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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 (2009) 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 (2008) was selected as a key study of drinking water ingestion for pregnant and lactating women. Kahn and Stralka (2008) 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 (2009; 2008) 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, 2009; Kahn and Stralka, 2008). 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 3.2.1 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 (2009) 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 (2008), 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]	
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	See Table 3-7 and Table 3-11 for children <3 years old and Table 3-23 and Table 3-28 for individuals >3 years old.
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]	
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	See Table 3-15 and Table 3-19 for children <3 years old and Table 3-33 and Table 3-38 for individuals >3 years old.
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 (2009) 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 (2009); 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 (2008).

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 (2008) 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 (2008) 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] 97th 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 (2009)—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 (2009) 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, 2000). 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 (2009) 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 (2009) 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 (2009) only reported the mean and 90th and 95th percentile estimates of per capita and consumer-only ingestion. The full distributions of ingestion estimates were provided by the author (Kahn, 2008). Table 3-7 to Table 3-22 presents full distributions for the various water source categories (community water, bottled water, other sources, and all sources). Table 3-7 to Table 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). Table 3-11 to Table 3-14 present the same information as Table 3-7 to Table 3-10 but in units of mL/kg-day. Table 3-15 to Table 3-18 provide consumer-only combined direct and indirect water ingestion estimates in mL/day for the various source categories. Table 3-19 to Table 3-22 present the same information as Table 3-15 to Table 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 (2009). 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 (U.S. EPA, 2000; USDA, 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.

Table 3-23 to Table 3-42 present full distributions for the various water source categories (community water, bottled water, other sources, and all sources). Table 3-23 to Table 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 90th and 95th percentiles of total water ingestion from all water sources. Table 3-28 to Table 3-32 present the same information as Table 3-23 to Table 3-27 but in units of mL/kg-day. Table 3-33 to Table 3-36 provide consumer-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. Table 3-38 to Table 3-42 present the same information as Table 3-33 to Table 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 consumer-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: Starling (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 Table 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 10th and 90th percentile intakes, expressed as both mL/day and mL/kg-day as a function of age. This shows that the mean and 90th 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 90th 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 Table 3-64 and Table 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 (2009) 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. (2003b)—Patterns of Beverage Consumption During the Transition Stage of Infant Nutrition*

Marshall et al. (2003b) 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., 2003b). 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., 2003b). 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., 2003b). Marshall et al. (2003b) 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. (2003a)—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. (2003a) 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. (2003a) 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 Infants 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 (2008)—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 (2008) 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. Table 3-75 through Table 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. Table 3-83 and Table 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: 25th = 0.5 L/day, 50th = 1.4 L/day, 75th = 2.4 L/day, and 90th = 3.8 L/day). The overall mean bottled water ingested was 0.6 L/day (percentiles: 25th = 0.1 L/day, 50th = 0.2 L/day, 75th = 0.6 L/day, and 90th = 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*" (FASEB/LSRO, 1995).

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

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

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)

[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* (FASEB/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* (FASEB/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* (FASEB/LSRO, 1995).

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

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

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)

[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*" (FASEB/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* (FASEB/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* (FASEB/LSRO, 1995).

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

			Percentile						
Age	**Sample Size**	**Mean**	**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

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)

[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* (FASEB/LSRO, 1995).

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

Table 3-15. Consumer-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*" (FASEB/LSRO, 1995).

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

Table 3-16. Consumer-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* (FASEB/LSRO, 1995).

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

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

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

[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* (FASEB/LSRO, 1995).

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

Table 3-18. Consumer-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* (FASEB/LSRO, 1995).

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

Table 3-19. Consumer-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* (FASEB/LSRO, 1995).

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

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

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

[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* (FASEB/LSRO, 1995).

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

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

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

[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* (FASEB/LSRO, 1995).

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

Table 3-22. Consumer-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* (FASEB/LSRO, 1995).

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

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

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

[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.

		Mean			90th percentile			95th percentile		
			90% CI			90% BI			90% BI	
Age	Sample Size	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

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)

[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.

			Percentile						
Age	Sample Size	Mean	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

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)

[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.

		Mean			90th percentile			95th percentile		
			90% CI			90% BI			90% BI	
Age	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	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

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)

[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. Consumer-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. Consumer-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. Consumer-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. Consumer-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. Consumer-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		
			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	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. Consumer-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. Consumer-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. Consumer-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. Consumer-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.

		Mean			90th percentile			95th percentile		
Age	Sample Size	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

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)

[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								
	All Individuals					Consumers Only[a]		
Beverage	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).

Amount Consumed[a] L/day	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

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

Age Group (years)

[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)

Activity Level[a]	Work		Spare Time	
	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]													
	Number of Observations					Percentile Distribution								
Age (years)	Actual Count	Weighted Count	Mean	SD	SE of Mean	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	10th–90th Percentiles	Mean	10th–90th 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).

Age (years)	Source	% of Tap Water							
		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							

Table 3-59. General Dietary Sources of Tap Water for Both Sexes[a,b]

[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					Arithmetic Average
	2.5	25	50	75	97.5	
<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).

Population Group	Total N	None	Number of Glasses in a Day					
			1–2	3–5	6–9	10–19	20+	DK
Table 3-64. Number of Respondents That Consumed Tap Water at a Specified Daily Frequency								
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 (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 Source	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

	6 Months	9 Months	12 Months	16 Months	20 Months	24 Months	6 to 24 Months[a]
Age at Questionnaire							
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. (2003b).

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

Beverage	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. (2003a).

	Table 3-74. Consumption of Beverages by Infants and Toddlers (Feeding Infants and Toddlers Study)

Table 3-74. Consumption of Beverages by Infants and Toddlers (Feeding Infants and Toddlers Study)

Beverage Category	Age (months)
	\multicolumn{2}{c}{4 to 6 Months (N = 862)}	\multicolumn{2}{c}{7 to 8 Months (N = 483)}	\multicolumn{2}{c}{9 to 11 Months (N = 679)}	\multicolumn{2}{c}{12 to 14 Months (N = 374)}	\multicolumn{2}{c}{15 to 18 Months (N = 308)}	\multicolumn{2}{c}{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

[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).

		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

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)

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 (FASEB/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)

Women Categories	Sample Size	Mean Estimate	90% CI Lower Bound	90% CI Upper Bound	90th Percentile Estimate	90% BI Lower Bound	90% BI Upper Bound	95th Percentile Estimate	90% BI Lower Bound	90% BI 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 (FASEB/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)

Women Categories	Sample Size	Mean Estimate	90% CI Lower Bound	90% CI Upper Bound	90th Percentile Estimate	90% BI Lower Bound	90% BI Upper Bound	95th Percentile Estimate	90% BI Lower Bound	90% BI 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 (FASEB/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)

Women Categories	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
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 (FASEB/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)

Women Categories	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
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 (FASEB/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)

Women Categories	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
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 (FASEB/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)

Women Categories	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
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 (FASEB/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)

| Women Categories | 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
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 (FASEB/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			Pregnant Women			Lactating Women		
	Mean[b]	Percentile		Mean[b]	Percentile		Mean[b]	Percentile	
		50	95		50	95		50	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]	
	$\underline{N}$[d]	Intake	$\underline{N}$	Intake	$\underline{N}$	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						
	Adults				Children <15 years	
Parameter	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)							
	Surface Water Study				Swimming Pool Study		
Activity	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).