate to a critical level (µg hour^{-1}),
E_0 = initial emission rate (µg hour^{-1}),
k_s = decay factor (µg hour^{-1}), and
t_c = critical time period (hours),

or

$$\frac{M_c}{M} = 1 - e^{-k_s t_c} \qquad \text{(Eqn. 19-5)}$$

where:

M_c = critical mass (µg), and
M = total mass (µg).

The critical time period can be derived from product-specific considerations (e.g., equating drying time for paint to 90% emissions reduction). Given such an estimate for k_s, the initial emission rate can be estimated by integrating the emission formula to infinite time under the assumption that all chemical mass is released:

$$M = \int_0^\infty E_0\, e - k_s t\, dt = \frac{E_0}{k_s} \qquad \text{(Eqn. 19-6)}$$

The basis for the exponential source algorithm has also been extended to the description of more complex diffusion-limited sources. With these sources, diffusive or evaporative transport at the interface may be much more rapid than diffusive transport from within the source material, so that the abundance at the source/air interface becomes depleted, limiting the transfer rate to the air. Such effects can prevail with skin formation in "wet" sources like stains and paints (see, for example, Chang and Guo, 1992). Similar emission profiles have been observed with the emanation of formaldehyde from particleboard with "rapid" decline as formaldehyde evaporates from surface sites of the particleboard over the first few weeks. It is then followed by a much slower decline over ensuing years as formaldehyde diffuses from within the matrix to reach the surface (see, for example, Zinn et al., 1990).

Transport-based sources bring contaminated air from other areas into the airspace of concern. Examples include infiltration of outdoor contaminants, and soil gas entry. Soil gas entry is a particularly complex phenomenon and is frequently treated as a separate modeling issue (Little et al., 1992; Sextro, 1994). Room-to-room migration of indoor contaminants would also fall under this category, but this concept is best considered using multi-zone models.

19.6.2. Source Descriptions for Waterborne Contaminants

Residential water supplies may be a route for exposure to chemicals through ingestion, dermal contact, or inhalation. These chemicals may appear in the form of contaminants (e.g., trichloroethylene) as well as naturally occurring by-products of water system history (e.g., chloroform, radon). Among indoor water uses, showering, bathing, and hand-washing of dishes or clothes provide the primary opportunities for dermal exposure. The escape of volatile chemicals to the gas phase associates water use with inhalation exposure. The exposure potential for a given chemical will depend on the source of water, the types and extents of water uses, and the extent of volatilization of specific chemicals. Primary types of residential water use include showering/bathing, toilet use, clothes washing, dishwashing, and faucet use (e.g., for drinking, cooking, general cleaning, or washing hands).

Upper-bounding estimates of chemical release rates from water use can be formulated as simple emission factors by combining the concentration in the feed water (g m^{-3}) with the flow rate for the water use (m^3 hour^{-1}), and assuming that the chemical escapes to the gas phase. For some chemicals, however, not all of the chemical escapes in realistic situations due to diffusion-limited transport and solubility factors. For inhalation exposure estimates, this may not pose a problem because the bounding estimate would overestimate emissions by no more than approximately a factor of two. For multiple exposure pathways, the chemical mass remaining in the water may be of importance. Refined estimates of volatile emissions are usually considered under two-resistance theory to accommodate mass transport aspects of the water-air system (see, for example, U.S. EPA, 2000; Howard-Reed et al., 1999; Moya et al., 1999; Little, 1992; Andelman, 1990; McKone, 1987). More detailed descriptions of models used to estimate emissions from indoor water sources including showers, bathtubs, dishwashers, and washing machines are included in U.S. EPA, 2000. Release rates (*S*) are formulated as

$$S = K_m F_w \left[C_w - \frac{C_a}{H} \right] \qquad \text{(Eqn. 19-7)}$$

where:

- S = chemical release rate (g hour^{-1}),
- K_m = dimensionless mass-transfer coefficient,
- F_w = water flow rate (m^3 hour^{-1}),
- C_w = concentration in feed water (g m^{-3}),
- C_a = concentration in air (g m^{-3}), and
- H = dimensionless Henry's Law constant.

Because the emission rate is dependent on the air concentration, recursive techniques are required. The mass-transfer coefficient is a function of water use characteristics (e.g., water droplet size spectrum, fall distance, water film) and chemical properties (diffusion in gas and liquid phases). Estimates of practical value are based on empirical tests to incorporate system characteristics into a single parameter (see, for example, Giardino et al., 1990). Once characteristics of one chemical-water use system are known (reference chemical, subscript *r*), the mass-transfer coefficient for another chemical (index chemical, subscript *i*) delivered by the same system can be estimated using formulations identified in the review by Little (1992):

$$\frac{1}{K}\left(\frac{D_{Li}}{D_{Lr}}\right)^{1/2} = \frac{1}{K_{Lr}}$$

$$= \frac{1}{K_{Gr}} - \frac{1}{H}\left(\frac{D_{Gr}}{D_{Gi}}\right)^{2/3}\left(\frac{D_{Li}}{D_{Lr}}\right)^{1/2} \quad \text{(Eqn. 19-8)}$$

where:

D_L = liquid diffusivity (m^2 $second^{-1}$),
DG = gas diffusivity (m^2 $second^{-1}$),
KL = liquid-phase mass-transfer coefficient,
KG = gas-phase mass transfer coefficient, and
H = dimensionless Henry's Law constant.

19.6.3. Soil and House Dust Sources

The rate process descriptions compiled for soil and house dust provide inputs for estimating indoor emission rates:

$$S_d = M_d R_d A_f \quad \text{(Eqn. 19-9)}$$

where:

S_d = dust emission (g $hour^{-1}$),
M_d = dust mass loading (g m^{-2}),
R_d = resuspension rates ($hour^{-1}$), and
A_f = floor area (m^2).

Because house dust is a complex mixture, transfer of particle-bound constituents to the gas phase may be of concern for some exposure assessments. For emission estimates, one would then need to consider particle mass residing in each reservoir (dust deposit, airborne).

19.7. ADVANCED CONCEPTS

19.7.1. Uniform Mixing Assumption

Many exposure measurements are predicated on the assumption of uniform mixing within a room or zone of a house. Mage and Ott (1994) offer an extensive review of the history of use and misuse of the concept. Experimental work by Baughman et al. (1994) and Drescher et al. (1995) indicates that, for an instantaneous release from a point source in a room, fairly complete mixing is achieved within 10 minutes when convective flow is induced by solar radiation. However, up to 100 minutes may be required for complete mixing under quiescent (nearly isothermal) conditions. While these experiments were conducted at extremely low air exchange rates (<0.1 ACH), based on the results, attention is focused on mixing within a room.

The situation changes if a human invokes a point source for a longer period and remains in the immediate vicinity of that source. Personal exposure in the near vicinity of a source can be much higher than the well-mixed assumption would suggest. A series of experiments conducted by GEOMET (1989) for the U.S. EPA involved controlled point-source releases of carbon monoxide tracer (CO), each for 30 minutes. Breathing-zone measurements located within 0.4 m of the release point were 10 times higher than for other locations in the room during early stages of mixing and transport.

Similar investigations conducted by Furtaw et al. (1995) involved a series of experiments in a controlled-environment, room-sized chamber. Furtaw et al. (1995) studied spatial concentration gradients around a continuous point source simulated by sulfur hexafluoride (SF_6) tracer with a human moving about the room. Average breathing-zone concentrations when the subject was near the source exceeded those several meters away by a factor that varied inversely with the ventilation intensity in the room. At typical room ventilation rates, the ratio of source-proximate to slightly-removed concentration was on the order of 2:1.

19.7.2. Reversible Sinks

For some chemicals, the actions of reversible sinks are of concern. For an initially "clean" condition in the sink material, sorption effects can greatly deplete indoor concentrations. However, once enough of the chemical has been adsorbed, the diffusion gradient will reverse, allowing the chemical to escape. For persistent indoor sources, such effects can serve to reduce indoor levels initially, but once the system equilibrates, the net effect on the average concentration of the reversible sink is negligible. Over suitably short time frames, this can also affect integrated exposure. For indoor sources whose emission profile declines with time (or ends abruptly), reversible sinks can serve to extend the emissions period as the chemical desorbs long after direct emissions are finished. Reversible sink effects have been observed for a number of chemicals in the presence of carpeting, wall coverings, and other materials commonly found in residential environments.

Interactive sinks (and models of the processes) are of special importance; while sink effects can greatly reduce indoor air concentrations, re-emission at lower rates over longer time periods could greatly extend the exposure period of concern. For completely reversible sinks, the extended time could bring the cumulative exposure to levels approaching the sink-free case. Publications (Axley and Lorenzetti, 1993; Tichenor et al., 1991) show that first principles provide useful guidance in postulating models and setting assumptions for reversible-irreversible sink models. Sorption/desorption can be described in terms of Langmuir (monolayer) as well as Brunauer-Emmet-Teller (BET, multilayer) adsorption.

19.8. REFERENCES FOR CHAPTER 19

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Table 19-6. Average Estimated Volumes of U.S. Residences, by Housing Type and Ownership

	Ownership					
	Owner-Occupied		Rental[a]		All Units	
Housing Type	Volume[b] (m^3)	% of Total	Volume[b] (m^3)	% of Total	Volume[b] (m^3)	% of Total
Single-Family (Detached)	637	57.7	449	7.2	616	64.9
Single-Family (Attached)	544	3.8	313	3.1	440	6.8
Multifamily (2–4 units)	363	1.7	211	5.3	247	7.0
Multifamily (5+ Units)	253	2.1	189	13.0	197	15.1
Mobile Home	249	5.2	196	1.1	240	6.3
All Types	586	70.5	269	29.7	492	100

[a] The classification "Occupied without payment of rent" is included in the estimates for rentals.
[b] Volumes calculated from floor areas assuming a ceiling height of 8 feet. Excludes floor space in unheated garages.

Source: U.S. EPA Analysis of U.S. DOE, 2008a.

Table 19-7. Residential Volumes in Relation to Year of Construction

Year of Construction	Volume[a] (m^3)	% of Total
Before 1940	527	13.2
1940–1949	464	6.7
1950–1959	465	11.3
1960–1969	446	11.2
1970–1979	422	17.0
1980–1989	451	16.7
1990–1999	567	15.6
2000–2005	640	8.3
All Years	492	100

[a] Volumes calculated from floor areas assuming a ceiling height of 8 feet. Excludes floor space in unheated garages.

Source: U.S. EPA Analysis of U.S. DOE, 2008a.

Table 19-8. Summary of Residential Volume Distributions Based on U.S. DOE (2008a)[a] (m^3)	
Parameter	Volume
Arithmetic Mean	492
Standard Deviation	349
10th Percentile	154
25th Percentile	231
50th Percentile	395
75th Percentile	648
90th Percentile	971

[a] All housing types, all units.

Source: U.S. EPA's Analysis of U.S. DOE, 2008a.

Table 19-9. Summary of Residential Volume Distributions Based on Versar (1990) (m^3)	
Parameter	Volume
Arithmetic Mean	369
Standard Deviation	209
10th Percentile	167
25th Percentile	225
50th Percentile	321
75th Percentile	473
90th Percentile	575

Source: Versar, 1990; based on PFT database.

Table 19-10. Number of Residential Single Detached and Mobile Homes by Volume[a] (m^3) and Median Volumes by Housing Type

			Year-Round					
				Occupied		Vacant		
Housing Units	Total housing units	Seasonal	Total	Owner	Renter	Total Vacant	New units in last 4 years	Manuf./ mobile homes
Total all housing units	130,112	4,618	125,494	76,428	35,378	13,688	5,955	8,769
Single detached and manufactured/mobile homes	91,241	3,524	87,717	68,742	11,176	7,799	4,291	8,769
Volume (m^3)								
Less than 113.3	988	225	764	383	220	161	10	331
113.3–169.7	2,765	462	2,303	1,085	686	532	19	1,020
169.9–226.3	6,440	593	5,847	3,519	1,495	833	68	1,935
226.5–339.6	21,224	814	20,410	14,978	3,441	1,991	557	2,779
339.8–452.8	20,636	521	20,115	16,284	2,235	1,596	827	1,309
453.1–566.1	14,361	284	14,077	12,057	1,134	886	813	334
566.3–679.4	7,589	141	7,448	6,622	429	398	535	126
679.6–905.9	7,252	137	7,115	6,391	301	424	751	54
906 or more	4,456	113	4,343	3,787	243	313	469	146
Not reported/Don't know	5,529	234	5,295	3,638	992	666	241	735
Median Volume (m^3)	385.1	260.5	393.3	407.8	294.5	339.8	521.0	247.4

[a] Converted from ft^2. Assumes 8-foot ceiling.

Source: U.S. Census Bureau, 2010.

Table 19-11. Dimensional Quantities for Residential Rooms

Nominal Dimensions	Length (meters)	Width (meters)	Height (meters)	Volume (m^3)	Wall Area (m^2)	Floor Area (m^2)	Total Area (m^2)
8-Foot Ceiling							
12’ × 15’	4.6	3.7	2.4	41	40	17	74
12’ × 12’	3.7	3.7	2.4	33	36	13	62
10’ × 12’	3.0	3.7	2.4	27	33	11	55
9’ × 12’	2.7	3.7	2.4	24	31	10	51
6’ × 12’	1.8	3.7	2.4	16	27	7	40
4’ × 12’	1.2	3.7	2.4	11	24	4	32
12-Foot Ceiling							
12’ × 15’	4.6	3.7	3.7	61	60	17	94
12’ × 12’	3.7	3.7	3.7	49	54	13	80
10’ × 12’	3.0	3.7	3.7	41	49	11	71
9’ × 12’	2.7	3.7	3.7	37	47	10	67
6’ × 12’	1.8	3.7	3.7	24	40	7	54
4’ × 12’	1.2	3.7	3.7	16	36	4	44

Table 19-12. Examples of Products and Materials Associated with Floor and Wall Surfaces in Residences

Material Sources	Assumed Amount of Surface Covered[a] (m^2)
Silicone caulk	0.2
Floor adhesive	10.0
Floor wax	50.0
Wood stain	10.0
Polyurethane wood finish	10.0
Floor varnish or lacquer	50.0
Plywood paneling	100.0
Chipboard	100.0
Gypsum board	100.0
Wallpaper	100.0

[a] Based on typical values for a residence.

Source: Adapted from Tucker, 1991.

Table 19-13. Residential Heating Characteristics by U.S. Census Region

Space Heating Characteristics	Housing Units (%)	U.S. Census Region			
		Northeast	Midwest	South	West
Total	100.0	100.0	100.0	100.0	100.0
Do Not Have Space Heating Equipment	1.1	Q	Q	Q	2.9
Have Main Space Heating Equipment	98.8	99.5	100.0	99.0	96.7
Main Heating Fuel and Equipment					
Natural Gas	52.4	55.3	71.9	33.4	60.7
Central Warm-Air Furnace	40.2	29.6	63.3	27.0	47.1
Steam or Hot Water System	7.4	23.8	6.3	2.5	2.5
Floor, Wall or Pipeless Furnace	2.1	Q	1.2	0.5	6.6
Room Heater	1.8	Q	Q	2.2	3.3
Other Equipment	0.8	1.0	Q	1.0	1.2
Electricity	30.3	7.8	13.7	54.3	26.9
Built-in Electric Units	4.5	4.4	4.3	3.7	6.6
Central Warm-Air Furnace	14.4	1.5	5.5	27.0	14.0
Heat Pump	8.3	Q	3.1	17.7	4.1
Portable Electric Heater	1.4	Q	Q	2.2	2.1
Other Equipment	1.7	1.0	Q	3.4	Q
Fuel Oil	6.9	30.1	2.7	1.2	1.2
Steam or Hot Water System	4.2	20.9	Q	Q	Q
Central Warm-Air Furnace	2.5	8.7	2.0	0.7	Q
Other Equipment	0.3	Q	Q	Q	Q
Wood	2.6	2.4	2.7	2.2	3.3
Propane/LPG[a]	5.4	1.9	7.4	6.6	4.1
Central Warm-Air Furnace	3.7	1.0	6.6	3.7	2.5
Room Heater	0.8	Q	Q	1.7	Q
Other Equipment	0.9	Q	Q	1.0	1.2
Kerosene	0.6	1.0	Q	1.0	Q
Other Fuel	0.5	Q	Q	Q	Q
Secondary Heating Fuel and Equipment					
No	68.6	78.6	63.3	71.0	61.6
Yes (More than One May Apply)	31.4	21.4	36.7	29.0	38.4
Natural Gas	4.5	1.9	5.9	3.2	7.4
Fireplace	2.4	Q	3.1	1.5	4.5
Room Heater	0.5	Q	Q	0.7	Q
Central Warm-Air Furnace	1.0	Q	1.6	Q	1.7
Other Equipment	0.7	Q	Q	Q	1.2
Electricity	17.7	12.1	20.7	17.0	21.1
Portable Heater	14.4	9.7	16.8	13.8	16.9
Built-in Electric Units	2.0	1.9	2.3	1.0	2.9
Heat Pump	0.5	N/R	Q	1.0	Q
Other Equipment	1.2	Q	1.6	1.5	1.7
Fuel Oil	0.4	1.0	Q	Q	N/R
Wood	8.0	4.4	8.6	7.6	11.2
Propane/LPG	2.1	1.5	2.7	2.7	N/R
Kerosene	0.8	1.0	1.2	1.0	N/R
Other Fuel	0.2	Q	Q	Q	Q

[a] Liquefied Petroleum Gas.

Q = Data withheld either because the Relative Standard Error (RSE) was greater than 50% or fewer than 10 households were sampled.

N/R = No cases in reporting sample.

Source: U.S. DOE, 2008a.

Table 19-14. Residential Heating Characteristics by Urban/Rural Location					
Space Heating Characteristics	Housing Units (%)	Urban/Rural Location			
		City	Town	Suburbs	Rural
Total	100.0	100.0	100.0	100.0	100.0
Do Not Have Space Heating Equipment	1.1	1.5	Q	0.9	Q
Have Main Space Heating Equipment	98.8	98.3	99.5	99.1	99.1
Main Heating Fuel and Equipment					
Natural Gas	52.4	57.3	62.6	65.6	19.3
Central Warm-Air Furnace	40.2	42.0	45.3	56.4	16.1
Steam or Hot Water System	7.4	9.3	11.1	6.2	1.3
Floor, Wall or Pipeless Furnace	2.1	2.5	2.6	1.8	Q
Room Heater	1.8	2.3	2.6	Q	Q
Other Equipment	0.8	0.8	1.6	Q	Q
Electricity	30.3	33.8	24.2	25.6	33.2
Built-in Electric Units	4.5	5.3	4.2	4.0	4.0
Central Warm-Air Furnace	14.4	16.8	14.2	10.1	14.3
Heat Pump	8.3	7.2	4.2	9.7	12.1
Portable Electric Heater	1.4	1.7	Q	Q	2.2
Other Equipment	1.7	2.5	Q	Q	Q
Fuel Oil	6.9	5.1	8.9	5.3	10.8
Steam or Hot Water System	4.2	3.8	4.7	3.5	5.4
Central Warm-Air Furnace	2.5	1.3	3.7	2.2	4.5
Other Equipment	0.3	Q	Q	N/R	Q
Wood	2.6	0.6	Q	Q	10.3
Heating Stove	1.8	Q	Q	Q	6.7
Other Equipment	0.8	Q	Q	N/R	3.1
Propane/LPG[a]	5.4	0.6	1.1	1.3	23.3
Central Warm-Air Furnace	3.7	Q	Q	Q	16.6
Room Heater	0.8	Q	Q	Q	3.1
Other Equipment	0.9	Q	Q	Q	3.6
Kerosene	0.6	Q	Q	Q	1.8
Other Fuel	0.5	0.6	Q	Q	Q
Secondary Heating Fuel and Equipment					
No	68.6	75.2	73.2	67.4	52.0
Yes (More than One May Apply)	31.4	24.8	26.8	32.2	48.4
Natural Gas	4.5	3.8	3.7	7.5	3.1
Fireplace	2.4	1.9	1.6	4.8	1.8
Room Heater	0.5	Q	Q	Q	Q
Central Warm-Air Furnace	1.0	0.8	Q	1.3	Q
Other Equipment	0.7	0.8	Q	Q	Q
Electricity	17.7	15.9	15.8	17.6	23.3
Portable Heater	14.4	13.2	13.7	14.5	17.0
Built-in Electric Units	2.0	1.7	Q	2.2	3.1
Heat Pump	0.5	Q	Q	Q	1.3
Other Equipment	1.2	0.8	1.1	Q	2.2
Fuel Oil	0.4	N/R	Q	Q	Q
Wood	8.0	5.5	6.3	7.0	15.2
Propane/LPG	2.1	Q	Q	1.3	8.1
Kerosene	0.8	Q	Q	Q	2.2
Other Fuel	0.2	Q	Q	Q	Q

[a] Liquefied Petroleum Gas.

Q = Data withheld either because Relative Standard Error (RSE) was >50% or <10 households were sampled.

N/R = No cases in reporting sample.

Source: U.S. DOE, 2008a.

Table 19-15. Residential Air Conditioning Characteristics by U.S. Census Region

Air Conditioning Characteristics	Housing Units (%)	U.S. Census Region			
		Northeast	Midwest	South	West
Total	100.0	100.0	100.0	100.0	100.0
Do Not Have Cooling Equipment	16.0	19.4	8.2	3.4	42.6
Have Cooling Equipment	84.0	80.1	91.8	96.6	57.4
Air-Conditioning Equipment[a, b]					
Central System	59.3	29.1	67.6	78.9	43.4
Window/Wall Units	26.0	51.9	25.8	19.7	14.9
Frequency of Central Air-Conditioner Use					
Never	1.3	Q	Q	1.0	3.3
Only a Few Times When Needed	10.3	7.8	15.2	6.1	14.0
Quite a Bit	11.3	5.8	17.6	11.1	9.9
All Summer	36.5	14.6	34.4	60.9	16.1
Frequency Most-Used Unit Used					
Never	0.5	Q	Q	Q	Q
Only a Few Times When Needed	10.9	23.8	12.1	5.2	8.3
Quite a Bit	6.8	14.6	6.3	5.4	2.9
All Summer	7.7	12.6	7.0	8.8	2.9

[a] In the 2005 RECS, 1.5 million housing units reported having both central and window/wall air conditioners.

[b] The number of housing units using air-conditioning includes a small, undetermined number of housing units where the fuel for central air-conditioning was other than electricity; these housing units were treated as if the air-conditioning fuel was electricity.

Q = Data withheld either because the Relative Standard Error (RSE) was greater than 50% or fewer than 10 households were sampled.

Source: U.S. DOE, 2008a.

Table 19-16. Percent of Residences with Basement, by Census Region and U.S. EPA Region

Census Region	U.S. EPA Regions	% of Residences with Basements
Northeast	1	93.4
Northeast	2	55.9
Midwest	3	67.9
Midwest	4	19.3
South	5	73.5
South	6	4.1
South	7	75.3
West	8	68.5
West	9	10.3
West	10	11.5
	All Regions	45.2

Source: Lucas et al., 1992.

Table 19-17. Percent of Residences with Basement, by Census Region

Census Region	Census Divisions	% of Residences with Basements
Northeast	1 New England	83.2
Northeast	2 Mid Atlantic	69.1
Midwest	3 East North Central	68.7
Midwest	4 West North Central	65.3
South	5 South Atlantic	27.0
South	6 East South Central	23.7
South	7 West South Central	2.8
West	8 Mountain	29.9
West	9 Pacific	10.9
	All Divisions	40.6

Source: U.S. EPA Analysis of U.S. DOE, 2008a.

Table 19-18. States Associated with U.S. EPA Regions and Census Regions

U.S. EPA Regions			
Region 1	Region 4	Region 6	Region 8
Connecticut	Alabama	Arkansas	Colorado
Maine	Florida	Louisiana	Montana
Massachusetts	Georgia	New Mexico	North Dakota
New Hampshire	Kentucky	Oklahoma	South Dakota
Rhode Island	Mississippi	Texas	Utah
Vermont	North Carolina		Wyoming
	South Carolina	Region 7	
Region 2	Tennessee	Iowa	Region 9
New Jersey		Kansas	Arizona
New York	Region 5	Missouri	California
	Illinois	Nebraska	Hawaii
Region 3	Indiana		Nevada
Delaware	Michigan		
District of Columbia	Minnesota		Region 10
Maryland	Ohio		Alaska
Pennsylvania	Wisconsin		Idaho
Virginia			Oregon
West Virginia			Washington
U.S. Census Bureau Regions			
Northeast Region	Midwest Region	South Region	West Region
Connecticut	Illinois	Alabama	Alaska
Maine	Indiana	Arkansas	Arizona
Massachusetts	Iowa	Delaware	California
New Hampshire	Kansas	District of Columbia	Colorado
New Jersey	Michigan	Florida	Hawaii
New York	Minnesota	Georgia	Idaho
Pennsylvania	Missouri	Kentucky	Montana
Rhode island	Nebraska	Louisiana	Nevada
Vermont	North Dakota	Maryland	New Mexico
	Ohio	Mississippi	Oregon
	South Dakota	North Carolina	Utah
	Wisconsin	Oklahoma	Washington
		South Carolina	Wyoming
		Tennessee	
		Texas	
		Virginia	
		West Virginia	

Source: U.S. DOE, 2008a.

Table 19-19. Percent of Residences with Certain Foundation Types by Census Region

Census Region	% of Residences[a]		
	With Basement	With Crawlspace	With Concrete Slab
Northeast	72.9	18.9	24.5
Midwest	67.7	27.4	30.2
South	19.1	29.7	58.5
West	17.0	36.9	61.8
All Regions	40.6	28.7	46.0

[a] Percentage may add to more than 100 because more than one foundation type may apply to a given residence.

Source: U.S. EPA Analysis of U.S. DOE, 2008a.

Table 19-20. Average Estimated Volumes[a] of U.S. Commercial Buildings, by Primary Activity

Primary Building Activity	*N*	Mean	SE of Mean	Percentiles					% of Total
				10th	25th	50th	75th	90th	
Vacant	134	4,789	581	408	612	1,257	3,823	11,213	3.7
Office	976	5,036	397	510	714	1,359	3,398	8,155	17.0
Laboratory	43	24,681	1,114	2,039	5,437	10,534	40,776	61,164	0.2
Non-refrigerated warehouse	473	9,298	992	1,019	1,812	2,945	7,504	16,990	12.0
Food sales	125	1,889	106	476	680	951	2,039	3,398	4.6
Public order and safety	85	5,253	482	816	1,019	1,699	3,398	8,495	1.5
Outpatient healthcare	144	3,537	251	680	1,019	2,039	3,398	6,966	2.5
Refrigerated warehouse	20	19,716	3,377	1,133	1,699	3,398	8,212	38,511	0.3
Religious worship	311	3,443	186	612	917	2,039	4,163	8,325	7.6
Public assembly	279	4,839	394	595	1,019	2,277	4,417	7,136	5.7
Education	649	8,694	513	527	867	2,379	10,194	23,786	7.9
Food service	242	1,889	112	442	680	1,189	2,039	3,568	6.1
Inpatient healthcare	217	82,034	5,541	17,330	25,485	36,019	95,145	203,881	0.2
Nursing	73	15,522	559	1,546	5,097	10,534	17,330	38,737	0.4
Lodging	260	11,559	1,257	527	1,376	4,078	10,194	27,184	2.5
Strip shopping mall	349	7,891	610	1,359	2,277	4,078	6,966	19,709	4.3
Enclosed mall	46	287,978	14,780	35,679	35,679	113,268	453,070	849,505	0.1
Retail other than mall	355	3,310	218	510	680	1,631	3,398	6,116	9.1
Service	370	2,213	182	459	629	934	2,039	4,587	12.8
Other	64	5,236	984	425	544	1,427	3,398	9,175	1.4
All Buildings[b]	5,215	5,575	256	527	816	1,699	4,248	10,194	100

[a] Volumes calculated from floor areas assuming a ceiling height of 12 feet for other structures and 20 feet for warehouses.
[b] Weighted average calculated from floor areas assuming a ceiling height of 12 feet for all buildings except warehouses and enclosed malls, which assumed 20-foot ceilings.
N = Number of observations.
SE = Standard error.

Source: U.S. EPA Analysis of U.S. DOE, 2008b.

Table 19-21. Non-Residential Buildings: Hours per Week Open and Number of Employees

Primary Building Activity	*N*	%	Number of Hours/Week Open							Number of Employees During Main Shift						
			Mean	SE of Mean	Percentiles					Mean	SE of Mean	Percentiles				
					10th	25th	50th	75th	90th			10th	25th	50th	75th	90th
Vacant	134	2.8%	6.7	1.2	0	0	0	0	40	0.35	0.08	0	0	0	0	0
Office	976	20.2%	54.7	1.6	40	45	54	65	168	34.2	2.8	4	11	57	300	886
Laboratory	43	0.9%	103.5	0.8	50	58	98	168	168	105.6	4.5	20	55	156	300	435
Non-refrigerated warehouse	473	9.8%	66.2	4.8	20	40	55	80	168	7.0	0.9	0	1	8	25	64
Food sales	125	2.6%	107.3	2.5	60	80	109	127	168	6.3	0.5	1	2	4	15	50
Public order and safety	85	1.8%	103.0	7.6	10	40	168	168	168	19.1	2.2	1	4	15	60	200
Outpatient healthcare	144	3.0%	52.0	2.8	40	45	54	70	168	21.5	1.9	5	8	40	125	200
Refrigerated warehouse	20	0.4%	61.3	0.7	44	53	102	126	168	18.2	2.4	4	8	38	61	165
Religious worship	311	6.5%	32.0	2.4	5	13	40	60	79	4.6	0.5	1	1	3	10	19
Public assembly	279	5.8%	50.3	3.8	12	40	63	96	125	8.7	1.5	0	2	5	22	80
Education	649	13.5%	49.6	1.0	38	42	54	70	85	32.4	8.8	3	14	38	75	133
Food service	242	5.0%	85.8	2.6	40	66	84	105	130	10.5	0.9	2	4	8	15	33
Inpatient healthcare	217	4.5%	168.0	*	168	168	168	168	168	471.0	40.4	175	315	785	1,300	2,250
Nursing	73	1.5%	168.0	*	168	168	168	168	168	44.8	2.5	15	25	50	80	170
Lodging	260	5.4%	166.6	0.8	168	168	168	168	168	12.3	2.0	1	3	10	25	80
Retail other than mall	355	7.4%	59.1	1.5	42	50	62	80	105	7.8	0.7	2	3	6	22	72
Service	370	7.7%	55.0	2.1	40	40	50	68	105	5.9	0.6	1	2	4	10	35
Other	64	1.3%	57.8	7.1	12	40	51	90	168	12.3	1.7	1	2	10	44	150
All Activities	4,820	100.0%	61.2	1.2	30	45	60	98	168	15.7	1.2	1	3	14	66	300

* All sampled inpatient healthcare and nursing buildings reported being open 24 hours a day, 7 days a week.
N = Number of observations.
SE = Standard error.

Source: U.S. EPA Analysis of U.S. DOE, 2008b.

Table 19-22. Non-Residential Heating Energy Sources for Non-Mall Buildings

	All Buildings[a]	Buildings with Space Heating	Space-Heating Energy Sources Used[b]					
			Electricity	Natural Gas	Fuel Oil	District Heat	Propane	Other[c]
All Buildings[a]	4,645	3,982	1,766	2,165	360	65	372	113
Building Floorspace (ft²)								
1,001–5,000	54.9%	52.7%	50.3%	46.8%	54.4%	Q	65.3%	63.7%
5,001–10,000	19.1%	19.6%	19.8%	20.8%	23.9%	Q	19.4%	Q
10,001–25,000	15.9%	16.5%	17.6%	18.9%	12.8%	27.7%	10.2%	Q
25,001–50,000	5.2%	5.7%	6.5%	7.0%	3.1%	13.8%	3.0%	Q
50,001–100,000	2.8%	3.1%	3.4%	3.9%	2.2%	12.3%	Q	Q
100,001–200,000	1.4%	1.6%	1.6%	1.8%	2.5%	13.8%	Q	Q
200,001–500,000	0.5%	0.6%	0.6%	0.7%	1.1%	6.2%	Q	Q
Over 500,000	0.2%	0.2%	0.2%	0.2%	0.3%	3.1%	Q	Q
Principal Building Activity								
Education	8.3%	9.6%	10.2%	8.6%	5.8%	38.5%	9.7%	Q
Food Sales	4.9%	4.7%	5.5%	3.6%	Q	N/R	Q	Q
Food Service	6.4%	7.1%	7.1%	7.9%	Q	Q	8.3%	Q
Health Care	2.8%	3.1%	3.5%	3.1%	Q	3.1%	Q	Q
Lodging	3.1%	3.6%	5.8%	2.6%	4.4%	Q	Q	Q
Retail (Other Than Mall)	9.5%	10.2%	9.6%	10.9%	9.7%	Q	10.8%	Q
Office	17.7%	20.1%	21.5%	21.5%	12.8%	24.6%	9.7%	Q
Public Assembly	6.0%	6.5%	4.7%	6.5%	10.3%	9.2%	Q	Q
Public Order and Safety	1.5%	1.8%	1.4%	1.4%	Q	Q	Q	Q
Religious Worship	8.0%	9.0%	8.6%	9.6%	10.0%	Q	11.8%	N/R
Service	13.4%	12.9%	10.2%	12.3%	22.8%	Q	20.2%	60.2%
Warehouse and Storage	12.9%	7.9%	8.5%	8.2%	7.8%	Q	6.5%	Q
Other	1.7%	1.7%	1.8%	1.9%	Q	Q	Q	Q
Vacant	3.9%	1.7%	1.5%	1.8%	Q	Q	Q	Q
Year Constructed								
Before 1920	7.1%	7.6%	3.7%	8.5%	20.0%	Q	Q	Q
1920–1945	11.3%	11.1%	8.0%	14.3%	13.3%	18.5%	Q	Q
1946–1959	12.1%	12.4%	11.0%	12.9%	18.1%	20.0%	11.0%	Q
1960–1969	12.5%	13.2%	12.0%	13.0%	13.6%	20.0%	11.6%	Q
1970–1979	15.7%	16.3%	16.6%	16.6%	12.8%	9.2%	12.9%	39.8%
1980–1989	15.2%	15.5%	19.9%	12.5%	10.0%	6.2%	19.9%	Q
1990–1999	18.9%	18.1%	21.5%	17.2%	9.4%	12.3%	19.4%	Q
2000–2003	7.2%	5.9%	7.1%	4.9%	Q	Q	12.6%	Q
Census Region and Division								
Northeast	15.6%	16.9%	10.1%	16.0%	63.6%	26.2%	6.5%	Q
Midwest	27.3%	27.9%	20.2%	35.8%	16.4%	20.0%	38.7%	31.9%
South	38.2%	36.7%	50.0%	29.1%	14.2%	30.8%	36.6%	Q
West	18.9%	18.5%	19.7%	19.1%	6.1%	23.1%	18.0%	Q
Heating Equipment[b]								
Heat Pumps	10.2%	12.0%	26.4%	5.7%	1.7%	3.1%	7.5%	Q
Furnaces	40.1%	46.8%	31.4%	58.8%	52.2%	Q	57.0%	57.5%
Individual Space Heaters	17.6%	20.6%	34.2%	18.4%	21.9%	6.2%	32.8%	35.4%
District Heat	1.4%	1.6%	0.3%	0.2%	Q	100.0%	Q	N/R
Boilers	12.5%	14.5%	9.1%	18.3%	40.0%	Q	8.1%	15.9%
Packaged Heating Units	20.5%	23.9%	32.4%	24.4%	4.7%	4.6%	21.2%	Q

Table 19-22. Non-Residential Heating Energy Sources for Non-Mall Buildings (continued)

	All Buildings[a]	Buildings with Space Heating	Space-Heating Energy Sources Used[b]					
			Electricity	Natural Gas	Fuel Oil	District Heat	Propane	Other[c]
Other	4.4%	5.1%	6.6%	3.7%	10.0%	Q	10.8%	41.6%

[a] Figures in this table do not include enclosed malls and strip malls.
[b] More than one may apply.
[c] "Other" includes wood, coal, solar, and all other energy sources.
Q = Data withheld because the Relative Standard Error (RSE) was >50%, or <20 buildings were sampled.
N/R = No responding cases in sample.

Source: U.S. DOE, 2008b.

Table 19-23. Non-Residential Air Conditioning Energy Sources for Non-Mall Buildings

	All Buildings[a]	Buildings with Cooling	Cooling Energy Sources[b]		
			Electricity	Natural Gas	District Chilled Water
All Buildings[a]	4,645	3,625	3,589	17	33
Building Floorspace (ft^2)					
1,001–5,000	54.9%	50.8%	51.2%	Q	Q
5,001–10,000	19.1%	20.2%	20.3%	Q	Q
10,001–25,000	15.9%	17.4%	17.2%	Q	Q
25,001–50,000	5.2%	6.0%	5.9%	Q	18.2%
50,001–100,000	2.8%	3.3%	3.2%	Q	15.2%
100,001–200,000	1.4%	1.7%	1.5%	Q	18.2%
200,001–500,000	0.5%	0.6%	0.6%	Q	6.1%
Over 500,000	0.2%	0.2%	0.1%	Q	3.0%
Principal Building Activity					
Education	8.3%	9.7%	9.4%	Q	42.4%
Food Sales	4.9%	5.8%	5.8%	N/R	N/R
Food Service	6.4%	7.8%	7.9%	Q	Q
Health Care	2.8%	3.6%	3.6%	0.0%	3.0%
Lodging	3.1%	3.6%	3.6%	Q	Q
Retail (Other Than Mall)	9.5%	11.2%	11.3%	Q	Q
Office	17.7%	21.8%	21.8%	Q	27.3%
Public Assembly	6.0%	5.9%	5.9%	Q	9.1%
Public Order and Safety	1.5%	1.7%	1.7%	Q	Q
Religious Worship	8.0%	8.5%	8.6%	Q	Q
Service	13.4%	10.2%	10.3%	Q	N/R
Warehouse and Storage	12.9%	7.3%	7.3%	Q	Q
Other	1.7%	1.6%	1.6%	Q	Q
Vacant	3.9%	1.4%	1.4%	N/R	Q
Year Constructed					
Before 1920	7.1%	6.4%	6.4%	Q	Q
1920–1945	11.3%	10.5%	10.6%	Q	Q
1946–1959	12.1%	11.9%	11.9%	Q	12.1%
1960–1969	12.5%	12.9%	12.8%	Q	12.1%
1970–1979	15.7%	16.8%	16.9%	Q	15.2%
1980–1989	15.2%	15.9%	15.9%	Q	15.2%
1990–1999	18.9%	19.2%	19.1%	Q	24.2%
2000–2003	7.2%	6.5%	6.5%	Q	Q
Census Region and Division					
Northeast	15.6%	14.3%	14.3%	41.2%	18.2%
Midwest	27.3%	26.4%	26.5%	Q	12.1%
South	38.2%	40.8%	40.9%	Q	42.4%
West	18.9%	18.5%	18.4%	Q	27.3%
Cooling Equipment[b]					
Central Air Conditioners	21.7%	27.8%	28.0%	Q	Q
Heat Pumps	10.6%	13.6%	13.7%	47.1%	3.0%
Individual Air Conditioners	16.0%	20.5%	20.7%	Q	6.1%
District Chilled Water	0.7%	0.9%	0.3%	Q	100.0%
Central Chillers	2.4%	3.1%	3.0%	29.4%	Q
Packaged A/C Units	34.7%	44.5%	44.9%	23.5%	12.1%
Swamp Coolers	2.6%	3.4%	3.4%	Q	Q
Other	0.9%	1.1%	0.8%	Q	Q

a Figures in this table do not include enclosed malls and strip malls.
b More than one may apply.
Q = Data withheld because the Relative Standard Error (RSE) was >50%, or <20 buildings were sampled.
N/R = No responding cases in sample.

Source: U.S. DOE, 2008b.

Table 19-24. Summary Statistics for Residential Air Exchange Rates (in ACH),[a] by Region

	West Region	Midwest Region	Northeast Region	South Region	All Regions
Arithmetic Mean	0.66	0.57	0.71	0.61	0.63
Arithmetic Standard Deviation	0.87	0.63	0.60	0.51	0.65
Geometric Mean	0.47	0.39	0.54	0.46	0.46
Geometric Standard Deviation	2.11	2.36	2.14	2.28	2.25
10th Percentile	0.20	0.16	0.23	0.16	0.18
50th Percentile	0.43	0.35	0.49	0.49	0.45
90th Percentile	1.25	1.49	1.33	1.21	1.26
Maximum	23.32	4.52	5.49	3.44	23.32

[a] ACH = Air changes per hour.

Source: Koontz and Rector, 1995.

Table 19-25. Summary of Major Projects Providing Air Exchange Measurements in the PFT Database

Project Code	State	Month(s)[a]	Number of Measurements	Mean Air Exchange Rate (ACH)	SD[b]	Percentiles				
						10th	25th	50th	75th	90th
ADM	CA	5–7	29	0.70	0.52	0.29	0.36	0.48	0.81	1.75
BSG	CA	1, 8–12	40	0.53	0.30	0.21	0.30	0.40	0.70	0.90
GSS	AZ	1–3, 8–9	25	0.39	0.21	0.16	0.23	0.33	0.49	0.77
FLEMING	NY	1–6, 8–12	56	0.24	0.28	0.05	0.12	0.22	0.29	0.37
GEOMET1	FL	1,6–8, 10–12	18	0.31	0.16	0.15	0.18	0.25	0.48	0.60
GEOMET2	MD	1–6	23	0.59	0.34	0.12	0.29	0.65	0.83	0.92
GEOMET3	TX	1–3	42	0.87	0.59	0.33	0.51	0.71	1.09	1.58
LAMBERT1	ID	2–3, 10–11	36	0.25	0.13	0.10	0.17	0.23	0.33	0.49
LAMBERT2	MT	1–3, 11	51	0.23	0.15	0.10	0.14	0.19	0.26	0.38
LAMBERT3	OR	1–3, 10–12	83	0.46	0.40	0.19	0.26	0.38	0.56	0.80
LAMBERT4	WA	1–3, 10–12	114	0.30	0.15	0.14	0.20	0.30	0.39	0.50
LBL1	OR	1–4, 10–12	126	0.56	0.37	0.28	0.35	0.45	0.60	1.02
LBL2	WA	1–4, 10–12	71	0.36	0.19	0.18	0.25	0.32	0.42	0.52
LBL3	ID	1–5, 11–12	23	1.03	0.47	0.37	0.73	0.99	1.34	1.76
LBL4	WA	1–4, 11–12	29	0.39	0.27	0.14	0.18	0.36	0.47	0.63
LBL5	WA	2–4	21	0.36	0.21	0.13	0.19	0.30	0.47	0.62
LBL6	ID	3–4	19	0.28	0.14	0.11	0.17	0.26	0.38	0.55
NAHB	MN	1–5, 9–12	28	0.22	0.11	0.11	0.16	0.20	0.24	0.38
NYSDH	NY	1–2, 4, 12	74	0.59	0.37	0.28	0.37	0.50	0.68	1.07
PEI	MD	3–4	140	0.59	0.45	0.15	0.26	0.49	0.83	1.20
PIERCE	CT	1–3	25	0.80	1.14	0.20	0.22	0.38	0.77	2.35
RTI1	CA	2	45	0.90	0.73	0.38	0.48	0.78	1.08	1.52
RTI2	CA	7	41	2.77	2.12	0.79	1.18	2.31	3.59	5.89
RTI3	NY	1–4	397	0.55	0.37	0.26	0.33	0.44	0.63	0.94
SOCAL1	CA	3	551	0.81	0.66	0.29	0.44	0.66	0.94	1.43
SOCAL2	CA	7	408	1.51	1.48	0.35	0.59	1.08	1.90	3.11
SOCAL3	CA	1	330	0.76	1.76	0.26	0.37	0.48	0.75	1.11
UMINN	MN	1–4	35	0.36	0.32	0.17	0.20	0.28	0.40	0.56
UWISC	WI	2–5	57	0.82	0.76	0.22	0.33	0.55	1.04	1.87

[a] 1 = January, 2 = February, etc.
[b] SD = Standard deviation.

Source: Adapted from Versar, 1990.

Table 19-26. Distributions of Residential Air Exchange Rates (in ACH)[a] by Climate Region and Season

Climate Region[b]	Season	Sample Size	Arithmetic Mean	Standard Deviation	Percentiles				
					10th	25th	50th	75th	90th
Coldest	Winter	161	0.36	0.28	0.11	0.18	0.27	0.48	0.71
	Spring	254	0.44	0.31	0.18	0.24	0.36	0.53	0.80
	Summer	5	0.82	0.69	0.27	0.41	0.57	1.08	2.01
	Fall	47	0.25	0.12	0.10	0.15	0.22	0.34	0.42
Colder	Winter	428	0.57	0.43	0.21	0.30	0.42	0.69	1.18
	Spring	43	0.52	0.91	0.13	0.21	0.24	0.39	0.83
	Summer	2	1.31	-	-	-	-	-	-
	Fall	23	0.35	0.18	0.15	0.22	0.33	0.41	0.59
Warmer	Winter	96	0.47	0.40	0.19	0.26	0.39	0.58	0.78
	Spring	165	0.59	0.43	0.18	0.28	0.48	0.82	1.11
	Summer	34	0.68	0.50	0.27	0.36	0.51	0.83	1.30
	Fall	37	0.51	0.25	0.30	0.30	0.44	0.60	0.82
Warmest	Winter	454	0.63	0.52	0.24	0.34	0.48	0.78	1.13
	Spring	589	0.77	0.62	0.28	0.42	0.63	0.92	1.42
	Summer	488	1.57	1.56	0.33	0.58	1.10	1.98	3.28
	Fall	18	0.72	1.43	0.22	0.25	0.42	0.46	0.74

[a] ACH = air changes per hour.

[b] The coldest region was defined as having 7,000 or more heating degree days, the colder region as 5,500–6,999 degree days, the warmer region as 2,500–5,499 degree days, and the warmest region as fewer than 2,500 degree days.

\- Few observations for summer results in colder regions. Data not available.

Source: Murray and Burmaster, 1995.

Table 19-27. Air Exchange Rates in Commercial Buildings by Building Type

Building Type	*N*	Mean (ACH[a])	SD	10th Percentile	Range (ACH)
Educational	7	1.9			0.8 to 3.0
Office (<100,000 ft^2)	8	1.5			0.3 to 4.1
Office (>100,000 ft^2)	14	1.8			0.7 to 3.6
Libraries	3	0.6			0.3 to 1.0
Multi-use	5	1.4			0.6 to 1.9
Naturally ventilated	3	0.8			0.6 to 0.9
Total (all commercial)	40	1.5	0.87	0.60[b]	0.3 to 4.1

[a] ACH = air changes per hour.

[b] Calculated from data presented in Turk et al. (1987), Table IV.C.1.

N = Number of observations.

SD = Standard deviation.

Source: Turk et al., 1987.

Table 19-28. Statistics of Estimated Normalized Leakage Distribution Weighted for all Dwellings in the United States

House Code	Estimated normalized leakage percentiles							Estimated	
	5th	10th	25th	50th	75th	90th	95th	GM	GSD
Low income	0.30	0.39	0.62	0.98	1.5	2.2	2.7	0.92	1.9
Conventional	0.17	0.21	0.31	0.48	0.75	1.1	1.4	0.49	1.9
Whole U.S.	0.17	0.22	0.33	0.52	0.84	1.3	1.7	0.54	2.0

GM = Geometric mean.
GSD = Geometric standard deviation.

Source: Chan et al., 2005.

Table 19-29. Particle Deposition During Normal Activities

Particle Size Range	Particle Removal Rate (hour^{-1})
1–5	0.5
5–10	1.4
10–25	2.4
>25	4.1

Source: Adapted from Thatcher and Layton, 1995.

Table 19-30. Deposition Rates for Indoor Particles

Size Fraction	Deposition Rate (hour^{-1})
$PM_{2.5}$	0.39
PM_{10}	0.65
Coarse	1.0

Source: Adapted from Wallace, 1996.

Table 19-31. Measured Deposition Loss Rate Coefficients (hour^{-1})

Median particle diameter (µm)	Fans off			Room core airspeed 5.4 cm/second			Room core airspeed			Room core airspeed 19.1 cm/second		
	Bare room surfaces	Carpeted room	Fully furnished	Bare room surfaces	Carpeted room	Fully furnished	Bare room surfaces	Carpeted room	Fully furnished	Bare room surfaces	Carpeted room	Fully furnished
0.55	1.10	0.12	0.20	0.10	0.13	0.23	0.09	0.18	0.23	0.14	0.16	0.27
0.65	0.10	0.12	0.20	0.10	0.13	0.23	0.10	0.19	0.24	0.14	0.17	0.28
0.81	0.10	0.11	0.19	0.10	0.15	0.24	0.11	0.19	0.27	0.15	0.19	0.30
1.00	0.13	0.12	0.21	0.12	0.20	0.28	0.15	0.23	0.33	0.20	0.25	0.38
1.24	0.20	0.18	0.29	0.18	0.28	0.38	0.25	0.34	0.47	0.33	0.38	0.53
1.54	0.32	0.28	0.42	0.27	0.39	0.54	0.39	0.51	0.67	0.51	0.59	0.77
1.91	0.49	0.44	0.61	0.42	0.58	0.75	0.61	0.78	0.93	0.80	0.89	1.11
2.37	0.78	0.70	0.93	0.64	0.84	1.07	0.92	1.17	1.32	1.27	1.45	1.60
2.94	1.24	1.02	1.30	0.92	1.17	1.46	1.45	1.78	1.93	2.12	2.27	2.89
3.65	1.81	1.37	1.93	1.28	1.58	1.93	2.54	2.64	3.39	3.28	3.13	3.88
4.53	2.83	2.13	2.64	1.95	2.41	2.95	3.79	4.11	4.71	4.55	4.60	5.46
5.62	4.41	2.92	3.43	3.01	3.17	3.51	4.88	5.19	5.73	6.65	5.79	6.59
6.98	5.33	3.97	4.12	4.29	4.06	4.47	6.48	6.73	7.78	10.6	8.33	8.89
8.66	6.79	4.92	5.45	6.72	5.55	5.77	8.84	8.83	10.5	12.6	11.6	11.6

Source: Thatcher et al., 2002.

Table 19-32. Total Dust Loading for Carpeted Areas

Household	Total Dust Load (g/m^2)	Fine Dust (<150 µm) Load (g/m^2)
1	10.8	6.6
2	4.2	3.0
3	0.3	0.1
4	2.2; 0.8	1.2; 0.3
5	1.4; 4.3	1.0; 1.1
6	0.8	0.3
7	6.6	4.7
8	33.7	23.3
9	812.7	168.9

Source: Adapted from Roberts et al., 1991.

Table 19-33. Particle Deposition and Resuspension During Normal Activities

Particle Size Range (μm)	Particle Deposition Rate ($hour^{-1}$)	Particle Resuspension Rate ($hour^{-1}$)
0.3–0.5	(not measured)	9.9×10^{-7}
0.6–1	(not measured)	4.4×10^{-7}
1–5	0.5	1.8×10^{-5}
5–10	1.4	8.3×10^{-5}
10–25	2.4	3.8×10^{-4}
>25	4.1	3.4×10^{-5}

Source: Adapted from Thatcher and Layton, 1995.

Table 19-34. Dust Mass Loading after 1 Week without Vacuum Cleaning

Location in Test House	Dust Loading (g/m^2)
Tracked area of downstairs carpet	2.20
Untracked area of downstairs carpet	0.58
Tracked area of linoleum	0.08
Untracked area of linoleum	0.06
Tracked area of upstairs carpet	1.08
Untracked area of upstairs carpet	0.60
Front doormat	43.34

Source: Adapted from Thatcher and Layton, 1995.

Table 19-35. Simplified Source Descriptions for Airborne Contaminants

Description	Components	Dimensions
Direct emission rate		
Combustion emission rate	$E_f H_f M_f$	g hour^{-1}
	E_f = emission factor	g J^{-1}
	H_f = fuel content	J mol^{-1}
	M_f = fuel consumption rate	mol hour^{-1}
Volume emission rate	$Q_p C_{p\_} \varepsilon$	g hour^{-1}
	Q_p = volume delivery rate	m^3 hour^{-1}
	C_p = concentration in carrier	g m^{-3}
	ε = transfer efficiency	g g^{-1}
Mass emission rate	$M_p w_e \varepsilon$	g hour^{-1}
	M_p = mass delivery rate	g hour^{-1}
	w_e = weight fraction	g g^{-1}
	ε = transfer efficiency	g g^{-1}
Diffusion limited emission rate	$(D_f \delta^{-1})(C_s - C_i)A_i$	g hour^{-1}
	D_f = diffusivity	m^2 hour^{-1}
	δ^{-1} = boundary layer thickness	meters
	C_s = vapor pressure of surface	g m^{-3}
	C_i = room concentration	g m^{-3}
	A_i = area	m^2
Exponential emission rate	$A_i E_o e^{-k t}$	g hour^{-1}
	A_i = area	m^2
	E_o = initial unit emission rate	g hour^{-1} m^{-2}
	k = emission decay factor	hour^{-1}
	t = time	hours
Transport		
Infiltration	$Q_{ii} C_i$	g hour^{-1}
Interzonal	Q_{ii} = air flow from zone j	m^3 hour^{-1}
Soil gas	C_i = air concentration in zone j	g m^{-3}

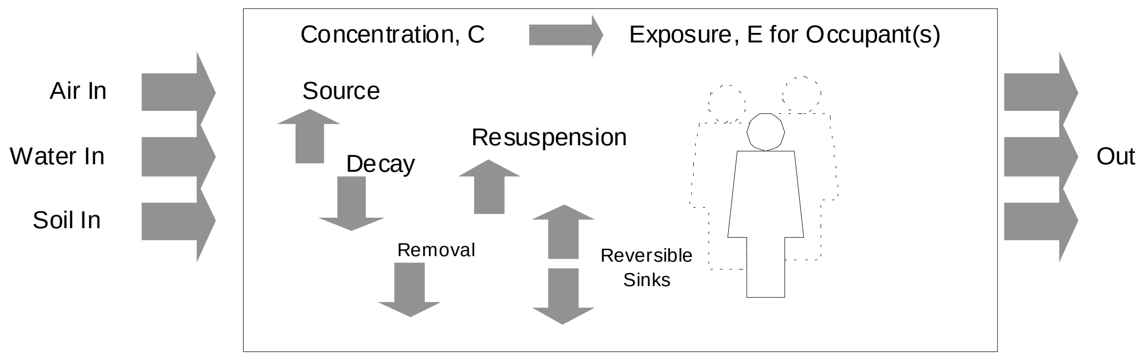

Figure 19-1. Elements of Residential Exposure.

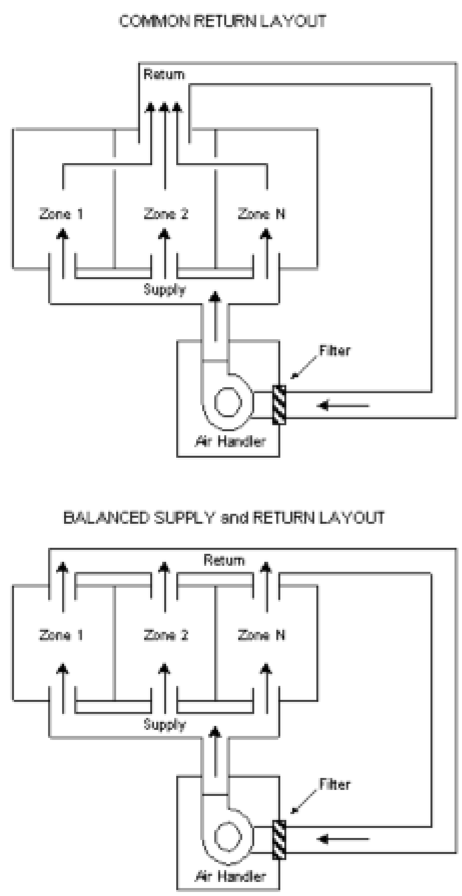

Figure 19-2. Configuration for Residential Forced-Air Systems.

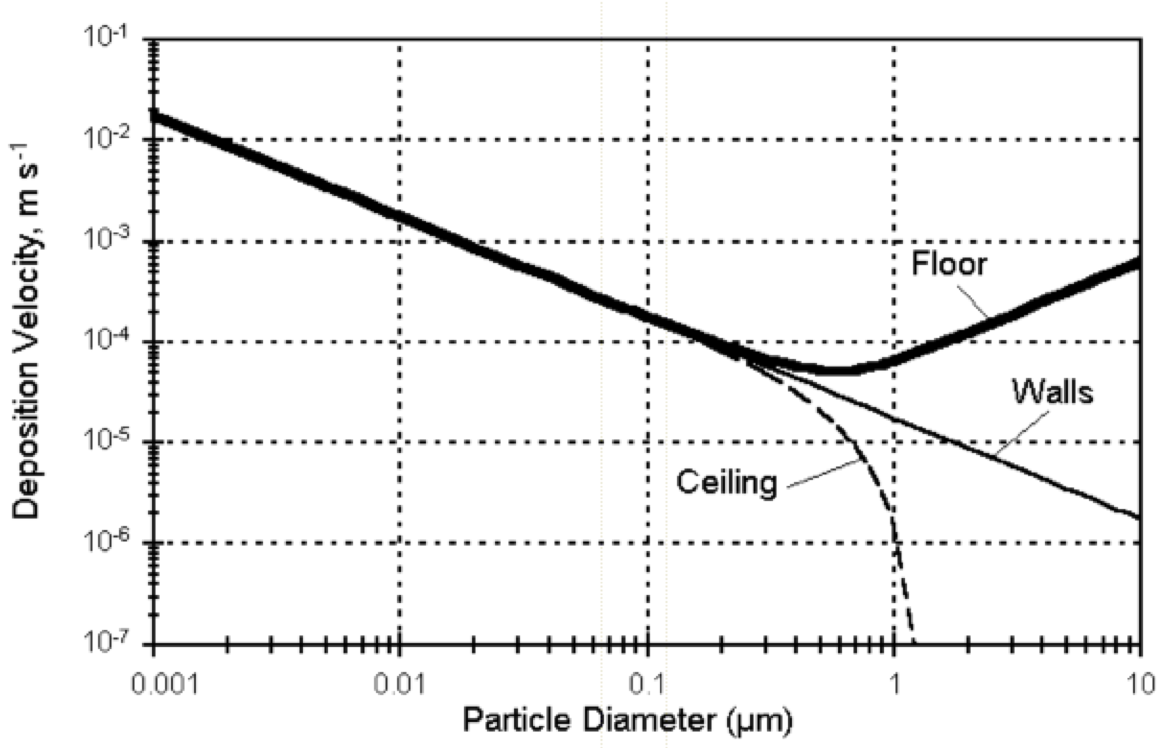

Figure 19-3. Idealized Patterns of Particle Deposition Indoors.

Source: Adapted from Nazaroff and Cass, 1989a.

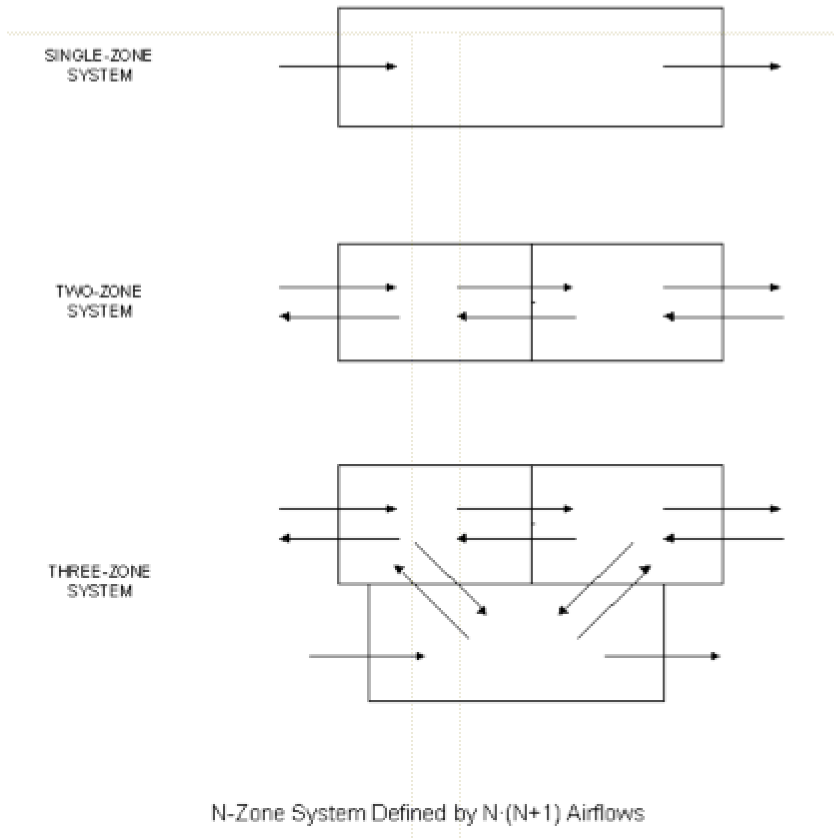

Figure 19-4. Air Flows for Multiple-Zone Systems.

GLOSSARY OF TERMS

Absorbed dose—The amount of an agent that enters a target by crossing an exposure surface that acts as an absorption barrier. See also ***Absorption barrier, Dose, and Internal dose.***

Absorption barrier—Any exposure surface that may retard the rate of penetration of an agent into a target. Examples include the skin, respiratory tract lining, and gastrointestinal tract wall.

Activity pattern data—Information on human activities used in exposure assessments. These may include a description of the activity, frequency of activity, duration spent performing the activity, and the microenvironment in which the activity occurs.

Acute exposure—A single exposure to a toxic substance which may result in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day, as compared to longer, continuing exposure over a period of time.

Adherence factor—The amount of a material (e.g., soil) that adheres to the skin per unit of surface area.

Activity pattern (time use) data—Information on activities in which various individuals engage, length of time spent performing various activities, locations in which individuals spend time and length of time spent by individuals within those various environments.

Age dependent adjustment factor (ADAF)—In cases where age-related differences in toxicity occur, differences in both toxicity and exposure need to be integrated across all relevant age intervals, by the use of age dependent potency adjustment factors (ADAFs). This is a departure from the way cancer risks have historically been calculated based upon the premise that risk is proportional to the daily average of the long-term adult dose.

Agent—Refers to a chemical, biological, or physical entity that contacts a ***target***.

Aggregate exposure—The combined exposure of an individual (or defined population) to a specific agent or stressor via relevant routes, pathways, and sources. Total exposure can include exposure through multiple routes (e.g., dermal, inhalation, and ingestion).

Agricultural commodity—Used by U.S. EPA to mean plant (or animal) parts consumed by humans as food. When such items are raw or unprocessed, they are referred to as "raw agricultural commodities."

Air exchange rate—Rate of air leakage through windows, doorways, intakes and exhausts, and “adventitious openings” (i.e., cracks and seams) that combine to form the leakage configuration of the building envelope plus natural and mechanical ventilation.

All water sources—Includes water from all supply sources such as community water supply (i.e., tap water), bottled water, etc.

Analytical uncertainty propagation—Examining how uncertainty in individual parameters affects the overall uncertainty of the exposure assessment.

Anthropometric—The study of human body measurements for use in anthropological classification and comparison.

As-consumed intake—Intake rate based on the weight of the food in the form that it is consumed (e.g., cooked or prepared).

Assessment—A determination or appraisal of possible consequences resulting from an analysis of data.

Average Daily Dose (ADD)—The mean amount of an agent to which a person is exposed on a daily basis, often averaged over a long period of time. U.S. EPA is transitioning from average daily dose methodologies to more refined aggregate and cumulative approaches for estimating exposure across each lifestage. See also ***Lifetime average daily dose (LADD)*** and ***Time-averaged exposure*****.**

Bayesian Analysis—Bayesian analysis is a method of statistical inference in which the knowledge of prior events is used to predict future events. Bayes’ Theorem is a means of quantifying uncertainty.

Benchmark Dose or Concentration—An exposure due to a dose or concentration of a substance associated with a specified low incidence of risk, generally in the range of 1% to 10%, of a health effect; or the dose or concentration associated with a specified measure or change of a biological effect.

Best Tracer Method (BTM)—Method for estimating soil ingestion that allows for the selection of the most recoverable tracer for a particular subject or group of subjects. Selection of the best tracer is made on the basis of the food/soil (F/S) ratio.

Bioaccumulate—The increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted.

Bias—A systematic error inherent in a method or caused by some feature of the measurement system.

Bioavailability—The rate and extent to which an agent can be absorbed by an organism and is available for metabolism or interaction with biologically significant receptors. Bioavailability involves both release from a medium (if present) and absorption by an organism.

Bioconcentrate—The accumulation of a chemical in tissues of a fish or other organism to levels greater than in the surrounding medium.

Biokinetic model comparison—A methodology that compares direct measurements of a biomarker such as blood or urine levels of a toxicant with predictions from a biokinetic model.

Biological marker or biomarker—An indicator of changes or events in biological systems. Biological markers of exposure are cellular, biochemical, analytical, or molecular measures that are obtained from biological media such as tissues, cells, or fluids and are indicative of exposure to an agent. Biomarkers of effect are quantifiable changes, indicating exposure to a compound, while biomarkers of susceptibility are characteristics that make an individual susceptible to the effects of an exposure.

Biomarker model comparison—A methodology that compares results from a biokinetic exposure model to biomarker measurements children blood. The method is used to confirm assumptions about ingested soil and dust quantities in this handbook.

Basal Metabolic Rate (BMR)—Minimum level of energy required to maintain normal body functions.

Body Mass Index (BMI)—The ratio of weight and height squared.

Bootstrap—A statistical method of resampling data use to estimate variance and bias of an estimator and provide confidence intervals for parameters.

Bounding estimate—An estimate of exposure, dose, or risk that is higher or lower than that incurred by the person with the highest or lowest exposure, dose, or risk in the population being assessed. Bounding estimates are useful in developing statements that exposures, doses, or risks are "not greater than" or “less than” the estimated value, because assumptions are used which define the likely bounding conditions.

Central tendency exposure—A measure of the middle or the center of an exposure distribution. The mean is the most commonly used measure of central tendency.

Chronic exposure—Repeated exposure by the oral, dermal, or inhalation route for more than approximately 10% of the life span in humans (more than approximately 90 days to 2 years in typically used laboratory animal species).

Chronic intake—The long term period over which a substance crosses the outer boundary of an organism without passing an absorption barrier.

Classical statistical methods—Estimating the population exposure distribution directly, based on measured values from a representative sample**.**

Coating—Method used to measure skin surface area, in which either the whole body or specific body regions are coated with a substance of known density and thickness.

Community water—Includes tap water ingested from community or municipal water supply.

Comparability—The ability to describe likenesses and differences in the quality and relevance of two or more data sets.

Concentration—Amount of a material or agent dissolved or contained in unit quantity in a given medium or system.

Confidence intervals—An estimated range of values with a given probability of including the population parameter of interest. The range of values is usually based on the results of a sample that estimated the mean and the sampling error or standard error.

Consumer-only intake rate—The average quantity of food consumed per person in a population composed only of individuals who ate the food item of interest during a specified period.

Contact boundary—The surface on a ***target*** where an *agent* is present. Examples of outer exposure surfaces include the exterior of an eyeball, the skin surface, and a conceptual surface over the nose and open mouth. Examples of inner exposure surfaces include the gastrointestinal tract, the respiratory tract, and the urinary tract lining. As an exposure surface gets smaller, the limit is an ***exposure point****.* It is also referred to as an ***exposure surface***.

Contaminant concentration—Contaminant concentration is the concentration of the contaminant in the medium (air, food, soil, etc.) contacting the body and has units of mass/volume or mass/mass.

Creel study—A study in which fishermen are interviewed while fishing.

Cumulative exposure—Exposure via mixtures of contaminants both indoors and outdoors. Exposure may also occur through more than one pathway. New directions in risk assessments in U.S. EPA put more emphasis on total exposures via multiple pathways.

Deposition—The removal of airborne substances to available surfaces that occurs as a result of gravitational settling and diffusion, as well as electrophoresis and thermophoresis.

Dermal absorption—A route of exposure by which substances can enter the body through the skin.

Dermal adherence—The loading of a substance onto the outer surface of the skin.

Diary study—Survey in which individuals are asked to record food intake, activities, or other factors in a diary which is later used to evaluate exposure factors associated with specific populations.

Direct water ingestion—Consumption of plain water as a beverage. It does not include water used for preparing beverages such as coffee or tea.

Distribution—A set of values derived from a specific population or set of measurements that represents the range and array of data for the factor being studied.

Doers—Survey respondents who report participating in a specified activity.

Dose—The amount of an agent that enters a target after crossing an exposure surface. If the exposure surface is an absorption barrier, the dose is an ***absorbed dose***. If the exposure surface is not an absorption barrier, the dose is an ***intake dose***.

Dose rate—Dose per unit time.

Dose-response assessment—Analysis of the relationship between the total amount of an agent administered to, taken up by, or absorbed by an organism, system, or target population and the changes developed in that organism, system, or target population in reaction to that agent, and inferences derived from such an analysis with respect to the entire population. Dose-response assessment is the second of four steps in risk assessment.

Dose-response curve—Graphical presentation of a dose-response relationship.

Dose-response relationship—The resulting biological responses in an organ or organism expressed as a function of a series of doses.

Dressed weight—The portion of the harvest brought into kitchens for use, including bones for particular species.

Drinking water— All fluids consumed by individuals to satisfy body needs for internal water.

Dry-weight intake rates—Intake rates that are based on the weight of the food consumed after the moisture content has been removed.

Dust Ingestion—Consumption of dust that results from various behaviors including, but not limited to, mouthing objects or hands, eating dropped food, consuming dust directly, or inhaling dust that passes from the respiratory system into the gastrointestinal tract.

Effect—Change in the state or dynamics of an organism, system, or (sub) population caused by exposure to an agent.

Employer tenure—The length of time a worker has been with the same employer.

Energy expenditures—The amount of energy expended by an individual during activities.

Exclusively breast fed—Infants whose sole source of milk comes from human milk with no other milk substitutes.

Exposed foods—Foods grown above ground.

Exposure—Contact between an agent and a target.

Exposure assessment—The process of estimating or measuring the magnitude, frequency, and duration of exposure to an agent, along with the number and characteristics of the population exposed.

Exposure concentration—The concentration of a chemical in its transport or carrier medium at the point of contact.

Exposure duration—Length of time over which contact with the contaminant lasts.

Exposure event—The occurrence of continuous contact between an agent and a target.

Exposure factor—Factors related to human behavior and characteristics that help determine an individual's exposure to an agent.

Exposure frequency—The number of exposure events in an exposure duration.

Exposure loading—The exposure mass divided by the exposure surface area. For example, a dermal exposure measurement based on a skin wipe sample, expressed as a mass of residue per skin surface area, is an exposure loading.

Exposure pathway—The physical course a chemical takes from the source to the organism exposed.

Exposure route—The way a chemical pollutant enters an organism after contact, e.g., by ingestion, inhalation, or dermal absorption.

Exposure scenario—A set of facts, assumptions, and interferences about how exposure takes place that aids the exposure assessor in evaluating estimating, or quantifying exposures.

Exposure surface—See contact boundary.

Fate—Pattern of distribution of an agent, its derivatives, or metabolites in an organism, system, compartment, or population of concern as a result of transport, partitioning, transformation, or degradation.

Foremilk—Milk produced at the beginning of breastfeeding.

General population—The total of individuals inhabiting an area or making up a whole group.

Geographic information system (GIS)—GIS is a system of hardware and software that captures, stores, analyzes, manages, and presents geographic data.

Geometric mean—The n^{th} root of the product of n values.

Geophagy—A form of soil ingestion involving the intentional ingestion of earths, usually associated with cultural practices.

Hazard—Inherent property of an agent or situation having the potential to cause adverse effects when an organism, system, or population is exposed to that agent.

Hazard assessment—A process designed to determine the possible adverse effects of an agent or situation to which an organism, system, or target population could be exposed. The process typically includes hazard identification, dose-response evaluation and hazard characterization. The process focuses on the hazard, in contrast to risk assessment, where exposure assessment is a distinct additional step.

High-end exposure—An estimate of individual exposure or dose for those persons at the upper end of an exposure or dose distribution, conceptually above the 90^{th} percentile, but not higher than the individual in the population who has the highest exposure or dose. See also Bounding estimate.

Hindmilk—Milk produced at the end of the breastfeeding.

Home-produced foods—Fruits and vegetables produced by home gardeners, meat and dairy products derived form consumer-raised livestock, game meat, and home caught fish.

Human Equivalent Concentration or Dose—The human concentration (for inhalation exposure) or dose (for other routes of exposure) of an agent that is believed to induce the same magnitude of toxic effect as the experimental animal species concentration or dose. This adjustment may incorporate toxicokinetic information on the particular agent, if available, or use a default procedure, such as assuming that daily oral doses experienced for a lifetime are proportional to body weight raised to the 0.75 power.

Indirect water ingestion—Includes water added during food preparation, but not water intrinsic to purchased foods. Indirect water includes for example, water used to prepare baby formulas, cake mix, and concentrated orange juice.

Indoor settled dust—Particles in building interiors that have settled onto objects, surfaces, floors, and carpeting. These particles may include soil particles that have been tracked into the indoor environment from outdoors.

Infiltration—Air leakage through random cracks, interstices, and other unintentional openings in the building envelope.

Inhalation dosimetry—Process of measuring or estimating inhaled dose.

Inhalation unit risk—The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air for a lifetime.

Inhaled dose—The amount of an inhaled substance that is available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism.

Insensible water loss—Evaporative water losses that occur during breastfeeding. Corrections are made to account for insensible water loss when estimating breast milk intake using the test weighing method.

Intake—The process by which a substance crosses the outer boundary of an organism without passing an absorption barrier (e.g., through ingestion or inhalation).

Intake dose—The amount of an agent that enters a target by crossing an exposure surface that does not act as an absorption barrier. See also ***Absorption barrier*** and ***Dose.***

Intake rate—Rate of inhalation, ingestion, and dermal contact depending on the route of exposure. For ingestion, the intake rate is simply the amount of food containing the contaminant of interest that an individual ingests during some specific time period (units of mass/time). For inhalation, the intake rate is the rate at which contaminated air is inhaled. Factors that affect dermal exposure are the amount of material that comes into contact with the skin, and the rate at which the contaminant is absorbed.

Inter-individual variability—Variations between individuals in terms of human characteristics such as age or body weight, or behaviors such as location, activity patterns, and ingestion rates.

Internal dose—The amount of an agent that enters a target by crossing an exposure surface that acts as an absorption barrier. Synonymous with absorbed dose. See also ***Absorption barrier and Dose.***

Interzonal air flows—Transport of air through doorways, ductwork, and service chaseways that interconnect rooms or zones within a building.

Intra-individual variability—Fluctuations in an individual's physiologic (e.g., body weight), or behavioral characteristics (e.g., ingestion rates or activity patterns).

Key study—A study that is the most up-to-date and scientifically sound for deriving recommendations for exposure factors. Alternatively, studies may be classified as "relevant" and not "key" for one or more of the following: (1) they provide supporting data (e.g., older studies on food intake that may be useful for trend analysis); (2) they provide information related to the factor of interest (e.g., data on prevalence of breast feeding); or (3) the study design or approach makes the data less applicable for exposure assessment purposes (e.g., studies with small sample size, studies not conducted in the United States). As new data or analyses are published, "key" studies may be moved to the "relevant" category because they are replaced by more up-to-date data or an analysis of improved quality.

Lead isotope ratio methodology—A method that measures different lead isotopes in children's blood and/or urine, food, water, and house dust and compares the ratio of these isotopes to infer sources of lead exposure that may include dust or other environmental exposures.

Life expectancy—The length of an individual's life.

Lifestage—A distinguishable time frame in an individual's life characterized by unique and relatively stable behavioral and/or physiological characteristics that are associated with development and growth.

Lifetime Average Daily Dose (LADD)—Dose rate averaged over a lifetime. The LADD is used for compounds with carcinogenic or chronic effects. The LADD is usually expressed in terms of mg/kg-day or other mass/mass-time units. Often used in carcinogen risk assessments that employ linear low-dose extrapolation methods. See also ***Average daily dose*** and ***Time-averaged exposure***.

Limiting Tracer Method (LTM)—Method for evaluating soil ingestion that assumes that the maximum amount of soil ingested corresponds with the lowest estimate from various tracer elements.

Local circulation—Convective and adjective air circulation and mixing within a room or within a zone.

Long-term exposure—Repeated exposure for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days).

Lowest-Observed-Adverse-Effect Level (LOAEL)—The lowest exposure level at which there are biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.

Margin of safety—For some experts, margin of safety has the same meaning as margin of exposure, while for others, margin of safety means the margin between the reference dose and the actual exposure.

Mass-balance/tracer techniques—Method for evaluating soil intake that accounts for both inputs and outputs of tracer elements. Tracers in soil, food, medicine and other ingested items as well as in feces and urine are accounted for.

Mean value—Simple or arithmetic average of a range of values, computed by dividing the total of all values by the number of values.

Measurement error—A systematic error arising from inaccurate measurement (or classification) of subjects on the study variables.

Measurement end-point—Measurable (ecological) characteristic that is related to the valued characteristic chosen as an assessment point.

Mechanical ventilation—Controlled air movement driven by fans. Also referred to as forced ventilation.

Median value—The value in a measurement data set such that half the measured values are greater and half are less.

Metabolic Equivalent of Work (MET)—A dimensionless energy expenditure metric used to represent an activity level.

Microenvironment—Surroundings that can be treated as homogeneous or well characterized in the concentrations of an agent (e.g., home, office, automobile, kitchen, store).

Mode of action—Defined as a sequence of key events and processes, starting with interaction of an agent with a cell, proceeding through operational and anatomical changes, and resulting in cancer formation.

Model uncertainty—Uncertainty regarding gaps in scientific theory required to make predictions on the basis of causal inferences.

Moisture content—The portion of foods made up by water. The percent water is needed for converting food intake rates and residue concentrations between whole-weight and dry-weight values.

Monte Carlo technique—A repeated random sampling from the distribution of values for each of the parameters in a generic (exposure or dose) equation to derive an estimate of the distribution of (exposures or doses in) the population.

Mouthing behavior—Activities in which objects, including fingers, are touched by the mouth or put into the mouth except for eating and drinking, and includes licking, sucking, chewing, and biting.

Natural ventilation—Airflow through open windows, doors, and other designed openings in the building envelope.

Non-dietary ingestion— Ingestion of non-food substances, typically resulting from the mouthing of hands and objects.

No-Observed-Adverse-Effect-Level (NOAEL)— The highest exposure level at which there are no biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects.

Occupational mobility—An indicator of the frequency at which workers change from one occupation to another.

Occupational tenure—The cumulative number of years a person worked in his or her current occupation, regardless of number of employers, interruptions in employment, or time spent in other occupations.

Outdoor settled dust—Particles that have settled onto outdoor objects and surfaces due to either wet or dry deposition.

Oxygen consumption (VO_2)—The rate at which oxygen is used by tissues.

Parameter uncertainty—Uncertainty regarding some parameter.

Partially breast fed—Infants whose source of milk comes from both human milk and other milk substitutes.

Pathway—The physical course a chemical or pollutant takes from the source to the organism exposed.

Physiologically-based pharmacokinetic (PBPK) modeling—PBPK modeling is an approach for predicting the absorption, distribution, metabolism and excretion of a compound in humans.

Per capita intake rate—The average quantity of food consumed per person in a population composed of both individuals who ate the food during a specified time period and those that did not.

Pica—Pica behavior is the repeated eating of non-nutritive substances, whereas soil-pica is a form of soil ingestion that is characterized by the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000–5,000 milligrams per day or more).

Plain tap water—Excludes tap water consumed in the form of juices and other beverages containing tap water.

Population mobility—An indicator of the frequency at which individuals move from one residential location to another.

Population risk descriptor—An assessment of the extent of harm to the population being addressed. It can be either an estimate of the number of cases of a particular effect that might occur in a population (or population segment), or a description of what fraction of the population receives exposures, doses, or risks greater than a specified value.

Potential dose—The amount of a chemical contained in material ingested, air breathed, or bulk material applied to the skin.

Poverty/income ratio—Ratio of reported family income to federal poverty level.

Precision—A measure of the reproducibility of a measured value under a given set of circumstances.

Preparation losses—Net cooking losses, which include dripping and volatile losses, post cooking losses, which involve losses from cutting, bones, excess fat, scraps and juices, and other preparation losses which include losses from paring or coring.

Primary data/analysis— Information gathered from observations or measurements of a phenomena or the surveying of respondents.

Probabilistic uncertainty analysis—Technique that assigns a probability density function to each input parameter, then randomly selects values from each of the distributions and inserts them into the exposure equation. Repeated calculations produce a distribution of predicted values, reflecting the combined impact of variability in each input to the calculation. Monte Carlo is a common type of probabilistic Uncertainty analysis.

Protected products—Foods that have an outer protective coating that is typically removed before consumption.

Questionnaire/survey response—A "question and answer" data collection methodology conducted via in-person interview, mailed questionnaire, or questions administered in a test format in a school setting.

Random samples—Samples selected from a statistical population such that each sample has an equal probability of being selected.

Range—The difference between the largest and smallest values in a measurement data set.

Ready-to-feed—Infant and baby products (formula, juices, beverages, baby food), and table foods that do not need to have water added to them prior to feeding.

Real-time hand recording—Method by which trained observers manually record information on children's behavior.

Reasonable maximum exposure—A semiquantitative term referring to the lower portion of the high end of the exposure, dose, or risk distribution. As a semiquantitative term, it should refer to a range that can conceptually be described as above the 90th percentile in the distribution, but below the 98th percentile.

Recreational/sport fishermen—Individuals who catch fish as part of a sporting or recreational activity and not for the purpose of providing a primary source of food for themselves or for their families.

Reference Concentration (RfC)—An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive target groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in U.S. EPA's noncancer health assessments. Durations include acute, short-term, subchronic, and chronic.

Reference Dose (RfD)—An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive target groups) that is likely to be without an appreciable risk of deleterious noncancer effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in U.S. EPA's noncancer health assessments. Durations include acute, short-term, subchronic, and chronic.

Relevant study—Studies that are applicable or pertinent, but not necessarily the most important to derive exposure factors. See also Key study.

Representativeness—The degree to which a sample is, or samples are, characteristic of the whole medium, exposure, or dose for which the samples are being used to make inferences.

Residential occupancy period—The time between a person moving into a residence and the time the person moves out or dies.

Residential volume—The volume (m^3) of the structure in which an individual resides and may be exposed to airborne contaminants.

Risk—The probability of an adverse effect in an organism, system, or population caused under specified circumstances by exposure to an agent.

Risk assessment—A process intended to calculate or estimate the risk to a given target organism, system, or population, including the identification of attendant uncertainties, following exposure to a particular agent, taking into account the inherent characteristics of the agent of concern as well as the characteristics of the specific target system. The risk assessment process includes four steps: hazard identification, hazard characterization (related term: Dose-response assessment), exposure assessment, and risk characterization. It is the first component in a risk analysis process.

Risk characterization—The qualitative and, wherever possible, quantitative determination, including attendant uncertainties, of the probability of occurrence of known and potential adverse effects of an agent in a given organism, system, or population, under defined exposure conditions. Risk characterization is the fourth step in the risk assessment process.

Risk communication—Interactive exchange of information about (health or environmental) risks among risk assessors, managers, news media, interested groups, and the general public.

Route—The way a chemical or pollutant enters an organism after contact, e.g., by ingestion, inhalation, or dermal absorption.

Sample—A small part of something designed to show the nature or quality of the whole. Exposure-related measurements are usually samples of environmental or ambient media, exposures of a small portion of a population for a short time, or biological samples, all for the purpose of inferring the nature and quality of parameters important to evaluating exposure.

Scenario uncertainty—Uncertainty regarding missing or incomplete information needed to fully define exposure and dose.

Screening-level assessment—An exposure assessment that examines exposures that would fall on or beyond the high end of the expected exposure distribution.

Secondary data/analysis—The reanalysis of data collected by other individuals or group; an analysis of data for purposes other than those for which the data were originally collected.

Sensitivity analysis—Process of changing one variable while leaving the others constant to determine its effect on the output. This procedure fixes each uncertain quantity at its credible lower and upper bounds (holding all others at their nominal values, such as medians) and computes the results of each combination of values. The results help to identify the variables that have the greatest effect on exposure estimates and help focus further information-gathering efforts.

Serving sizes—The quantities of individual foods consumed per eating occasion. These estimates may be useful for assessing acute exposures.

Short-term exposure—Repeated exposure for more than 24 hours, up to 30 days.

Slope Factor—An upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg-day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100.

Soil—Particles of unconsolidated mineral and/or organic matter from the earth’s surface that are located outdoors, or are used indoors to support plant growth.

Soil adherence—The quantity of soil that adheres to the skin and from which chemical contaminants are available for uptake at the skin surface.

Soil ingestion—The intentional or unintentional consumption of soil, resulting from various behaviors including, but not limited to, mouthing, contacting dirty hands, eating dropped food, or consuming soil directly. Soil-pica is a form of soil ingestion that is characterized by the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000–5,000 milligrams per day or more). Geophagy is also a form of soil ingestion defined as the intentional ingestion of earths and is usually associated with cultural practices.

Spatial variability—Variability across location, whether long- or short-term.

Subchronic exposure—Repeated exposure by the oral, dermal, or inhalation route for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days up to approximately 90 days in typically used laboratory animal species).

Subsistence fishermen—Individuals who consume fresh caught fish as a major source of food.

Surface area—Coating, triangulation, and surface integration are direct measurement techniques that have been used to measure total body surface area and the surface area of specific body parts. Consideration has been given for differences due to age, gender, and race. Surface integration is performed by using a planimeter and adding the areas.

Surface integration—Method used to measure skin surface area in which a planimeter is used to measure areas of the skin, and the areas of various surfaces are summed.

Survey response methodology—Responses to survey questions are analyzed. This methodology includes questions asked of children directly, or their care givers, about behaviors affecting exposures.

Target—refers to any physical, biological, or ecological object exposed to an ***agent***.

Tap water from food manufacturing—Water used in industrial production of foods.

Temporal variability—Variability over time, whether long- or short-term.

Threshold—Dose or exposure concentration of an agent below which a stated effect is not observed or expected to occur.

Time-averaged exposure—The time-integrated exposure divided by the exposure duration. An example is the daily average exposure of an individual to carbon monoxide. (Also called timeweighted average exposure.)

Total dietary intake—The sum of all foods in the following food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. It does not include beverages, sugar, candy, sweets, nuts and nut products.

Total tap water—Water consumed directly from the tap as a beverage or used in the preparation of foods and beverages (i.e., coffee, tea, frozen juices, soups, etc.).

Total fluid intake—Consumption of all types of fluids including tapwater, milk, soft drinks, alcoholic beverages, and water intrinsic to purchased foods.

Total water—Water from tap water and non tap water sources including water contained in food.

Toxicodynamics—The physiological mechanisms by which toxins are absorbed, distributed, metabolized and excreted

Toxicokinetics—The passage through the body of a toxic agent or its metabolites, usually in an action similar to that of pharmacokinetics.

Tracer-element studies—Soil ingestion studies that use trace elements found in soil and poorly metabolized in the human gut as indicators of soil intake.

Triangulation—Method used to measure skin surface area in which areas of the body are marked into geometric figures, then their linear dimensions are calculated.

Uncertainty—Uncertainty represents a lack of knowledge about factors affecting exposure or risk and can lead to inaccurate or biased estimates of exposure. The types of uncertainty include: scenario, parameter, and model.

Unit risk—The quantitative estimate in terms of either risk per µg/L drinking water (water unit risk) or risk per $\mu g/m^3$ air breathed (air unit risk).

Upper percentile—Values in the upper tail (i.e., between 90^{th} and 99.9^{th} percentile) of the distribution of values for a particular exposure factor. Values at the upper end of the distribution of values for a particular set of data.

Uptake—The process by which a substance crosses an absorption barrier and is absorbed into the body.

Usual dietary intakes— Refers to the long-term average daily intake by an individual.

Vapor intrusion—The migration of volatile chemicals from contaminated groundwater or soil into an overlying building.

Variability—Variability arises from true heterogeneity across people, places or time and can affect the precision of exposure estimates and the degree to which they can be generalized. The types of variability include: spatial, temporal, and inter-individual.

Ventilation Rate (VR)—Alternative term for inhalation rate or breathing rate. Usually measured as minute volume, i.e., volume (liters) of air exhaled per minute.

Video transcription—Method by which trained videographers tape a child's activities and subsequently extract data manually with computer software.

Wet-weight intake rates—Intake rates that are based on the wet (or whole) weight of the food consumed. This in contrast to dry-weight intake rates.

Worst case scenario—The maximum possible exposure, when everything that can plausibly happen to maximize exposure happens. The worst case represents a hypothetical individual and an extreme set of conditions that usually will not be observed in an actual population.

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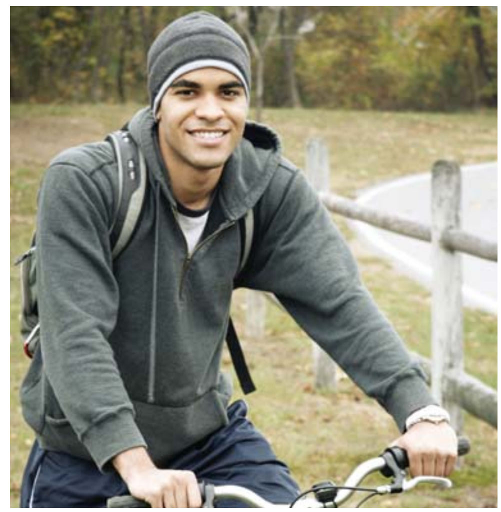

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