

Age Dependent Adjustment Factor (ADAF) Application

Office of Water Policy Document

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1.0 Background

The Environmental Protection Agency *Guidelines for Carcinogen Risk Assessment* (EPA, 2005b) require the consideration of the possibility of risks for cancer from early life stage exposure. In particular, the *Guidelines* recommend that life stage-specific, cancer slope factors be calculated when the data permit. In the absence of such data, the *Guidelines* specify the application of Age Dependant Adjustment Factors (ADAFs) in determining tumorigenic risk for chemicals that have a demonstrated mutagenic mode of action (MOA). In cases where it is not possible to determine that the response to dose is nonlinear through an identified MOA, EPA has chosen to use a default of low dose linear extrapolation without ADAF.

The Office of Water (OW) has yet to apply the ADAF guidance in any of its regulatory risk-based assessments of chemical contaminants under the 1996 Safe Drinking Water Act (SDWA) related activities. As part of the IRIS training for the Agency Reviewers, the National Center for Environmental Assessment (NCEA) indicated that IRIS documents would include a statement as to the advisability of inclusion of the ADAF in a Program Office risk assessment, but that the policies for its application would be developed by the Program Office.

This document was prepared for the purpose of establishing the policies the OW will follow when applying the ADAFs in the quantification of the risk of drinking water exposures from mutagenic carcinogens. Application of the ADAFs has no impact on the Maximum Contaminant Level Goal (MCLG) because it is zero for all carcinogens that lack a demonstrated non-mutagenic mode of action. On the other hand, the Maximum Contaminant Level (MCL) is based on technical (analytical and treatment limitations) and cost-benefit considerations which consider risk as an important benchmark in its determination. The MCL is generally selected so that the cancer risk falls within the one-in-ten thousand to one-in-million risk range.

The *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (EPA, 2005a) was published at the same time as the *Cancer Guidelines*. This document reviewed existing data for chemicals with early life exposures and concluded that exposure to chemical carcinogens with a mutagenic MOA are likely to increase incidence or reduce latency for cancer by comparison to exposures that begin after attainment of developmental maturity. The document recommends that when considering childhood exposure, ADAFs be applied to cancer slope factors calculated from studies (bioassay or epidemiological) that involve only adult exposures. Three age periods are delineated for the ADAFs; each is associated with a numeric value for the increase in risk during that age period. These are to be used with age-specific exposure information in risk characterization. The three age periods and their associated ADAFs are as follows:

- Birth to less than age 2 years: a 10-fold increase in slope factor (2 year duration)
- Age 2 to less than age 16: a 3-fold increase in slope factor (14 year duration)

- Age 16 to 70 years: risk as calculated from the adult only exposure (54 year duration).

The equation for the calculation of risk is as follows:

$$\text{Risk} = \text{CSF} \times \text{ADAF} \times \text{dose (mg/kg/day)} \times \text{exposure duration/70 years}$$

Where:

$$\text{CSF} = \text{Cancer Slope Factor (mg/kg/day)}^{-1}$$

The risk is calculated for each of the three exposure periods with application of its ADAF and then added together to obtain the total risk for a 70 year period initiated at birth. Risks can also be calculated for any exposure duration of interest combined with the doses for the age group of interest.

2.0 Consideration of Variables for the Office of Water (OW) Calculations

Drinking water is the exposure medium of concern for the OW. The following sections explain the OW policy development process and subsequent policy recommendations. The OW considered the following variables in the development of their policies: normalization of drinking water intakes and body weights (independent versus ratio), percentile level for analysis (90th versus 95th), and selection of drinking water intakes (all individuals versus consumer-only).

2.1 Normalization of Drinking Water Intakes and Body Weights across the ADAF Ages

For drinking water the dose for each of the three exposure durations will vary with the normalized water intake and the normalized body weight of the individual over the specified time period. The information needed to determine the normalized drinking water intakes and body weights can be identified in the *Child-Specific Exposure Factor's Handbook* (EPA, 2008) and the *OW Estimated Per Capita Water Ingestion in the United States* (EPA, 2004). In both cases the values presented are derived from the USDA Continuing Survey of Food Intakes by Individuals (CSFII 1994-1996 and 1998).

There are several policy options that the OW can consider in obtaining the dose (water intake and body weight) estimates. They are as follows:

Approach 1: Use independent body weight (kg) and water intake (L/day) values

Approach 2: Use ratio of water intake to body weight in terms of L/kg/day

For the first approach the statistical analysis of body weights and water intakes of the populations were evaluated independently. For the second measure, the ratio of water intake to body weight was determined for each individual in the population and the ratios were analyzed statistically.

The differences between the two data sets for the two normalization approaches can be described as follows:

- Approach 1: The distributions for body weight were derived from all of the body weight data in the CSFII without consideration of the water intake associated with each body weight. The situation was similar for the distribution of the drinking water intake information. The analysis was derived for each measure of drinking water intake without consideration of the body weight associated with each intake.
- Approach 2: The ratio data are linked at the level of the individual rather than the population. The analysis of the exposure values using the L/kg body weight measures is based on a set of monitoring values in which the water intake of each study participant was first divided by their body weight before completing the statistical analysis of the data.

The OW consulted the Office of Children's Health Protection (OCHP) on the approach to use for normalizing body weights and drinking water intakes across the age range for each of the ADAF periods. The OCHP recommended that the product of each age-specific variable multiplied by the its fraction of the total duration be summed to obtain the normalized drinking water intake, body weight, and L drinking water/kg body weight variables for each ADAF age period. It was further recommended that the Child Specific Exposure Factors Handbook (U.S. EPA, 2008) be used as the source for the body weight and exposure variables. Table 1 provides an example for normalization of body weights across the four age subgroupings within the 2 year to <16 year age period using the body weight values from the Child-specific Exposure Factor's Handbook (2008). In order to be consistent with the data source for the drinking water intakes (CSFII)], the OW has used the mean body-weight data from Kahn and Stralka (2008), Table 8-24 in EPA (2008), in place of the data derived from the NHANES 1999-2006 data (EPA [2008] Table 8-1).

Table 1: Normalized Body Weight for the 2-year to 16 year Age Period (Kahn and Stralka, 2008) Table 3-24 (EPA, 2008)			
Age Range Years	Body Weight kg	Duration Fraction years	Product (body wt. x duration fraction) kg
2 to <3	14	1/14	1
3 to <6	18	3/14	3.857
6 to <11	30	5/14	10.714
11 to < 16	54	5/14	19.286
Normalized value (sum of the age specific products)			34.857

The same approach (i.e. multiplication of the variable by the fraction of the ADAF age period and summing the results) is used for each of the ADAF age groups and each of the variables (body weight, drinking water intakes or L drinking water/ Kg body weight) needed for the calculations. Tables 1 through 9 in the supporting data attachment show the derivation of the normalized values for body weight, drinking water intake, and

drinking water intake body weight ratios for each of the three ADAF age groupings using the data from EPA (2008) and EPA (2004).

In order to illustrate the impact of variable selection, OW calculated the unit risk and total 70 year unit risk after application of the ADAFs for the 90th percentile consumer-only direct and indirect water intakes and average body weights (Table 2) as compared to the values calculated using drinking water intake body weight ratios (L/kg/day) using the same assumptions (Table 3). Both sets of calculations are based on a sample CSF of 21 (mg/kg/day)⁻¹. The unit risk is defined as the risk associated with a drinking water concentration of 1 µg/L (0.001 mL/day).

Table 2: Approach 1- Unit Risk Derived from 90th Percentile Drinking Water Intakes and Average Body Weights (CSF = 21 /mg/kg/day)					
Unit Risk = CSF x ADAF x DWI/bw x 0.001 mg/L x Exposure Duration/70 years					
Age Range years	Body Weight (bw) kg	ADAF	Drinking Water Intake (DWI) L/day	Exposure Duration years	Unit Risk µg/L
Birth to < 2	9.71	10	0.861	2/70	5.320 x 10 ⁻⁴
2 to < 16	34.857	3	1.012	14/70	3.658 x 10 ⁻⁴
16 to 70	75.277	1	2.237	54/70	4.814 x 10 ⁻⁴
Total unit risk					1.379 x 10⁻³

Table 3: Approach 2- Unit Risk Derived from 90th Percentile Drinking Water Intakes Average Body Weight Ratios (CSF = 21 /mg/kg/day)				
Unit Risk = CSF x ADAF x DWI/bw Ratio x 0.001 mg/L x Exposure Duration/70 years				
Age Range	Drinking Water Intake / body weight ratio L/kg/day	ADAF	Exposure Duration years	Unit Risk µg/L
Birth to < 2	0.104	10	2/70	6.240 x 10 ⁻⁴
2 to < 16	0.037	3	14/70	4.662 x 10 ⁻⁴
16 to 70	0.032	1	54/70	5.184 x 10 ⁻⁴
Total unit risk				1.609 x 10⁻³

The total unit risk values can be converted to the concentration in drinking water equivalent to a 1 x 10⁻⁶ risk using the following equation:

$$\text{Concentration (µg/L) at } 1 \times 10^{-6} \text{ risk} = 1 \times 10^{-6} \div \text{unit risk (µg/L)}^{-1}$$

The concentration equivalent to a one-in-a million risk for a 70 year exposure initiated at birth as calculated in Table 2 is 0.000725 µg/L rounded to 0.7 ng/L

The concentration equivalent to a one-in-a million risk for a 70 year exposure initiated at birth as calculated in Table 3 is 0.000622 µg/L rounded to 0.6 ng/L.

Tables 2 and 3 demonstrate the difference in one-in-a-million risk concentrations for a 70 year exposure initiated at birth based on the using two different data sets to represent the relationship between drinking water intakes and body weights. It is the OW policy to express the final risk value using one significant figure.

2.1 Percentile Level for Analysis

A second variable that was considered for the OW policy development process was the percentile level to select for the analysis: 90th versus 95th. The OW has traditionally used an adult body weight of 70 kg (once a mean value) and a 2 L/day water intake (~90th percentile) in its chronic exposure assessments for cancer endpoints. The *Child-Specific Exposure Factor's Handbook* (EPA, 2008) recommends that the 95th percentile values be used. However, as per EPA (2008) the 95th percentile values are problematic for some age groups because the sample size (CSFII (1994-1996, 1998) did not meet minimum requirements as described in the third report on nutrition monitoring in the United States. Although this is also the case at the 90th percentile, fewer groups are affected. For example, the minimum requirements are not met for data on water consumption from birth to 6 months and ages 16-21 years at the 95th percentile with the direct and indirect water intake estimates for consumers only (EPA, 2008). At the 90th percentile value only the birth to <3 month groups fail to meet the size requirement.

2.3 Selection of Drinking Water Intakes

Another variable for consideration is selection of the drinking water intakes for all individuals or for consumers only. The earlier OW defaults of 2 L/ day for adults and 1 L/day for children were approximate estimates for the 90th percentile of all individuals in a study by Ershow and Cantor (1989) which were reaffirmed in the analysis that produced the updated evaluation of population drinking water intakes based on the most recent CSFII data(EPA(2004). These estimates are not appropriate in carrying out the ADAP evaluations wherein age-specific intakes are needed. Several ongoing assessments which do not involve cancer have used the consumers-only data as the preferred values to protect sensitive populations. It is the recommendation of this document to continue use of the more recent consumers-only policy.

3.0 Calculating Risk for a Less than Lifetime Exposure

As mentioned above, the ADAP's allow the user to calculate risks for a less than lifetime exposure such as the first 7 years of life. Seven years is the age period used by the OW in the derivation of the longer-term health advisory for a child because that is frequently the duration granted by a variance or exemption for a public drinking water system to

achieve the MCL for a regulated contaminant. Table 4 provides an example of the risk calculation for this exposure period using the drinking water intake/body weight ratio.

Table 5: Unit Risk Derived from 90th Percentile Drinking Water Intake Average Body Weight Ratios for a Birth to 7-year Exposure (CSF = 21 /mg/kg/day)				
Unit Risk = CSF x ADAF x DWI/bw Ratio x 0.001 mg/L x Exposure Duration/70 years				
Age Range	Drinking Water Intake / Body Weight Ratio L/kg/day	ADAF	Exposure Duration years	Unit Risk µg/L
Birth to < 2	0.104	10	2/70	6.240×10^{-4}
2 to < 7	0.046	3	5/70	2.070×10^{-4}
Total unit risk				8.310×10^{-4}

The concentration equivalent to a one-in-million risk for developing cancer during a 70 year lifetime with an exposure that lasts from birth to age 7 is calculated by dividing the total unit risk into 1×10^{-6} . The resultant value is 0.00120 µg/L rounded to 1 ng/L. Calculating this value makes it possible to compare the cancer risk for such an exposure to the longer term health advisory for non-cancer effects. Providing estimate of the lifetime cancer risk for a longer term exposure as well as a value protective for non-cancer effects from the same exposure provides important information to the risk manager during decision making for mutagenic chemicals present in public drinking water supplies.

4.0 Internal Peer Review

The preceding portions of this document were reviewed by Rita Schoeny of the OW and Brenda Foos of the Office of Children's Health Protection (OCHP). Recommendations of the peer reviewers were accommodated in the revisions to the draft document. Additional input on evolving policies related to perchlorate was provided by Eric Burneson of the Office of Groundwater and Drinking Water (OGWDW). Other alternatives to this process were suggested by the OCHP during the internal review of this document. They are as follows:

- Use the data from all 11 child-specific age periods as provided by the EPA (2008) combined with 20+ data from (EPA, 1004) derived from the same CSFII data set rather than the compressed three data sets.
- Work with the ORD Exposure researchers to obtain appropriate values for the three ADAF age periods from the CSFII (1994-1996, 1998) data directly.

The OW feels that communication of the ADAF adjustment to its stakeholder community is facilitated by a presentation using the three age groupings as established by the ADAF

guidelines. Once the policy decisions related to drinking water intake and body weight relationships for each of the age groups have been established they will be a constant for the calculation, simplifying presentation and supported by a citation to this document. The first OCHP suggestion could be accommodated in an appendix to the OW reports for those who desire refined breakdown of the individual impacts for the 12 component age ranges. Postponing the application of the ADAFs until ORD could reanalyze the original data would be preferred if they would be able to do it within a time period where it could be used for Regulatory Determinations 3, but that is unlikely.

5.0 Recommendation

After considering the options discussed above, the OW recommends the use of the 90th percentile consumers-only drinking water intake body weight ratio data (L/kg/day) when applying ADAFs to risk values for carcinogens with an established mutagenic mode of action. The 90th percentile data were selected because, for all but the birth to < 3 month age groupings, the population size was sufficient for the drinking water intake body weight ratio analysis thereby minimizing the uncertainty in the values. Use of the 90th percentile is consistent with the long term OW policy. Use of the consumers-only values insures that the resultant risk values are applicable for those totally reliant on drinking water (direct and indirect) from public drinking water systems. The ratio data are preferable to using the body weight and water intake parameters separately because the two parameters are linked at the level of the individual rather than the population.

6.0 References:

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<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=56747>

Supporting Information

The supplemental information describes how drinking water intake and body weight were normalized based on age ranges for the three ADAP adjustment periods. The OW believes that the normalization of the body weight and drinking water intake data across the three age periods specified in the ADAP guidance document rather than including calculations for each of the eleven age periods included in the Child-Specific Exposure Factors Handbook simplifies the presentation of the data for stakeholders without having a substantial impact on the outcome of the analysis.

Body Weights: Approach 1

Table 1: Normalized Body Weight for the Birth to <2-year Age Period EPA, 2008 Table 8-24)			
Age Range Months	Body Weight kg	Duration Fraction	Product kg
Birth to <1	4	1/24	0.167
1 to <3	5	2/24	0.417
3 to <6	7	3/24	0.875
6 to <12	9	6/24	2.250
12 to <24	12	12/24	6.000
Normalized value (sum of the age specific numbers)			9.71

Table 2: Normalized Body Weight for the 2-year to <16-year Age Period EPA, 2008 Table 8-24)			
Age Range Years	Body Weight kg	Duration Fraction	Product kg
2 to <3	14	1/14	1
3 to <6	18	3/14	3.857
6 to <11	30	5/14	10.714
11 to <16	54	5/14	19.286
Normalized value (sum of the age specific products)			34.857

Table 3: Normalized Body Weight for the 16-year to 70-year Age Period (EPA, 2008 Table 8-24; EPA, 2004 Table 7.2			
Age Range Years	Body Weight kg	Duration Fraction	Product kg
16 to <18	67	2/54	2.481
18 to <21	69	3/54	3.833
20+	76	49/54	68.963
Normalized value (sum of the age specific numbers)			75.277

Drinking Water Intakes: Approach 1

Table 4: Consumers only direct and indirect drinking water intakes normalized for the birth to <2-year Age Period (EPA, 2008 Table 3-14)

Age Range Months	Drinking Water Intake L/day	Duration Fraction	Product L/day
Birth to <1	0.849*	1/24	0.035
1 to <3	0.943*	2/24	0.079
3 to <6	1.021	3/24	0.128
6 to <12	0.971	6/24	0.243
12 to <24	0.674	12/24	0.337
Normalized value (sum of the age specific numbers)			0.822

Table 5: Consumers only direct and indirect drinking water intakes normalized for the 2-year to 16-year Age Period (EPA, 2008 Table 3-14)

Age Range Years	Drinking Water Intake L/day	Duration Fraction	Product L/day
2 to <3	0.700	1/14	0.050
3 to <6	0.867	3/14	0.186
6 to <11	0.994	5/14	0.355
11 to <16	1.432	5/14	0.511
Normalized value (sum of the age specific numbers)			1.102

Table 6: Consumers only direct and indirect drinking water intakes normalized for the 16-year to 70 year Age Period (EPA, 2008 Table 3-14; EPA, 2004 Table A2 P. E-100)

Age Range Years	Drinking Water Intake L/day	Duration Fraction	Product L/day
16 to <18	1.647	2/54	0.061
18 to <21	1.860	3/54	0.103
21 to 70	2.284	49/54	2.073
Normalized value (sum of the age specific numbers)			2.237

Drinking Water Intake Body Weight Ratios: Approach 2

Table 7: Consumers only direct and indirect drinking water intake/body weight ratios normalized for the birth to <2 year Age Period (EPA, 2008 Table 3-19)

Age Range Months	Drinking water intake/ body weight ratio L/kg/day	Duration Fraction	Product L/kg/day
Birth to <1	0.235	1/24	0.010
1 to <3	0.228	2/24	0.019
3 to <6	0.148	3/24	0.019
6 to <12	0.112	6/24	0.028
12 to <24	0.056	12/24	0.028
Normalized value (sum of the age specific numbers)			0.104

Table 8: Consumers only direct and indirect drinking water intake/body weight ratios normalized for the 2-year to 16 year Age Period (EPA, 2008 Table 3-19)

Age Range Years	Drinking Water Intake/ body weight ratio L/kg/day	Duration Fraction	Product L/kg/day
2 to <3	0.052	1/14	0.004
3 to <6	0.049	3/14	0.011
6 to <11	0.035	5/14	0.013
11 to <16	0.026	5/14	0.009
Normalized value (sum of the age specific numbers)			0.037

Table 9: Consumers only direct and indirect drinking water intake/body weight ratios normalized for the 16-year to 70 year Age Period (EPA, 2008 Table 3-19; EPA, 2004 Table A1 page E 139)

Age Range Years	Drinking Water Intake/ body weight ratio L/kg/day	Duration Fraction	Product L/kg/day
16 to <18	0.024	2/54	0.001
18 to <21	0.029	3/54	0.002
20+	0.032	49/54	0.029
Normalized value (sum of the age specific numbers)			0.032

**Birth to Seven Year Exposure Using a Drinking Water Intake/ Body Weight Ratio:
Approach 2**

Table 10: Consumers only direct and indirect drinking water intake/body weight ratios normalized for the 2-year to <7 year Age Period (EPA, 2008 Table 3-19)			
Age Range Years	Drinking Water Intake/ body weight ratio L/kg/day	Duration Fraction	Product L/kg/day
2 to <3	0.052	1/5	0.010
3 to <6	0.049	3/5	0.029
6 to <7	0.035*	1/5	0.007
Normalized value (sum of the age specific numbers)			0.046
* Value applies to the 6 to <11 age range as reported in the Exposure Factor's Handbook			



Chapter 8 - Body Weight

Table 8-23. Estimated Body Weights of Typical Age Groups of Interest in U.S. EPA Risk Assessments ^a										
Age Group	NHANES	Males (kg)			Females (kg)			Overall (kg)		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
1 to 6 years	II	17.0	4.6	2,097	16.3	4.7	1,933	16.7	4.5	4,030
	III	16.9	4.7	3,149	16.5	4.9	3,221	16.8	5.0	6,370
	IV	17.1	4.9	633	17.5	5.0	541	17.3	5.0	1,174
7 to 16 years	II	45.2	17.6	1,618	43.9	15.9	1,507	44.8	17.5	3,125
	III	49.3	20.9	2,549	46.8	18.0	2,640	47.8	18.4	5,189
	IV	47.9	20.1	1,203	47.9	19.2	1,178	47.7	19.1	2,381
^a Estimates were weighted using the sample weights provided with each survey. SD = Standard Deviation. N = Number of individuals.										
Source: Portier et al., 2007.										

Table 8-24. Estimated Percentile Distribution of Body Weight by Fine Age Categories Derived From 1994-96, 1998 CSFII											
Age Group	Sample Size	Mean	Weight (kilograms)								
			1 st	Percentile							
				5 th	10 th	25 th	50 th	75 th	90 th	95 th	99 th
Birth to 1 month	88	4	1 ^a	2 ^a	3 ^a	3	3	4	4 ^a	5 ^a	5 ^a
1 to <3 months	245	5	2 ^a	3 ^a	4	4	5	6	6	7 ^a	8 ^a
3 to <6 months	411	7	4 ^a	5	5	6	7	8	9	10	12 ^a
6 to <12 months	678	9	6 ^a	7	7	8	9	10	11	12	13 ^a
1 to <2 years	1,002	12	8 ^a	9	9	10	11	13	14	15	19 ^a
2 to <3 years	994	14	10 ^a	10	11	12	14	16	18	19	22 ^a
3 to <6 years	4,112	18	11	13	13	16	18	20	23	25	32
6 to <11 years	1,553	30	16 ^a	18	20	23	27	35	41	45	57 ^a
11 to <16 years	975	54	29 ^a	33	36	44	52	61	72	82	95 ^a
16 to <18 years	360	67	41 ^a	46 ^a	50	56	63	73	86	100 ^a	114 ^a
18 to <21 years	383	69	45 ^a	48 ^a	51	58	66	77	89	100 ^a	117 ^a
^a Sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States" (LSRO, 1995).											
Source: Kahn and Stralka, 2008.											



Table 3-14. Consumers Only^a Estimates of Combined Direct and Indirect^b Water Ingestion: Community Water (mL/day)

Age	Sample size	Mean	Percentiles						
			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*

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

Source: Kahn and Stralka, 2008 and supplementary data.

Table 3-15. Consumers Only^a Estimates of Combined Direct and Indirect^b Water Ingestion: Bottled Water (mL/day)

Age	Sample size	Mean	Percentiles						
			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*

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

Source: Kahn and Stralka, 2008 and supplementary data.



Chapter 3 - Water Ingestion

Table 3-19. Consumers Only^a Estimates of Direct and Indirect^b Water Ingestion: Community Water (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			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*

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

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

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

Source Kahn and Stralka, 2008 and supplementary data.

Table 3-20. Consumers Only^a Estimates of Direct and Indirect^b Water Ingestion: Bottled Water (mL/kg-day)

Age	Sample size	Mean	Percentiles						
			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*

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

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

- Insufficient sample size to estimate means and percentiles.

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

Source: Kahn and Stralka, 2008 and supplementary data.

Table 7.2. Estimated Distribution of Body Weight
Gender and Fine Age Categories
All Individuals

Kilograms**														
Gender	Age	Sample size	Population	Mean	P1	P5	P10	P25	P50	P75	P90	P95	P99	
b. Male														
	<0.5	361	954,525	6	3*	3*	4	5	6	7	8	9*	11*	
	0.5-0.9	333	872,410	9	6*	7*	7	8	9	10	11	12*	13*	
	1-3	1,851	6,127,169	14	9*	10	11	12	14	16	18	19	23*	
	4-6	1,520	5,799,447	21	13*	15	16	18	20	22	26	28	36*	
	7-10	537	7,645,200	32	18*	21	22	27	31	36	44	48	63*	
	11-14	392	7,522,213	52	28*	32*	35	41	50	60	72	81*	92*	
	15-19	409	9,294,121	73	44*	53	56	61	68	80	94	107	116*	
	20-24	336	9,172,756	80	52*	58	61	68	78	86	100	112	134*	
	25-54	2,499	56,219,548	85	54	63	66	75	83	93	104	111	134	
	55-64	775	9,564,795	84	54*	61	67	74	83	93	103	109	125*	
	65 +	1,114	12,993,304	80	51*	59	63	70	78	88	99	104	117*	
c. Both sexes														
	20 +	4,724	87,950,403	84	54	61	65	72	82	91	104	110	130	
	<2	1,197	3,917,902	10	3*	4	6	8	10	12	13	14	17*	
	2-15	3,797	25,003,062	33	11	13	15	19	28	43	57	66	84	
	15 +	5,133	97,244,524	82	52	60	63	72	81	91	103	109	129	
	<6	3,791	11,889,007	15	4	7	8	11	15	18	21	23	29	
	6-15	1,203	17,031,957	40	18*	20	22	27	36	50	61	71	86*	
	All ages	10,127	126,165,488	70	9	15	22	27	36	50	61	71	86*	
	<0.5	744	1,890,461	6	2*	3	3	4	6	7	8	9	11*	
	0.5-0.9	678	1,770,700	9	6*	7	7	8	9	10	11	12	13*	
	1-3	3,645	11,746,146	14	8	9	10	11	13	16	18	19	23	
	4-6	2,988	11,570,747	21	12	14	16	17	20	22	26	28	36	
	7-10	1,028	14,541,011	32	17*	20	22	26	29	36	43	48	59*	
	11-14	790	15,183,156	51	28*	32	35	42	50	58	68	79	89*	
	15-19	816	17,825,164	67	42*	47	50	56	63	73	85	99	113*	
	20-24	676	18,402,877	72	45*	49	53	59	68	81	94	104	130*	
	25-54	4,830	111,382,877	77	45	52	54	63	75	86	100	109	127	
	55-64	1,516	20,691,260	77	46	52	57	65	75	87	99	105	124	
	65 +	2,139	30,578,210	72	44	50	54	62	71	81	93	100	113	
	20 +	9,161	181,055,224	76	45	51	54	63	73	86	98	107	126	
	<2	2,424	7,695,535	10	3	4	5	7	10	11	13	14	17	
	2-15	7,449	49,006,686	33	11	13	15	19	28	43	56	63	82	
	15 +	9,977	198,880,388	75	45	50	54	61	72	84	97	106	125	
	<6	7,530	23,160,174	15	4	6	8	11	14	18	21	23	28	
	6-15	2,343	33,542,047	40	17	20	22	27	36	50	59	68	85	
	All ages	19,850	255,582,609	65	8	15	22	27	36	50	59	68	85	
													122	

Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII)

*: The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States."
**: Multiply values by 2.2 to convert to estimated weight in pounds.

NOTE: 757 individuals did not report body weight. They represent 6,314,627 individuals in the population.

Part III: Estimates of Direct, Indirect, and Both Direct and Indirect Water Ingestion
Table A2. Community Water: Gender by Fine Age Categories
Consumers Only

III-8

		Milliliters/Person/Day											
Gender	Age	Sample size	Population	Mean	P1	P5	P10	P25	P50	P75	P90	P95	P99
C. Both sexes													
Direct and Indirect													
	<0.5	435	1,057,243	548	10*	29	52	209	552	814	985	1,139	1,433*
	0.5-0.9	562	1,437,057	467	3*	25	44	105	426	710	971	1,147	1,586*
	<2	1,913	6,176,837	386	3*	22	44	114	301	587	856	1,014	1,401*
	1-3	3,422	11,011,095	349	3	23	48	119	270	485	723	946	1,393
	4-6	2,916	11,352,187	442	4	29	61	152	355	607	943	1,176	1,729
	<6	6,807	21,037,341	398	4	25	51	130	315	564	842	1,051	1,573
	7-10	1,027	14,327,436	487	6*	34	72	180	382	707	993	1,241	1,942*
	11-14	759	14,432,607	641	7*	59	115	235	473	833	1,415	1,742	2,564*
	15-19	777	16,744,959	817	7*	51	99	266	608	1,065	1,671	2,161	3,862*
	20 +	8,611	172,088,785	1,176	13	103	208	524	995	1,572	2,284	2,848	4,631
	20-24	644	17,658,027	1,033	10*	68	122	359	711	1,218	2,175	3,082	5,356*
	25-54	4,599	106,779,569	1,171	14	100	201	503	965	1,561	2,326	2,926	4,735
	55-64	1,410	19,484,112	1,242	11	115	237	651	1,111	1,657	2,297	2,721	4,222
	65 +	1,958	28,167,077	1,242	24	155	310	704	1,149	1,657	2,190	2,604	3,668
	All ages	18,509	242,451,369	1,000	9	64	127	355	786	1,375	2,069	2,601	4,274

Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII)

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Estimates are based on 2-day averages.

All estimates exclude commercial and biological water.

-: Means zero.

*: The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States."

Part IV: Estimates of Direct, Indirect, and Both Direct and Indirect Water Ingestion
Table A1. Community Water: Gender by Broad Age Categories
Consumers Only

IV-2

		Milliliters/Kg of Body Weight/Day											
Gender	Age	Sample size	Population	Mean	P1	P5	P10	P25	P50	P75	P90	P95	P99
C. Both sexes Direct	< 1	398	1,012,461	18	1*	2*	3	5	11	23	39	57*	117*
	1-10	5,087	26,870,324	17	1	2	3	6	12	22	36	47	78
	11-19	1,245	25,303,467	11	1*	1	2	4	8	13	22	28	58*
	20 +	6,583	130,511,025	11	1	1	2	4	8	14	23	30	50
	All ages	13,313	183,697,277	12	1	1	2	4	8	15	25	33	57
Indirect	< 1	898	2,247,324	67	1*	2	5	12	57	100	141	172	249*
	1-10	6,331	30,701,858	8	-	-	1	2	6	11	19	26	45
	11-19	1,282	26,304,246	5	-	-	-	1	3	6	10	14	25*
	20 +	8,055	160,396,393	8	-	-	1	3	6	11	17	22	39
	All ages	16,566	219,649,821	8	-	-	1	2	6	11	17	23	51
Direct and Indirect	< 1	948	2,373,335	71	1*	3	6	17	62	106	145	185	261*
	1-10	6,901	34,527,957	21	-	1	3	7	16	28	44	57	92
	11-19	1,507	30,759,097	13	-	1	2	4	10	17	26	34	60*
	20 +	8,459	168,957,363	16	-	1	3	7	13	22	32	39	62
	All ages	17,815	236,617,752	17	-	1	3	7	13	22	33	44	77

Source of data: 1994-1996, 1998 USDA Continuing Survey of Food Intakes by Individuals (CSFII)

Estimates are based on 2-day averages.

All estimates exclude commercial and biological water.

-: Means zero.

*: The sample size does not meet minimum reporting requirements as described in the "Third Report on Nutrition Monitoring in the United States."
NOTE: 757 individuals did not report body weight. They represent 6,314,627 individuals in the population.

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