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**BLOOD LEAD CONCENTRATIONS OF
U.S. ADULT FEMALES:
SUMMARY STATISTICS FROM PHASES 1 AND 2
OF THE NATIONAL HEALTH AND NUTRITION
EVALUATION SURVEY (NHANES III)**

Office of Solid Waste and Emergency Response
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Washington, DC 20460

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Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III)

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1.0 Introduction

In 1996 the Technical Review Workgroup for Lead (TRW) provided guidance for assessing lead risks to adults from exposures to lead in soil. The Adult Lead Methodology (ALM) (U.S. EPA, 1996) includes two parameters that are the subject of this report. The background blood lead concentration ($PbB_{adult,0}$) represents the typical blood lead concentration (PbB) ($\mu\text{g}/\text{dL}$) in women of child-bearing age, in the absence of exposures at the site being assessed. The parameter $GSD_{i,adult}$ is the estimated value of the individual geometric standard deviation (GSD); the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations. Default values for both $PbB_{adult,0}$ and $GSD_{i,adult}$ were derived from an analysis of blood lead data for women 17–45 years of age, from Phase 1 of the Third National Health and Nutrition Evaluation Survey (NHANES III, Phase 1) as well as consideration of available site-specific data on PbB GSDs (U.S. EPA, 1996). Based on those analyses the following default values ranges were recommended: $PbB_{adult,0}$, 1.7–2.2 $\mu\text{g}/\text{dL}$ and $GSD_{i,adult}$, 1.9–2.1.

Data from Phase 2 of the NHANES III became available subsequent to the latter analysis. The NHANES III survey was designed to be completed in two phases; while unbiased estimates of population parameters may be obtained using data from either phase separately, more precise estimates are obtained from combining the two phases (CDC, 1996a). Therefore, the availability of the complete NHANES III data prompted a reexamination of the basis for the default values for these two parameters, the results of which are provided in this report. The analysis reported here estimates the geometric mean (GM) and GSD of PbBs of U.S. non-institutionalized women between the ages 17–45 years based on data collected in Phases 1 and 2 of the NHANES. As was the approach taken in 1996, estimates were made for the major race/ethnicity categories represented in the NHANES III survey: non-Hispanic white, non-Hispanic black, Mexican-American, and *Other*. Additionally, results of the combined Survey Phases are presented separately for each of the regional quadrants of the NHANES Survey.

Decreases in estimates of GM PbBs observed between Phases 1 and 2 are offset by increases in the GSD. The net effect is that the ranges of Preliminary Remediation Goals (PRGs) calculated using the ALM do not differ appreciably between the two phases.

Technical Approach: Information on age, race/ethnicity, and PbB concentration for adults 17–45 years of age was extracted from the NHANES III database (CDC, 1997). Data from both phases of the NHANES III was used in this analysis in accordance with CDC recommendations (CDC, 1996a). An accurate estimate for the GM from any subset of the PbB concentrations can be made by using the sample weights included in the NHANES III database. To obtain an accurate estimate for the GSD from a subset of the PbB concentrations, however, is more complicated because the mathematical formula that is used to calculate a GSD is not linear. When estimating a measure of variability, such as the GSD, the sample weights provided in NHANES do not fully account for the complex sampling design used in NHANES III. Furthermore, the nature and degree of bias in the estimate of a GSD that is calculated using only the sample weights are unknown. To partially address this source of uncertainty, two approaches were used to estimate the GSD as described below.

In the first approach, estimates for the GM and GSD were obtained using SAS (release 8.00, SAS Institute Inc.) and the sample weights recommended by CDC (1996a); this was the same

approach used in the analysis of the NHANES Phase 1 data (U.S. EPA, 1996). Standard errors for the estimates of the GM PbB were estimated using SUDAAN (version 7.5, a program that is implemented within SAS).

In the second approach, a lognormal probability plot was created using the empirical cumulative distribution (ECD) (i.e., percentiles) estimated with SUDAAN for each race/ethnicity group defined in NHANES III. The ECDs were estimated using SUDAAN. SUDAAN is designed to compute statistics (e.g., means and percentiles) and their standard errors for data derived from complex sample surveys such as the NHANES III. (SUDAAN does not calculate estimates of population variance, such as the GSD.) The analysis utilizes the sample weights and pseudo-primary sampling units and pseudo-stratums provided in the NHANES III (CDC, 1996a). The sample weights incorporate the differential probabilities of selection of survey participants and include adjustments for non-coverage and non-response. The pseudo-primary sampling units and pseudo-stratums account for the multistage sampling design and are necessary to estimate accurate standard errors of parameter estimates.

The GM PbB and GSD estimated from the probability plots were compared to those estimated directly from NHANES III with SUDAAN and SAS as a qualitative check on the curve fitting procedure. A quantitative check on the curve fitting is provided by the coefficient of determination (R^2) that is reported for each probability plot.

2.0 Results

Table 1 presents the percentiles of PbB estimated for U.S. women, 17–45 years of age, stratified by race/ethnicity, along with their standard errors and 95% confidence intervals. Table 2 presents estimates of the GM PbB and GSD, stratified by race/ethnicity. The values of the GM estimated from the probability plots (Figures 1–5) were close to those estimated directly from NHANES III using SUDAAN, although they were consistently higher (by an average of 0.03 $\mu\text{g}/\text{dL}$). The values of GSD estimated from the probability plots were close to the those estimated using SAS, however, the values of GSD estimated from the probability plots are consistently lower (by an average of 0.10 $\mu\text{g}/\text{dL}$).

The probability plots and the close agreement between the estimates of the GM and GSD based on the two approaches is a qualitative indication that the lognormal distribution is a reasonable model for the PbBs included in this analysis. A more quantitative indication is provided by the high R^2 's shown in Figures 1–5.

The results indicate that the GM PbB for the non-Hispanic black and Mexican-American race/ethnicity groups are greater than the GMs for the non-Hispanic white group and the combined groups. The results also indicate greater variability in the PbBs of the Mexican-American group than the non-Hispanic black, non-Hispanic white, or combined groups. These outcomes are consistent with the results obtained from the analysis of Phase 1 of the NHANES (U.S. EPA, 1996). Due to the small sample size and related high uncertainty, the results shown for the *Other* race/ethnicity group should be interpreted with caution (CDC, 1996a).

Table 3a shows the GM and GSD by census regions and race/ethnicity. Figure 6 shows the delineation of the states into the four census regions (U.S. Census Bureau, 2001). In these analyses, GSDs were estimated using SAS. The pattern of higher GM in non-Hispanic blacks and Mexican Americans than in non-Hispanic whites persisted when data were stratified by geographic quadrant. The GMs for all race/ethnicity categories were higher in the northeast quadrant than in other quadrants. GSDs for the non-Hispanic whites and *Others* groups were relatively consistent across quadrants; the GSDs for non-Hispanic black and Mexican-American groups varied from 1.9–2.2 and 1.9–2.4, respectively. The lowest GSDs for each race/ethnicity group occurred in the northeast quadrant, while the highest GSDs are found in the midwest region. The Mexican-American race/ethnicity group has the largest GSD for each census region, with the exception of the northeast. The GM and GSD estimated for Mexican-Americans in the northeast region should be interpreted with caution due to the low sample number (24).

In Tables 3b and 3c the 17–45 year age group was further divided into three age groups: 17–25, 26–35, and 36–45. Table 3b shows the GM and GSD by the three age categories and race/ethnicity; Table 3c shows the GM and GSD by the three age categories and census region. Table 3b shows the GM PbB for all race/ethnicity groups combined increases with age; this pattern is also observed within each of the race/ethnicity groups. The pattern of higher GM in non-Hispanic blacks and Mexican Americans persisted when data were stratified by age groups. Estimates of the GSD across age groups for all race/ethnic groups combined varied by only 0.02. Variance of the estimated GSDs across age groups increases once the data is stratified by race-ethnicity.

Table 3c shows the trend of higher GM PbBs in the northeast persisted after the data were stratified by age groups. Table 3c also shows the largest increase in GM PbBs across age groups occurs in the Midwest, followed by the Northeast, West, and South. Estimates of the GSD across age groups and within census region varied by 0.01–0.02.

3.0 Discussion and Conclusions

3.1 SOURCES OF UNCERTAINTY

Table 4 shows the occurrence of non-detects for each of the two phases of the NHANES III and for both phases combined. The percentage of non-detects for the combined race/ethnicity groups was 21% and ranged from 17% for the non-Hispanic black group to 28% for the non-Hispanic white group. The increase in the overall rate of non-detects between Phases 1 and 2 was 7.3% and was fairly consistent across the different race/ethnicity groups. In this analysis, non-detects were set equal to $\frac{1}{2}$ the detection limit of $1.0 \mu\text{g/dL}$, which is consistent with other reported analyses of PbB concentrations from the NHANES III (Brody et al., 1994). Preliminary analysis indicated the estimates of GM PbB and GSD are highly sensitive to values assigned to non-detects. Estimates of the GM/GSD for all of the race/ethnicity groups combined were 1.8/1.7, 1.5/2.1, and 1.3/2.7 when non-detects were set equal to the detection limit of $1.0 \mu\text{g/dL}$, $\frac{1}{2}$ the detection limit, and $\frac{1}{4}$ the detection limit, respectively. The sensitivity of the parameter estimates to the method used to treat non-detects should be considered in interpreting differences between parameter values estimated with different approaches or with different subsets of the NHANES III data. Furthermore, the impact of the uncertainty related to the treatment of detection limits will increase if the trend of decreasing PbB continues, unless the detection limits are lowered.

As previously discussed, the method used to estimate the PbB GSD does not fully account for the complex sampling design employed in the NHANES III. Research would be required to determine how to calculate more accurate estimates of the GSD and its standard error. It is not clear if such an effort would be of great value, in terms of reducing uncertainty in the GSD estimate. NHANES III is a well designed study and relatively large sample sizes were available for developing the GSD estimates. The more consequential issue for risk assessment is variation of the GSD between population subgroups as compared with the uncertainty in the estimates of GSD.

Based on this analysis and the above considerations, the lognormal distribution appears to provide an adequate model for distribution of PbBs for non-institutionalized U.S. women, 17–45 years of age. The results obtained from the probability plots were similar to those obtained with the direct computation of the GM and GSD; thus, either approach appears to be reasonable and adequate for parameter estimation. However, direct computation from the NHANES III is recommended as the preferred approach, due to its simplicity. Estimates for the PbB GM (point estimates and confidence intervals) and GSD, based on the direct computation approach, are discussed in the remainder of this report (confidence intervals for GSD could not be calculated with the approaches used in this analysis).

3.2 COMPARISON OF 1996 DEFAULT VALUES AND UPDATED RANGES BASED ON NHANES PHASES 1 AND 2

The purpose of this analysis was to incorporate data from Phase 2 of the NHANES III survey in the estimates of the GM and GSD of PbB in the non-institutionalized U.S. women, 17–45 years of age. This is consistent with the recommendations of the CDC (1996a); incorporation of the phase 2 data will tend to increase confidence in the estimates of the GM and GSD of the distribution of PbB in non-institutionalized U.S. women, 17–45 years of age.

Comparisons of the values for the GM PbB and GSD based on the data from the combined Phases 1 and 2 of the NHANES III with the values estimated from the NHANES III Phase 1 (U.S. EPA, 1996) and the default values for $PbB_{adult,0}$ and $GSD_{i,adult}$ used in the EPA ALM (U.S. EPA, 1996) are presented in Table 5. Several observations can be made from these comparisons:

- a. Both the EPA ALM default value range for $PbB_{adult,0}$ (1.7–2.2) and the range of GM PbB based on the NHANES III Phase 1 data (1.7–2.1), lie outside and above the 95% confidence intervals for the GM PbB estimated from the combined data from the NHANES III phases 1 and 2 (1.4–1.9). Thus, the combined data from Phases 1 and 2 of the NHANES III suggest a lower GM PbB than previously reported in the EPA ALM documentation (U.S. EPA, 1996).
- b. Both the upper end of the range of the EPA ALM default values for $GSD_{i,adult}$ and the upper end of the race/ethnicity range for the GSD estimated from the NHANES III Phase 1 data match the lower end of the race/ethnicity range for the GSD estimated from the combined data from the NHANES III Phases 1 and 2. Thus, the combined data from Phases 1 and 2 of the NHANES III suggest a higher GSD than previously reported in the EPA ALM documentation (U.S. EPA, 1996).
- c. The above results support several updated value ranges for $PbB_{adult,0}$ for use in the EPA ALM, depending upon how the results are stratified. Stratifying the data by race/ethnicity groups, two reasonable ranges for $PbB_{adult,0}$ are: 1) 1.4–1.8 $\mu\text{g/dL}$, the range of the estimated GMs for the three major race/ethnicity groups; and 2) a more conservative and equally supportable range would be 1.6–1.9, the range of the 95% upper confidence limits of the GM for the major race/ethnicity groups.
- d. Stratifying the data by census regions, reasonable updated ranges for $PbB_{adult,0}$ are: 1) 1.4–2.0 $\mu\text{g/dL}$, the range of the estimated GMs for the four census regions; and 2) a more conservative and equally supportable range would be 1.5–2.2, the range of the 95% upper confidence limits of the GM for the four census regions.
- e. The results also support use of an updated value ranges for $GSD_{i,adult}$ in the EPA ALM. Stratifying the data by race/ethnicity groups, a reasonable range for $GSD_{i,adult}$ is 2.1–2.3.
- f. Stratifying the data by census regions, a reasonable updated range for $GSD_{i,adult}$ is 2.0–2.2.

3.3 IMPACTS OF UPDATED VALUE RANGES FOR $PbB_{adult,0}$ AND $GSD_{i,adult}$ ON PRGS CALCULATED WITH THE EPA ALM

Table 3a contains preliminary remediation goals calculated with the EPA ALM, by census region and race/ethnicity, using the estimated GMs and GSDs for the respective regions and race/ethnicity groups.

- a. The range for the PRGs established in 1996, based on the range of GMs and GSDs provided in the ALM (Table 6), is 749–1754 $\mu\text{g Pb/g soil}$ (ppm).
- b. Based on the range of values shown for the major race/ethnicity groups in Table 3a (i.e., for “All Regions”), the range of the PRGs decreased considerably to 794–1,288 ppm.
- c. Based on the range of values shown for the census regions in Table 3a, the range of the PRGs decreased, but is shifted higher, to 1,079–1,366 ppm.

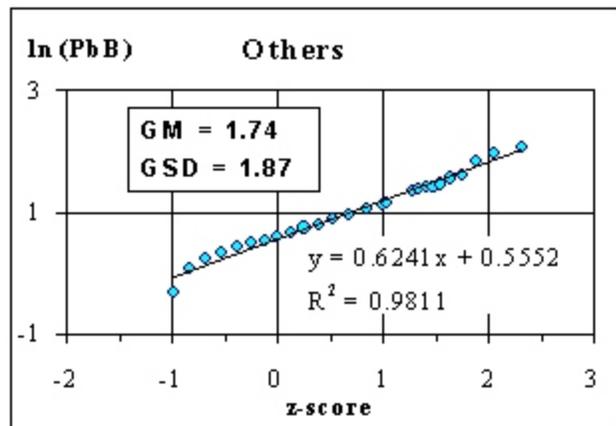
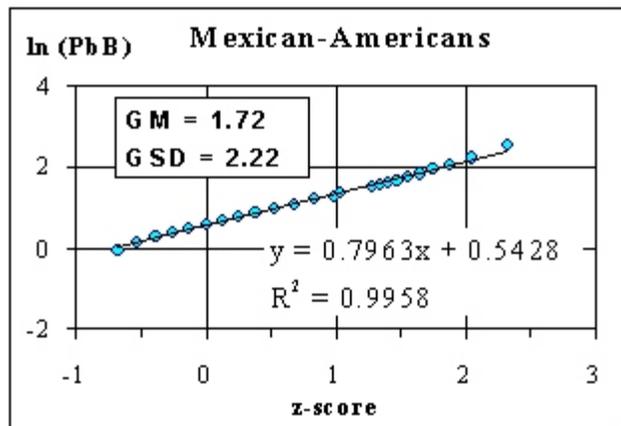
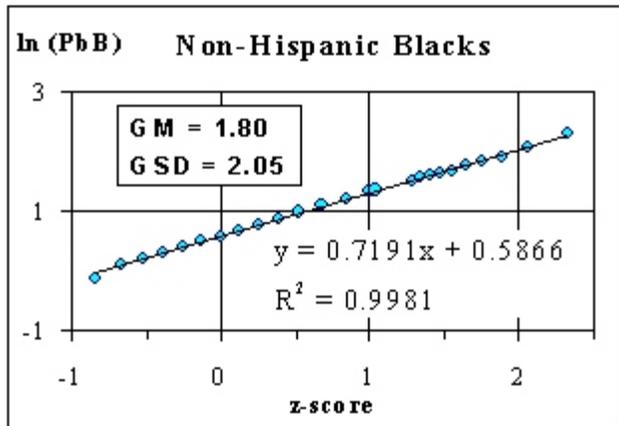
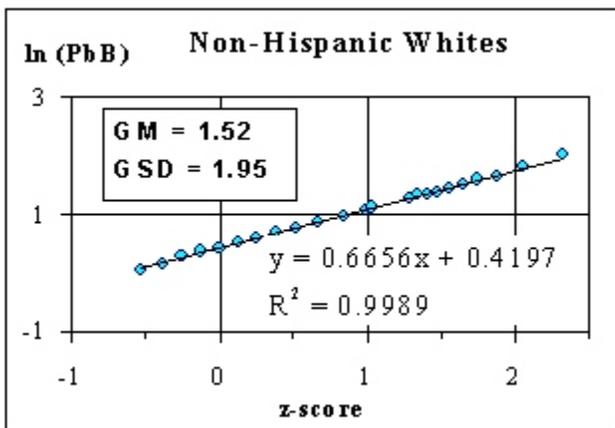
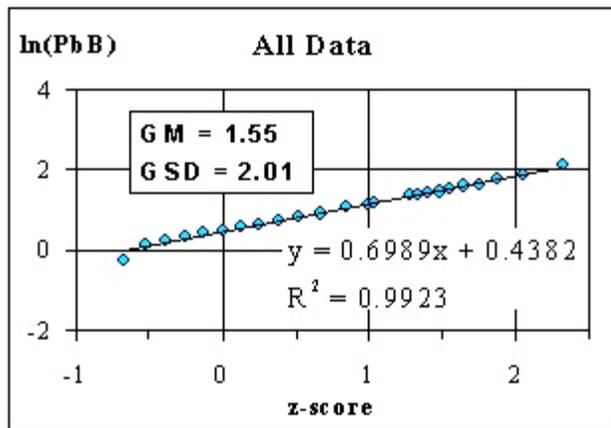
The similarity in the PRG ranges that are calculated, when each of the $PbB_{adult,0}$ and $GSD_{i,adult}$ ranges are assumed, suggests that use of the updated ranges for these parameters, although reasonably supported by the NHANES III, may not produce a large change in the PRG calculated at any given site.

3.4 RECOMMENDATIONS

Previous recommendations for the Interim Adult Lead Model were presented, in aggregate as well as separately, for the racial/ethnic categories used by the NHANES III survey. This revision retains the previous racial/ethnic categories and also presents the GM and GSD for each of the four geographic quadrants delineated by NHANES III. For site applications of the ALM, estimates of the $PbB_{adult,0}$ and $GSD_{i,adult}$ parameters could be based on either race/ethnicity or geographic categories determined appropriate based on the specific demographic or geographic characteristics of the site. Perceived gains in specificity achieved from stratifying on both demographic and geographic characteristics may be offset by increased uncertainty caused by using less of the available survey data. This uncertainty is evident in the reduction of sample size and increased standard errors in the PbB (GM). Unfortunately, corresponding uncertainty in the estimates of the GSD is not quantifiable by usual methods due to the complex sampling design used in NHANES III.

Estimates for $PbB_{adult,0}$ (GM) and $GSD_{i,adult}$ (GSD) by census region and race/ethnicity group are provided for information. However, it is not recommended to base estimates of the $PbB_{adult,0}$ and $GSD_{i,adult}$ from the NHANES III survey that are stratified by both census region and race/ethnicity group in the ALM to estimate site-specific risks because of the small sample sizes, particularly in the Northeast and Midwest regions (e.g., $n = 157$ for Mexican-Americans in the Midwest region). The small sample sizes are reflected in the large standard errors for the GM in those regions (relative to the South and West regions). In addition to race/ethnicity and census region, other factors that should be considered when selecting an estimate for the $PbB_{adult,0}$ and $GSD_{i,adult}$ include characteristics of current and anticipated future exposed populations, age of the housing stock in the area of the site and other potential sources of lead (e.g., industrial discharges).

Based on this analysis, updated ranges for the $PbB_{adult,0}$ and $GSD_{i,adult}$ parameters in the EPA ALM are supported by the data collected in the completed NHANES III survey (Phases 1 and 2). Although the use of these updated ranges in the EPA ALM may not appreciably change PRGs calculated with the methodology, it is recommended that data from both phases of NHANES III be used in all PbB analyses; this is consistent with the CDC's recommendation (CDC, 1996a).



FIGURES 1–5. Probability plots were prepared from the log-transformed percentiles estimated with SAS-SUDAAN. The geometric mean (GM) was estimated by exp (intercept) and the geometric standard deviation (GSD) was estimated by exp (Slope). The GM and GSD estimated with this method compare favorably with the estimates produced with SAS-SUDAAN. The mean difference between the GMs estimated by the two methods is approximately 0.03; the mean difference in the GSDs is approximately 0.10.

TABLE 1. Estimated Cumulative Distribution Function of Blood Lead Concentration ($\mu\text{g/dL}$) in U.S. Women, 17–45 years of Age

Race/ethnicity	Percentile	CTE ^a	SE ^b	95 th LCL ^c	95 th UCL ^c
All (<i>n</i> = 5016)	minimum ^d	0.5 ^e	na ^f	na	na
	5	– ^g	–	–	–
	10	–	–	–	–
	15	–	–	–	–
	20	–	–	–	–
	25	0.77	0.10	0.58	0.97
	30	1.11	0.03	1.05	1.16
	35	1.25	0.03	1.19	1.30
	40	1.38	0.02	1.34	1.43
	45	1.49	0.02	1.45	1.53
	50	1.61	0.02	1.56	1.66
	55	1.75	0.03	1.70	1.81
	60	1.89	0.03	1.83	1.95
	65	2.06	0.03	2.00	2.11
	70	2.22	0.03	2.16	2.28
	75	2.47	0.04	2.39	2.54
	80	2.81	0.05	2.71	2.90
	85	3.22	0.07	3.09	3.36
	90	3.81	0.05	3.71	3.90
	91	3.89	0.05	3.80	3.98
	92	4.05	0.07	3.90	4.19
93	4.26	0.08	4.10	4.42	
94	4.52	0.09	4.33	4.71	
95	4.84	0.12	4.61	5.07	
96	5.11	0.09	4.94	5.28	
97	5.73	0.18	5.37	6.09	
98	6.50	0.16	6.17	6.83	
99	8.13	0.14	7.86	8.41	
	maximum ^h	29.2	na	na	na

^aCTE: central tendency estimate

^bSE: standard error of the estimate (balanced repeated replication method)

^c95th LCL/UCL: lower/upper 95th % confidence limits for the estimated percentile

^dMinimum value shown is the value assigned to non-detects (i.e., 1/2 detection limit of 1 $\mu\text{g/dL}$)

^eThe value 0.5 is the value assigned to non-detects; the limit of detection for blood lead concentration reported by CDC is 1.0 $\mu\text{g/dL}$ (CDC, 1996b).

^fna: not applicable

^gIndicates the presence of non-detects prevented an estimate of the percentile and its standard error

^hMaximum value shown is the observed values extracted from the NHANES III database; it is not an estimate.

TABLE 1. Estimated Cumulative Distribution Function of Blood Lead Concentration ($\mu\text{g}/\text{dL}$) in U.S. Women, 17–45 years of Age—Continued

Race/ethnicity	Percentile	CTE ^a	SE ^b	95 th LCL ^c	95 th UCL ^c
non-Hispanic white (<i>n</i> = 1529)	minimum ^d	0.5 ^e	na ^f	na	na
	5	– ^g	–	–	–
	10	–	–	–	–
	15	–	–	–	–
	20	–	–	–	–
	25	–	–	–	–
	30	1.03	0.05	0.92	1.14
	35	1.18	0.03	1.11	1.25
	40	1.32	0.03	1.25	1.39
	45	1.44	0.02	1.39	1.49
	50	1.54	0.03	1.48	1.59
	55	1.67	0.04	1.60	1.74
	60	1.82	0.03	1.75	1.88
	65	1.97	0.04	1.89	2.04
	70	2.13	0.03	2.06	2.19
	75	2.31	0.05	2.21	2.42
	80	2.64	0.07	2.50	2.78
	85	3.06	0.08	2.90	3.22
	90	3.61	0.07	3.47	3.76
	91	3.74	0.06	3.62	3.87
	92	3.84	0.05	3.74	3.94
93	3.98	0.09	3.81	4.16	
94	4.23	0.11	4.01	4.44	
95	4.52	0.09	4.33	4.71	
96	4.89	0.14	4.61	5.18	
97	5.20	0.17	4.86	5.53	
98	6.03	0.20	5.62	6.43	
99	7.41	0.42	6.57	8.26	
	maximum ^h	12.4	na	na	na

^aCTE: central tendency estimate

^bSE: standard error of the estimate (balanced repeated replication method)

^c95th LCL/UCL: lower/upper 95th % confidence limits for the estimated percentile

^dMinimum value shown is the value assigned to non-detects (i.e., ½ detection limit of 1 $\mu\text{g}/\text{dL}$)

^eThe value 0.5 is the value assigned to non-detects; the limit of detection for blood lead concentration reported by CDC is 1.0 $\mu\text{g}/\text{dL}$ (CDC, 1996b).

^fna: not applicable

^gIndicates the presence of non-detects prevented an estimate of the percentile and its standard error

^hMaximum value shown is the observed values extracted from the NHANES III database; it is not an estimate. .

TABLE 1. Estimated Cumulative Distribution Function of Blood Lead Concentration ($\mu\text{g}/\text{dL}$) in U.S. Women, 17–45 years of Age—*Continued*

Race/ethnicity	Percentile	CTE ^a	SE ^b	95 th LCL ^c	95 th UCL ^c
non-Hispanic black (<i>n</i> = 1692)	minimum ^d	0.5 ^e	na ^f	na	na
	5	– ^g	–	–	–
	10	–	–	–	–
	15	–	–	–	–
	20	0.89	0.11	0.67	1.10
	25	1.13	0.03	1.07	1.19
	30	1.25	0.03	1.20	1.31
	35	1.38	0.04	1.30	1.46
	40	1.52	0.05	1.43	1.61
	45	1.66	0.04	1.57	1.74
	50	1.79	0.05	1.69	1.89
	55	1.95	0.06	1.83	2.08
	60	2.16	0.07	2.02	2.30
	65	2.40	0.08	2.23	2.57
	70	2.69	0.08	2.54	2.85
	75	3.03	0.08	2.88	3.19
	80	3.37	0.13	3.11	3.63
	85	3.87	0.11	3.65	4.09
	90	4.53	0.16	4.21	4.86
	91	4.75	0.13	4.48	5.01
	92	4.91	0.12	4.68	5.15
93	5.11	0.12	4.86	5.36	
94	5.28	0.23	4.81	5.75	
95	5.76	0.23	5.30	6.22	
96	6.25	0.21	5.83	6.68	
97	6.71	0.25	6.21	7.21	
98	7.84	0.30	7.25	8.43	
99	9.77	0.77	8.22	11.32	
	maximum ^h	20.3	na	na	na

^aCTE: central tendency estimate

^bSE: standard error of the estimate (balanced repeated replication method)

^c95th LCL/UCL: lower/upper 95th % confidence limits for the estimated percentile

^dMinimum value shown is the value assigned to non-detects (i.e., ½ detection limit of 1 $\mu\text{g}/\text{dL}$)

^eThe value 0.5 is the value assigned to non-detects; the limit of detection for blood lead concentration reported by CDC is 1.0 $\mu\text{g}/\text{dL}$ (CDC, 1996b).

^fna: not applicable

^gIndicates the presence of non-detects prevented an estimate of the percentile and its standard error

^hMaximum value shown is the observed values extracted from the NHANES III database; it is not an estimate.

TABLE 1. Estimated Cumulative Distribution Function of Blood Lead Concentration ($\mu\text{g}/\text{dL}$) in U.S. Women, 17–45 years of Age—Continued

Race/ethnicity	Percentile	CTE ^a	SE ^b	95 th LCL ^c	95 th UCL ^c
Mexican - American (n = 1562)	minimum ^d	0.5 ^e	na ^f	na	na
	5	— ^g	—	—	—
	10	—	—	—	—
	15	—	—	—	—
	20	—	—	—	—
	25	0.92	0.11	0.70	1.15
	30	1.14	0.03	1.07	1.21
	35	1.31	0.05	1.22	1.40
	40	1.47	0.04	1.40	1.55
	45	1.63	0.04	1.54	1.71
	50	1.81	0.05	1.72	1.90
	55	1.97	0.05	1.88	2.07
	60	2.16	0.05	2.07	2.26
	65	2.37	0.05	2.26	2.48
	70	2.59	0.06	2.48	2.70
	75	2.90	0.07	2.75	3.05
	80	3.29	0.08	3.14	3.44
	85	3.79	0.10	3.59	3.99
	90	4.51	0.13	4.24	4.77
	91	4.74	0.16	4.42	5.06
	92	5.02	0.16	4.70	5.34
93	5.34	0.20	4.94	5.75	
94	5.77	0.20	5.37	6.18	
95	6.26	0.34	5.58	6.94	
96	7.11	0.35	6.41	7.81	
97	7.85	0.40	7.05	8.66	
98	9.15	0.37	8.41	9.88	
99	12.29	0.97	10.34	14.23	
	maximum ^h	29.2	na	na	na

^aCTE: central tendency estimate

^bSE: standard error of the estimate (balanced repeated replication method)

^c95th LCL/UCL: lower/upper 95th % confidence limits for the estimated percentile

^dMinimum value shown is the value assigned to non-detects (i.e., ½ detection limit of 1 $\mu\text{g}/\text{dL}$)

^eThe value 0.5 is the value assigned to non-detects; the limit of detection for blood lead concentration reported by CDC is 1.0 $\mu\text{g}/\text{dL}$ (CDC, 1996b).

^fna: not applicable

^gIndicates the presence of non-detects prevented an estimate of the percentile and its standard error

^hMaximum value shown is the observed values extracted from the NHANES III database; it is not an estimate.

TABLE 1. Estimated Cumulative Distribution Function of Blood Lead Concentration ($\mu\text{g}/\text{dL}$) in U.S. Women, 17–45 years of Age—Continued

Race/ethnicity	Percentile	CTE ^a	SE ^b	95 th LCL ^c	95 th UCL ^c
other racial-ethnic groups (n = 233)	minimum ^d	0.5 ^e	na ^f	na	na
	5	– ^g	–	–	–
	10	–	–	–	–
	15	–	–	–	–
	20	1.07	0.18	0.71	1.42
	25	1.24	0.09	1.06	1.42
	30	1.37	0.06	1.25	1.50
	35	1.52	0.07	1.38	1.66
	40	1.63	0.05	1.53	1.72
	45	1.72	0.05	1.63	1.81
	50	1.81	0.05	1.71	1.92
	55	1.92	0.07	1.78	2.06
	60	2.06	0.07	1.92	2.20
	65	2.20	0.09	2.02	2.39
	70	2.39	0.08	2.23	2.55
	75	2.52	0.11	2.31	2.74
	80	2.80	0.13	2.53	3.06
	85	3.09	0.32	2.45	3.73
	90	3.88	0.13	3.62	4.13
	91	3.93	0.12	3.69	4.17
	92	3.99	0.12	3.74	4.24
93	4.11	0.15	3.80	4.42	
94	4.28	0.25	3.78	4.77	
95	4.71	0.36	3.99	5.42	
96	5.03	0.51	4.02	6.05	
97	6.21	0.95	4.30	8.12	
98	7.09	0.89	5.30	8.87	
99	7.86	0.62	6.61	9.10	
	maximum ^h	9.20	na	na	na

^aCTE: central tendency estimate

^bSE: standard error of the estimate (balanced repeated replication method)

^c95th LCL/UCL: lower/upper 95th % confidence limits for the estimated percentile

^dMinimum value shown is the value assigned to non-detects (i.e., 1/2 detection limit of 1 $\mu\text{g}/\text{dL}$)

^eThe value 0.5 is the value assigned to non-detects; the limit of detection for blood lead concentration reported by CDC is 1.0 $\mu\text{g}/\text{dL}$ (CDC, 1996b).

^fna: not applicable

^gIndicates the presence of non-detects prevented an estimate of the percentile and its standard error

^hMaximum value shown is the observed values extracted from the NHANES III database; it is not an estimate.

TABLE 2. Estimated Geometric Means and Geometric Standard Deviations of Blood Lead Concentration ($\mu\text{g/dL}$) in U.S. Women, 17–45 Years of Age

Race/ ethnicity ^a	<i>n</i>	GM ^b (prob plot)	GM ^c (SUDAAN)	GM SE ^d (SUDAAN)	GSD ^e (prob plot)	GSD ^f (SAS)	R ²
All	5016	1.55	1.53	0.05	2.01	2.11	>0.99
non-Hispanic white	1529	1.52	1.45	0.06	1.95	2.09	>0.99
non-Hispanic black	1692	1.80	1.78	0.06	2.05	2.16	>0.99
Mexican- American	1562	1.72	1.70	0.06	2.22	2.29	>0.99
<i>Other</i>	233	1.74	1.74	0.11	1.87	1.97	>0.98

^aRace-Ethnicity categories provided in NHANES III

^bGM: Estimates of the geometric mean PbB estimated from the log probability plots (Figures 1-5).

^cGM: Estimates of the geometric mean PbB estimated directly from NHANES III using SUDAAN software.

^dGM SE: Standard error of the geometric mean estimated with SUDAAN (Taylor series method).

^eGSD: Geometric standard deviation estimated from the log probability plots (Figures 1-5).

^fGSD: Geometric standard deviation estimated directly from NHANES III using SAS and the WTPFEX6 sample weight.

^gR²: Coefficient of variation from the probability plots shown in Figures 1–5.

TABLE 3a. Estimated Geometric Means and Geometric Standard Deviations of Blood Lead Concentration ($\mu\text{g/dL}$) in U.S. Women, 17 - 45 Years of Age, By Census Region and Race/Ethnicity

All Regions					
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d	PRG^e
All	5016	1.53	0.05	2.11	1,197
non-Hispanic white	1529	1.45	0.06	2.09	1,288
non-Hispanic black	1692	1.78	0.06	2.16	938
Mexican-American	1562	1.70	0.06	2.29	794
<i>Other</i>	233	1.74	0.11	1.97	1,321
Northeast Region					
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d	PRG^e
All	629	1.98	0.16	2.00	1,092
non-Hispanic white	240	1.93	0.18	2.01	1,107
non-Hispanic black	273	2.55	0.24	1.94	823
Mexican-American	24	3.32	0.60	1.89	NR ^f
<i>Other</i>	92	1.83	0.16	1.94	NR
Midwest Region					
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d	PRG^e
All	945	1.53	0.12	2.18	1,079
non-Hispanic white	428	1.42	0.14	2.11	1,273
non-Hispanic black	347	2.11	0.12	2.24	582
Mexican-American	157	1.88	0.25	2.39	535
<i>Other</i>	13	2.83	0.52	2.07	NR

TABLE 3a. Estimated Geometric Means and Geometric Standard Deviations of Blood Lead Concentration ($\mu\text{g/dL}$) in U.S. Women, 17 - 45 Years of Age, By Census Region and Race/Ethnicity—Continued

South Region					
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d	PRG^e
All	2159	1.39	0.04	2.07	1,366
non-Hispanic white	595	1.30	0.05	2.04	1,485
non-Hispanic black	947	1.51	0.07	2.11	1,211
Mexican-American	560	1.82	0.16	2.16	910
<i>Other</i>	57	1.76	0.20	1.85	NR
West Region					
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d	PRG^e
All	1283	1.40	0.09	2.11	1,287
non-Hispanic white	266	1.30	0.08	2.08	1,410
non-Hispanic black	125	1.87	0.13	2.04	1,089
Mexican-American	821	1.59	0.05	2.31	842
<i>Other</i>	71	1.48	0.20	1.92	NR

^aRace-Ethnicity categories provided in NHANES III

^bGM: Estimates of the geometric mean PbB estimated using SUDAAN software.

^cGM SE: Standard error of the geometric mean estimated with SUDAAN (Taylor series method).

^dGSD: geometric standard deviation estimated using SAS and the WTPFEX6 sample weight.

^ePRG: Preliminary Remediation Goal; determined with the EPA Adult Lead Model using the indicated GMs and GSDs and with the other ALM parameters set to default values.

^fNR: Not Reported; PRGs are not reported when the number of observations (*n*) is less than 100.

TABLE 3b. Estimated Geometric Means and Geometric Standard Deviations of Blood Lead Concentration ($\mu\text{g/dL}$) in U.S. Women, By Age and Race/Ethnicity

Age Group: 17-25				
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d
All	1625	1.23	0.05	2.08
non-Hispanic white	417	1.12	0.06	2.02
non-Hispanic black	547	1.50	0.07	2.07
Mexican-American	577	1.55	0.08	2.35
<i>Other</i>	84	1.39	0.14	2.00
Age Group: 26-35				
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d
All	1789	1.55	0.06	2.07
non-Hispanic white	568	1.47	0.07	2.05
non-Hispanic black	599	1.72	0.08	2.23
Mexican-American	555	1.74	0.08	2.27
<i>Other</i>	67	1.85	0.16	1.78
Age Group: 36-45				
Race/Ethnicity^a	<i>n</i>	GM^b	GM SE^c	GSD^d
All	1602	1.80	0.07	2.09
non-Hispanic white	544	1.71	0.07	2.09
non-Hispanic black	546	2.20	0.11	2.06
Mexican-American	430	1.86	0.09	2.21
<i>Other</i>	82	2.01	0.19	2.00

^aRace-Ethnicity categories provided in NHANES III

^bGM: Estimates of the geometric mean PbB estimated using SUDAAN software.

^cGM SE: Standard error of the geometric mean estimated with SUDAAN (Taylor series method).

^dGSD: geometric standard deviation estimated using SAS and the WTPFEX6 sample weight.

TABLE 3c. Estimated Geometric Means and Geometric Standard Deviations of Blood Lead Concentration ($\mu\text{g/dL}$) in U.S. Women, By Age and Census Region

Age Group: 17-25				
Census Region ^a	<i>n</i>	GM ^b	GM SE ^c	GSD ^d
All	1625	1.23	0.05	2.08
Northeast	211	1.67	0.15	2.01
Midwest	267	1.10	0.11	2.00
South	727	1.16	0.05	2.05
West	420	1.07	0.08	2.09
Age Group: 26-35				
Census Region ^a	<i>n</i>	GM ^b	GM SE ^c	GSD ^d
All	1789	1.55	0.06	2.07
Northeast	214	2.00	0.26	1.94
Midwest	370	1.54	0.10	2.19
South	744	1.40	0.04	2.05
West	461	1.44	0.11	1.98
Age Group: 36-45				
Census Region ^a	<i>n</i>	GM ^b	GM SE ^c	GSD ^d
All	1602	1.80	0.07	2.09
Northeast	204	2.30	0.14	1.99
Midwest	308	1.89	0.19	2.12
South	688	1.62	0.06	2.02
West	402	1.63	0.14	2.16

^aCensus regions provided in NHANES III

^bGM: Estimates of the geometric mean PbB estimated using SUDAAN software.

^cGM SE: Standard error of the geometric mean estimated with SUDAAN (Taylor series method).

^dGSD: geometric standard deviation estimated using SAS and the WTPFEX6 sample weight.

TABLE 4. Comparison of the Rate of Non-Detects in Blood Lead Concentrations Between Phases 1 and 2 of the NHANES III for U.S. Women, 17 - 45 Years of Age

Ethnicity ^a	Phases 1 and 2			Phase 2			Phase 1		
	<i>n</i>	non-detects	% of sample	<i>n</i>	non-detects	% of sample	<i>n</i>	non-detects	% of sample
All	5016	1070	21.3	2769	681	24.6	2247	389	17.3
non-Hispanic white	1529	434	28.4	788	259	32.9	741	175	23.6
non-Hispanic black	1692	285	16.8	1035	202	19.5	657	83	12.6
Mexican-American	1562	312	20.0	800	191	23.9	762	121	15.9
Other	233	39	16.7	146	29	19.9	87	10	11.5

TABLE 5. Comparison of Blood Lead Concentration Estimates of U.S. Women, 17–45 Years of Age, with Default Values Used in the EPA Adult Lead Methodology

Ethnicity ^a	NHANES Phases 1 and 2			NHANES Phase 1 (U.S. EPA, 1996)		
	<i>n</i>	GM (range)	GSD	<i>n</i>	GM	GSD
All	5016	1.5 (1.4–1.6)	2.1	2250	1.8	1.9
non-Hispanic white	1529	1.4 (1.3–1.6)	2.1	742	1.7	1.9
non-Hispanic black	1692	1.8 (1.7–1.9)	2.2	658	2.1	2.0
Mexican-American	1562	1.7 (1.6–1.8)	2.3	763	2.0	2.1
U.S. EPA ALM (1996)						
	–	1.7–2.2	1.8–2.1	–	1.7–2.2	1.8–2.1

TABLE 6. Comparison of PRGs Calculated with the EPA ALM Using Default Value Ranges or Updated Ranges for the $PbB_{adult,0}$ and $GSD_{i,adult}$ Parameters

	$PbB_{adult,0}$ (default) ^a			$PbB_{adult,0}$ (GM range) ^b			$PbB_{adult,0}$ (95% UCL range) ^c	
$GSD_{i,adult}$	1.7	2.2	$GSD_{i,adult}$	1.4	1.8	$GSD_{i,adult}$	1.6	1.9
1.8	1754	1406	1.9	1712	1434	1.9	1573	1365
2.1	1096	749	2.3	988	710	2.3	849	641

^aEPA ALM (U.S. EPA, 1996)

^bRace/ethnicity range of the GM PbBs

^cRace ethnicity range of the 95% upper confidence limit on the GM PbBs

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