Recent Tap Water Intake Studies

1) Burmaster, DE. (1998) Lognormal distributions for total water intake and tap water Intake by pregnant and lactating women in the United States. Risk Anal 18(2):215-219.

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Burmaster (1998) fit parametric (lognormal) distributions to data compiled by Ershow et al. (1993) for daily intake of total water and tap water by three groups of women, using probability plots and Maximum Likelihood Estimation (MLE). Ershow et al. used the Nationwide Food Consumption Survey (NFCS), conducted by the USDA in 1978, to compile their data. The NFCS collected dietary information on 30,770 individuals living in randomly assigned nonmilitary households in the contiguous 48 states for a period of 7 days. From this sample, the NFCS identified the number of women 15 to 49 years old and grouped them into three categories: control women (nonpregnant and nonlactating (N=6,201), pregnant women (N=188), and lactating women (N=77). Table 1 presents the summary statistics computed by Ershow et al.

First, lognormal distributions were fitted to the data using probability plots. Figure 1 shows the probability plots for the water intake of each of the three groups of women. The lines indicate best-fit lines created by ordinary least squares (OLS) regression. Table 2 presents the best-fit lognormal distributions for water intake of women, ages 15 to 49. The first two results columns in Table 2 show the intercept and the slope of the OLS lines in Figure 1. Column 3 gives the adjusted R^2 for the regression. The last three columns of results on the right side of Table 2 present the values for μ, σ, and the maximum of the log likelihood function.

The results in Table 2 were then interpreted in terms of bivariate lognormal distributions for water intake (WI) and body weight (BW) for the three groups of women. Those results are shown in Table 3.

The author noted that there are no known systematic biases in the selection of the population since the USDA designed the NFCS to select a representative sample of women from the general population and not to select or reject pregnant or lactating women. However, since the consumption of bottled water has increased in the United States since 1978, the results of the survey likely overstate current consumption patterns for home tap water. In general, the data show that lactating women ingest more water than do pregnant women and that pregnant women ingest more water than the control women. In addition, the author stated that lognormal distributions fit each of the data sets well and that the results in Table 2 from the two statistical methods (probability plots and MLE) agree to within a few percent for each group of women. The results in Table 2 for the control group are consistent with the previous results for drinking water ingestion by adult women and with previous results for body weight of women.

The author recommended that the "(marginal) distributions for water intake as fit by MLE for the variability in a population for use in short-term human health risk assessments and pharmacokinetics models. For the control, pregnant, and lactating groups, respectively, the standard "default" of 2 L/day for water ingestion fell at the 88th, 86th, and 86th percentiles of the fitted distributions for tap water."

The author also noted that his results are consistent with having variables WI and BW jointly distributed according to a bivariate lognormal distribution with a small positive Pearson correlation.

In addition, little or no precision is gained by normalizing water intake by body weight. A limitation of the analysis noted by the author is that the data of Ershow rely on self-reported data for three consecutive days. The lognormal distributions fitted for variability in short-term data in this study closely approximate the long-term average exposure.

Reference: Ershow, AG; Brown, LM; Cantor, KP. (1993) Intake of tap water and total water by pregnant and lactating women. Am J Public Health 81(3): 328-334.

Table 1. Data for Water Intake of Women, 15 to 49 Years Old[a]

Variable	Group	Source	*N*	Units for Ingestion	Arithmetic Mean	Arithmetic SD	5th Percentile	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile	95th Percentile
WI	Control	Total	6,201	g/day	1,940	686	995	1,172	1,467	1,835	2,305	2,831	3,186
WI	Control	Tap	6,201	g/day	1,157	635	310	453	709	1,065	1,503	1,983	2,310
WI	Pregnant	Total	188	g/day	2,076	743	1,085	1,236	1,553	1,928	2,444	3,028	3,475
WI	Pregnant	Tap	188	g/day	1,189	699	274	419	713	1,063	1,501	2,191	2,424
WI	Lactating	Total	77	g/day	2,242	658	1,185	1,434	1,833	2,164	2,658	3,169	3,353
WI	Lactating	Tap	77	g/day	1,310	591	430	612	855	1,330	1,696	1,945	2,191
WI/BW	Control	Total	6201	g/(kg-day)	32.3	12.3	15.8	18.5	23.8	30.5	38.7	48.4	55.4
WI/BW	Control	Tap	6201	g/(kg-day)	19.1	10.8	5.2	7.5	11.7	17.3	24.4	33.1	39.1
WI/BW	Pregnant	Total	188	g/(kg-day)	32.1	11.8	16.4	17.8	22.8	30.5	40.4	48.9	53.4
WI/BW	Pregnant	Tap	188	g/(kg-day)	18.3	10.4	4.9	5.9	10.7	16.4	23.8	34.5	39.6
WI/BW	Lactating	Total	77	g/(kg-day)	37.0	11.6	19.6	21.8	28.4	35.1	45.0	53.7	59.2
WI/BW	Lactating	Tap	77	g/(kg-day)	21.4	9.8	7.4	9.8	14.8	20.5	26.8	35.1	37.4

Source: Burmaster, 1998 (from Tables 2 and 3 (Ershow et al., 1991)).

Table 2. Best-Fit Lognormal Distributions for Water Intake of Women, 15 to 49 Years Old

Variable	Group	Source[a]	Units for Ingestion	ProbPlot Muhat	ProbPlot Sigmahat	ProbPlot aR^2	MLE Muhat	MLE Sigmahat	MLE MaxJ
WI	Control	Total	g/day	7.505	0.349	0.9984	7.510	.0347	-11,561.7
WI	Control	Tap	g/day	6.863	0.594	0.9801	6.906	0.594	-11,730.5
WI	Pregnant	Total	g/day	7.570	0.351	0.9997	7.570	0.349	-350.2
WI	Pregnant	Tap	g/day	6.856	0.646	0.9754	6.904	0.640	-358.9
WI	Lactating	Total	g/day	7.658	0.310	0.9838	7.675	0.307	-146.0
WI	Lactating	Tap	g/day	7.018	0.481	0.9550	7.073	0.492	-150.5
WI/BW	Control	Total	g/(kg-day)	3.402	0.377	0.9989	3.408	0.375	-11,556.6
WI/BW	Control	Tap	g/(kg-day)	2.762	0.595	0.9850	2.798	0.591	-11,687.0
WI/BW	Pregnant	Total	g/(kg-day)	3.398	0.377	0.9946	3.406	0.384	-353.3
WI/BW	Pregnant	Tap	g/(kg-day)	2.703	0.650	0.9881	2.740	0.646	-355.4
WI/BW	Lactating	Total	g/(kg-day)	3.548	0.342	0.9963	3.557	0.342	-144.2
WI/BW	Lactating	Tap	g/(kg-day)	2.924	0.489	0.9764	2.963	0.488	-147.0

a Total = tap water intake (including tea, coffee, and other beverages or foods made from or reconstituted with tap water) plus other water intake (including carbonated beverages, most alcoholic beverages and intrinsic water in foods).

Source: Burmaster, 1998.

Table 3. Best-Fit Bivariate Lognormal Distributions for Water Intake and Body Weight of Women, 15 to 49 Years Old

Group	Source	MLE WI Muhat	MLE WI Sigmahat	MLE WI/BW Muhat	MLE WI/BW Sigmahat	Implied BW Muhat	Paired BW Sigmahat	Paired WI, BW Rhohat	A Mean BW (kg)
Control	Total	7.510	0.347	3.408	0.375	4.102	0.228	0.201	62.07
Control	Tap	6.906	0.593	2.798	0.591	4.108			
Pregnant	Total	7.570	0.349	3.406	0.384	4.165	0.217	0.142	65.90
Pregnant	Tap	6.904	0.640	2.740	0.646	4.164			
Lactating	Total	7.675	0.307	6.557	0.642	4.117	0.259	0.278	63.48
Lactating	Tap	7.073	0.492	2.963	0.488	4.110			

Source: Burmaster, 1998.

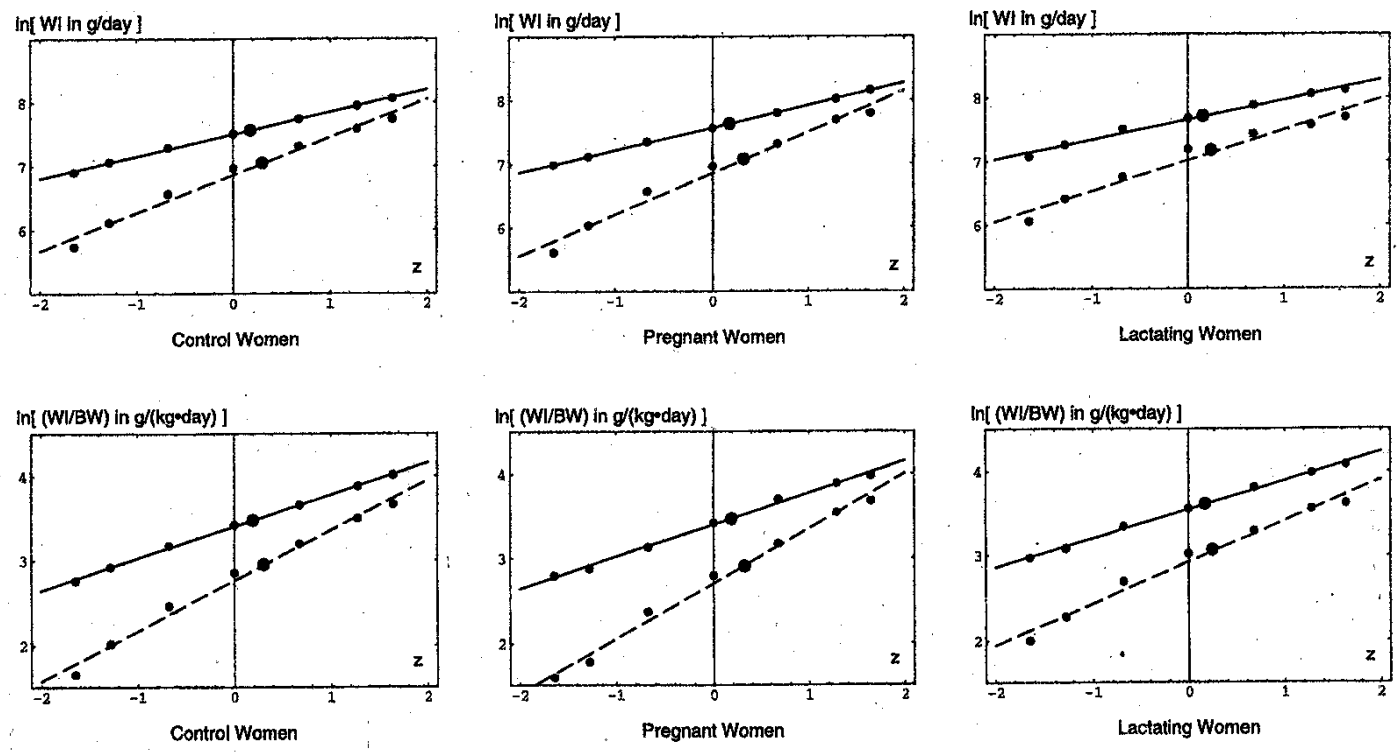

Figure 1. Lognormal Probability Plots for Water Ingested by Women (solid lines indicate total water intake and dashed lines indicate tap water intake).