REFERENCE RANGES FOR PCDDs, PCDFs, PCBs, PERSISTENT PESTICIDES, AND PCNs FOR THE U.S. POPULATION 2003-2004

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Introduction

The samples were collected as part of the National Health and Nutrition Examination Survey (NHANES) 2003/2004, which is administered by the CDC's National Center for Health Statistics. The NHANES design does not select or exclude participants on the basis of their potential for low or high exposure to a chemical. The current design does not permit examination of exposure levels by locality; state; or region; seasons of the year; proximity to sources of exposure; or use of particular products.

Materials and Methods

The NHANES 2003-2004 protocol includes a home interview followed by a standardized physical examination in a mobile center. Nonfasting blood was obtained by venipuncture. After collection, the serum samples were divided into aliquots and shipped on dry ice to CDC's National Center for Environmental Health were they were frozen until laboratory analysis. The PCDDs, PCDFs, PCBs, pesticides, and PCNs were measured in serum by high resolution gas chromatography/isotope dilution high resolution mass spectrometery (HRGC/IDHRMS).[1,2] The PCDDs, PCDFs, PCBs, and pesticides were measured in serum from a random one-third sub-sample of people aged 12 years and older. Results are given for the total population and also by age group, sex, and race/ethnicity. For these analyses, race/ethnicity is categorized as Mexican Americans (MA), non-Hispanic blacks (NHB), and non-Hispanic whites (NHW). Other race/ethnic groups are included in estimates that are based on the entire population sample. Because of a limited amount of serum available for the analysis, the PCNs are reported from pooled samples collected as part the NHANES 2001-2002 survey. Since the samples constituting the pools originated from the NHANES, which was designed to be representative of the non-institutionalized U.S. population, the pooled results should provide good coverage of the U. S. population. By pooling across design cells, however, we cannot be assured that estimates based on the pooled samples are unbiased. In addition, the measured value for a pooled sample (consisting of individual samples that tend to be log-normally distributed) is comparable to an arithmetic average of log-normal results and thus represents a biased estimate of the central tendency of the samples making up the pool. We corrected for this positive bias using the method described by Caudill et al.[3]

Because the NHANES sample design is complex, statistical sample weights must be used to adjust for the unequal probability of selection into the survey. Sample weights also are used to adjust for possible bias resulting from non-response and are post-stratified to U.S. Census Bureau estimates of the U.S. population. Data were analyzed using

the statistical software package Statistical Analysis System (SAS) **(**version 9.1.3; SAS Institute, Cary, NC**)** and the statistical software package SUDAAN **(**version 9.0.1; Research Triangle Institute, Research Triangle Park, NC**)**. SUDAAN uses sample weights and calculates variance estimates that account for the complex survey design.

Results and Discussion

Figure 1 gives the 95th percentile of the total TEQ for the US population by age group. The total TEQ increases by age using both the 1998 and 2005 TEFs and the total TEQ is lower using the 2005 TEFs mainly due to the lower TEFs assigned to the mono-ortho-PCBs. The total TEQ decreased for both the 90th and 95th percentiles from NHANES 2001-2002 and 2003-2004 (Figure 2). The total TEQ also decreased for each age group from NHANES 2001-2002 to 2003-2004 (see Figure 3).

The geometric means for the sum of the 35 PCBs by age groups for whole-weight and lipid adjusted weight are given in Figure 4. There is a statistically significant increase of the sum of the 35 PCBs with age. Figure 5 gives the mean percent contribution to the sum of the 35 PCBs by age group for the US population. It is apparent from Figure 5 that the older age groups have a higher percent contribution to the total PCBs from the higher chlorinated PCBs while the younger age groups have a larger percent contribution to the total PCBs from the lower chlorinated PCBs.

Figure 6 gives the geometric means and selected percentiles of the sum of the 35 PCBs by age group for all sex and race/ethnicity. All age group increases were statistically significant at all percentiles. Figure 7 gives the geometric mean and selected percentiles of the sum of the 35 PCBs by race/ethnicity for all age and sex. Mexican Americans had statistically significantly lower total PCBs for all percentiles than NHWs and NHBs. The total PCB levels were not statistically different between NHWs and NHBs.

The least squares geometric mean estimates of the sum of the 35 PCBs (Figure 8) was statistically higher in males than in females (p=0.0004). All age groups for MAs had statistically significantly lower total PCBs than NHBs and NHWs (see Figure 9). NHBs had statistically higher total PCBs than NHWs for the two older age groups (40-59 and 60+) but no differences for the two younger age groups (12-19 and 20-39).

A series of persistent pesticides were measured in the NHANES 2003-2004 survey and these reference ranges will be presented along with measurements of the polychlorinated naphthalenes in serum pools constructed from the NHANES 2001-2002 samples.

NHANES 2003-2004 Total TEQ (95th percentile) by Age Group for all Sex, Race/ Ethnicity in the U.S. Population

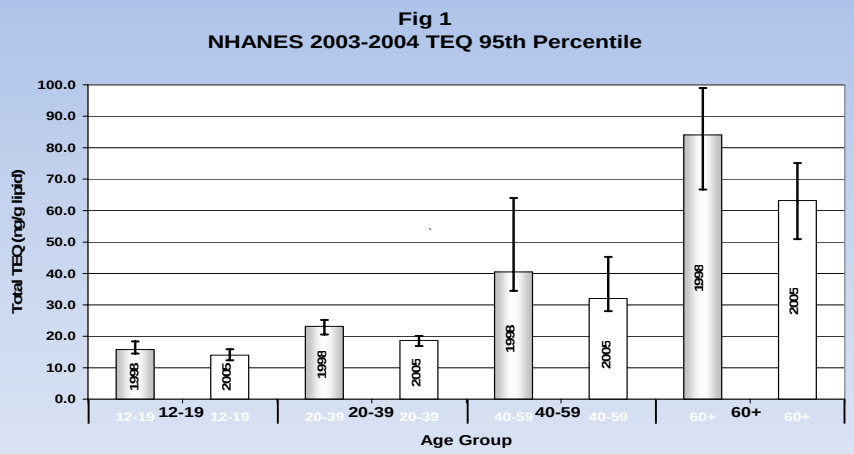

Figure 2.

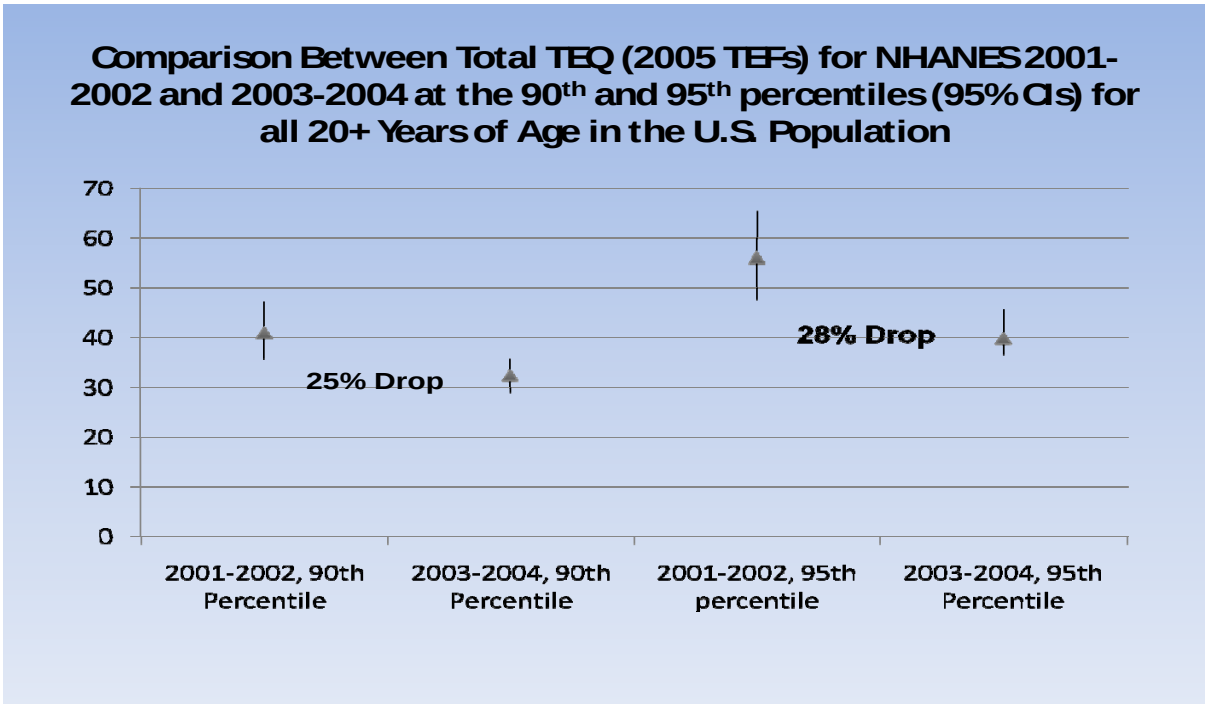
Comparison Between Total TEQ (2005 TEFs) for NHANES 2001-2002 and 2003-2004 at the 90th and 95th percentiles (95% CIs) for all 20+ Years of Age in the U.S. Population
70
60
50
40
30
20
10
0
25% Drop
28% Drop
2001-2002, 90th Percentile
2003-2004, 90th Percentile
2001-2002, 95th percentile
2003-2004, 95th Percentile

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Figure 3.

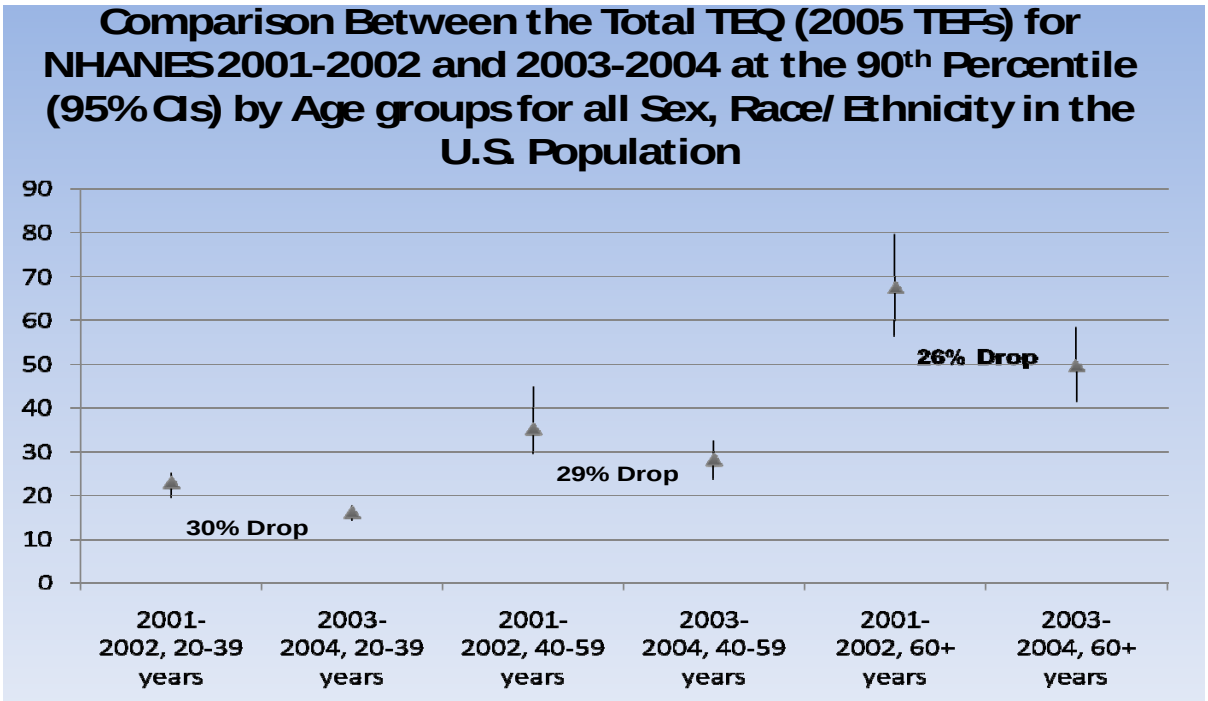

Comparison Between the Total TEQ (2005 TEFs) for NHANES 2001-2002 and 2003-2004 at the 90th Percentile (95% CIs) by Age groups for all Sex, Race/ Ethnicity in the U.S. Population
90
80
70
60
50
40
30
20
10
0
30% Drop
29% Drop
26% Drop
2001-2002, 20-39 years
2003-2004, 20-39 years
2001-2002, 40-59 years
2003-2004, 40-59 years
2001-2002, 60+ years
2003-2004, 60+ years

Figure 4.

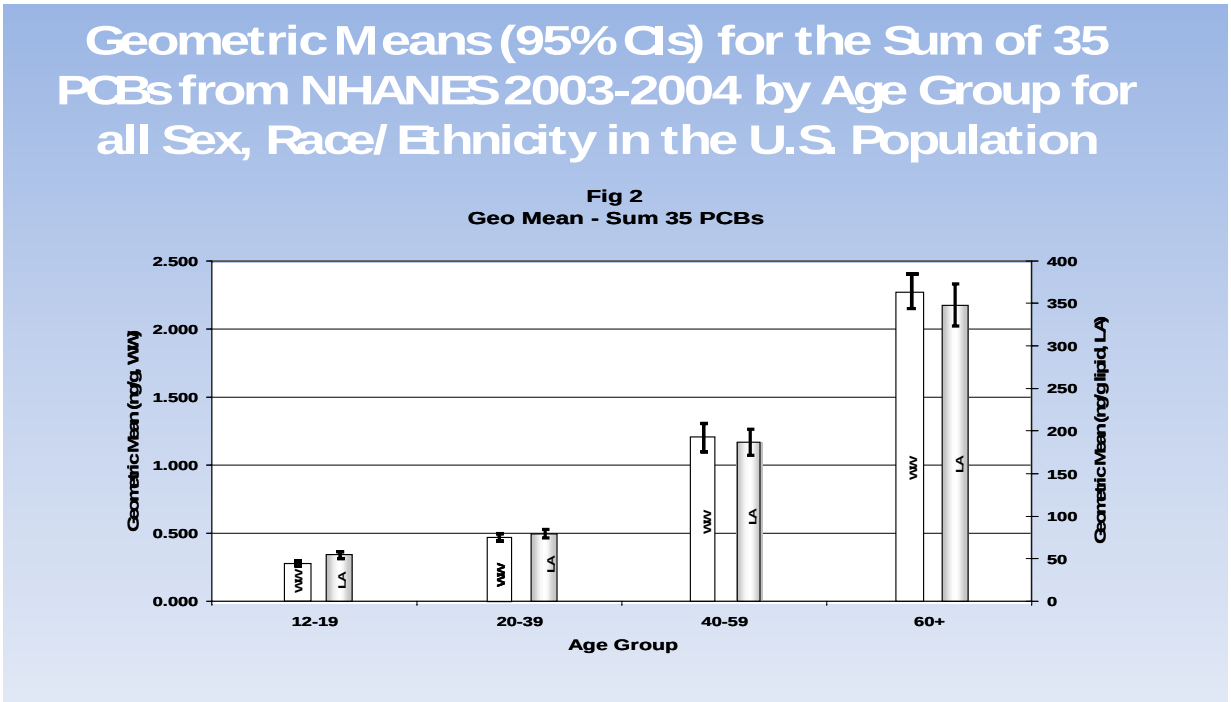


Figure 5.

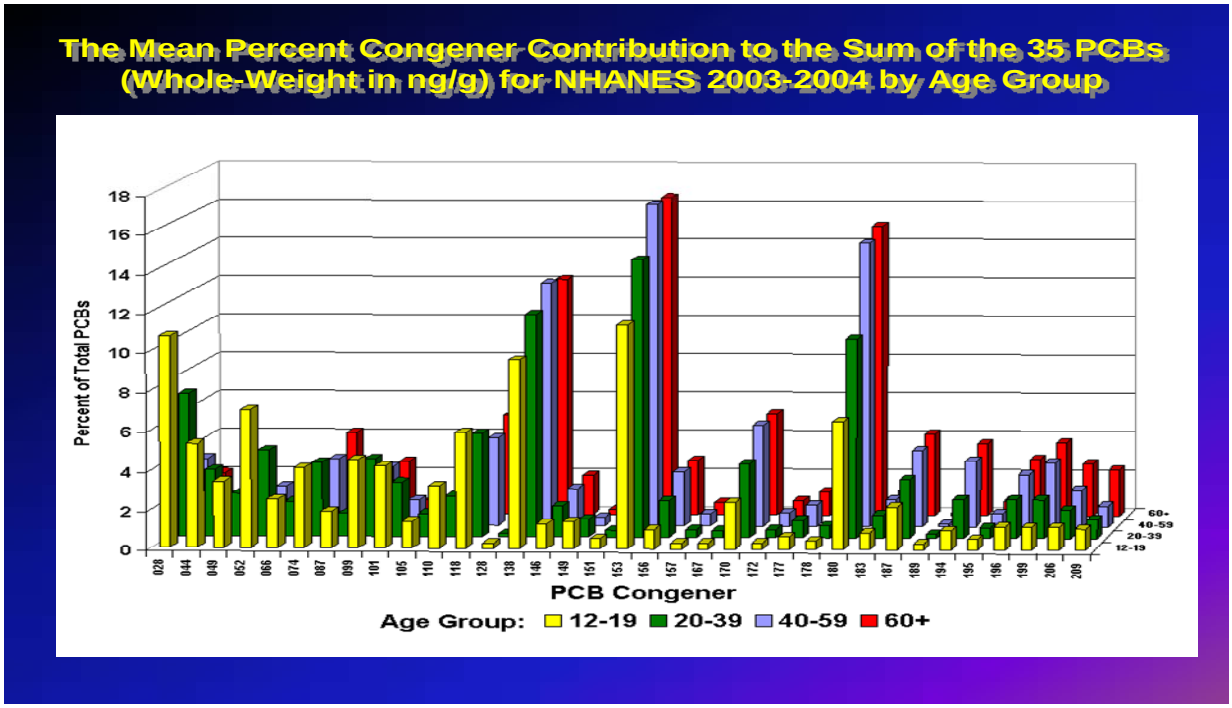

The Mean Percent Congener Contribution to the Sum of the 35 PCBs (Whole-Weight in ng/g) for NHANES 2003-2004 by Age Group
Percent of Total PCBs
0
2
4
6
8
10
12
14
16
18
028 044 049 052 066 074 087 099 101 105 110 118 128 138 146 149 151 153 156 157 167 170 172 177 178 180 183 187 189 194 195 196 199 206 209
PCB Congener
60+
40-59
20-39
12-19
Age Group: 12-19 20-39 40-59 60+

Figure 6.

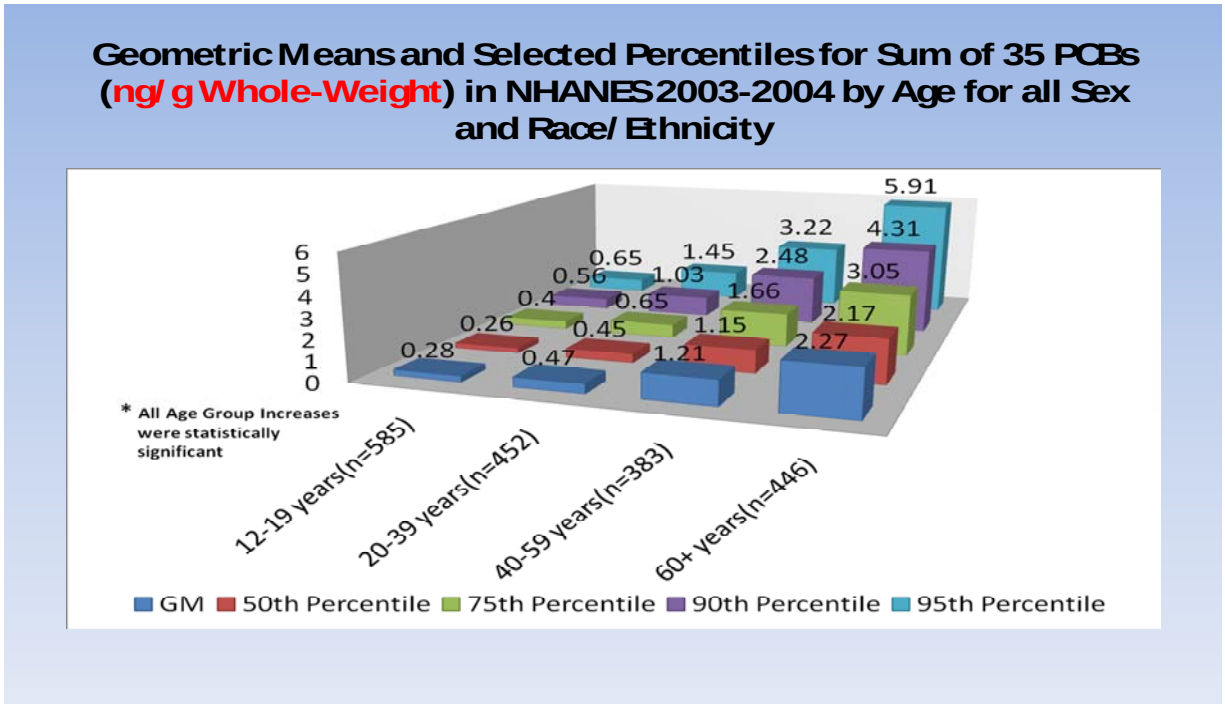
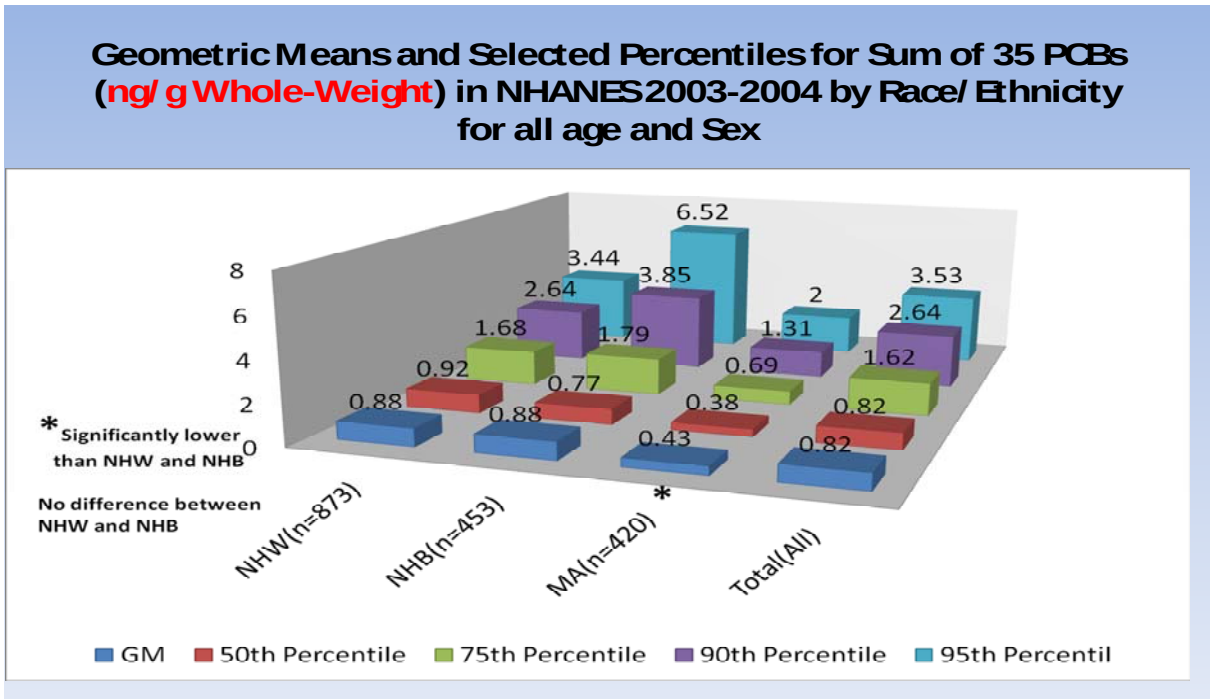
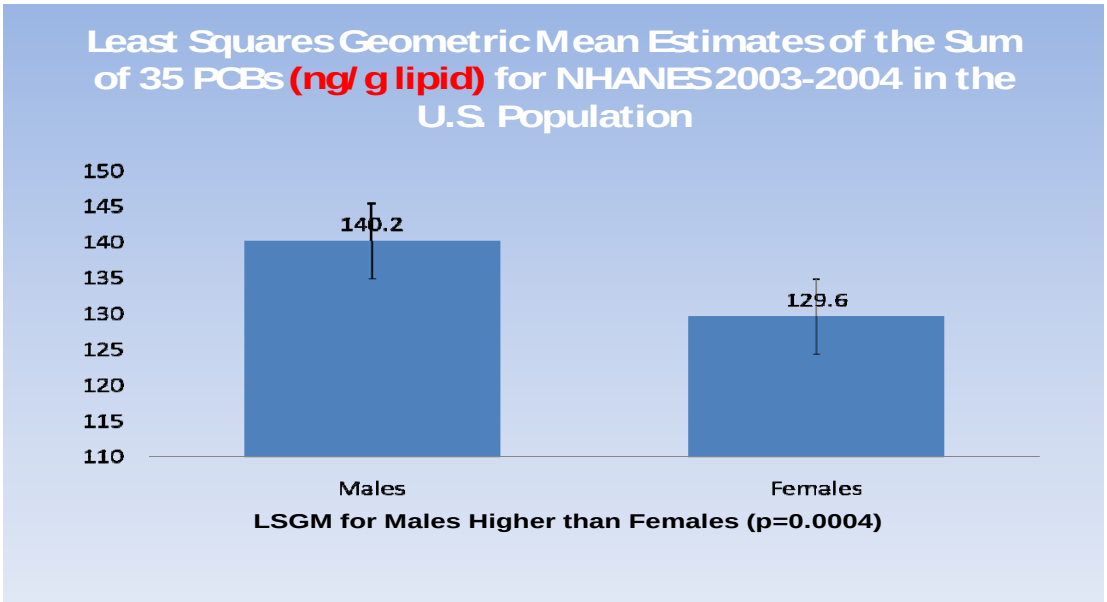
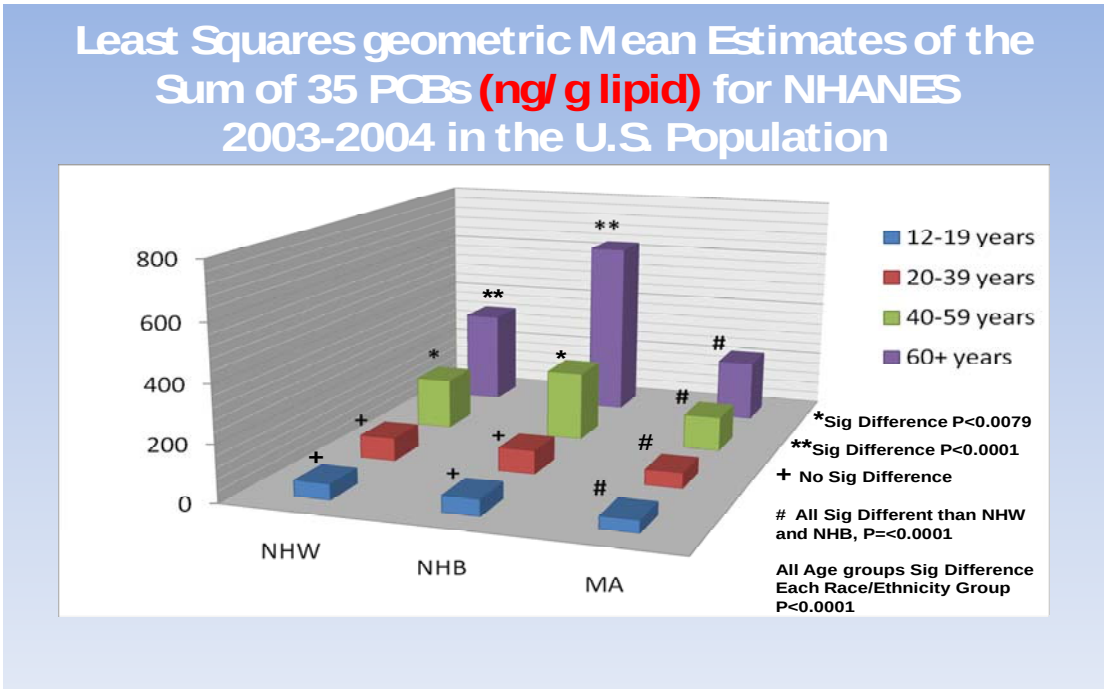

Geometric Means and Selected Percentiles for Sum of 35 PCBs (ng/g Whole-Weight) in NHANES 2003-2004 by Age for all Sex and Race/ Ethnicity
6
5
4
3
2
1
0
0.28
0.26
0.4
0.56
0.65
0.47
0.45
0.65
1.03
1.21
1.15
1.45
1.66
2.48
2.27
2.17
3.22
3.05
4.31
5.91
* All Age Group Increases were statistically significant
12-19 years(n=585)
20-39 years(n=452)
40-59 years(n=383)
60+ years(n=446)
GM
50th Percentile
75th Percentile
90th Percentile
95th Percentile

Figure 7.


Geometric Means and Selected Percentiles for Sum of 35 PCBs (ng/g Whole-Weight) in NHANES 2003-2004 by Race/ Ethnicity for all age and Sex
8
6
4
2
0
0.88
0.92
1.68
2.64
3.44
6.52
0.88
0.77
1.79
3.85
0.43
0.38
0.69
1.31
2
0.82
1.62
2.64
3.53
* Significantly lower than NHW and NHB
No difference between NHW and NHB
*
NHW(n=873)
NHB(n=453)
MA(n=420)
Total(All)
GM
50th Percentile
75th Percentile
90th Percentile
95th Percentil

Figures 8 and 9.





References

1. Patterson, D.G. Jr., Hampton L., Lapeza C.R., Jr., Belser W.T., Green, V., Alexander, L., Needham, L.L., 1987. High-Resolution Gas Chromatographic/High-Resolution Mass Spectrometric Analysis of Human Serum on a Whole-Weight and Lipid Basis for 2,3,7,8-TCDD. *Anal. Chem.* 59, 2000-2005.

2. Turner, W., DiPietro E., Lapeza C., Green, V., Gill, J., Patterson D.G. Jr., 1997. A Fast Universal Automated Cleanup System for the Isotope-Dilution High-Resolution Mass Spectrometric Analysis of PCDDs, PCDFs, Coplanar PCBs, PCB Congeners, Persistent Pesticides from the Same Serum Sample. *Organohalogen Compounds* 31, 26-31.

3. Caudill, S.P., Turner, W.E., and Patterson, D.G.Jr., 2007. Geometric Mean Estimation from Pooled Samples. Chemosphere 69, 371-380.