

PCDD/F AND DIOXIN-LIKE PCB TEQ REFERENCE RANGES, TEMPORAL TRENDS, AND DEMOGRAPHIC COMPARISONS FROM 1999-2004

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Introduction:

The National Health and Nutrition Examination Survey (NHANES) provides data on levels of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and polychlorinated biphenyls (PCBs) in serum collected from residents of the United States. Data from three different sampling periods (between 1999-2004) are now available from the Centers for Disease Control and Prevention (CDC). These data provide an opportunity to examine trends of serum concentrations of dioxin-like compounds (DLCs) over time, as well as to examine trends among various demographic parameters. Thus, the objective of this study was to develop descriptive statistics across time, as well as to make comparisons across several demographic subgroups and compare the contribution of individual congeners to the overall Toxic Equivalency (TEQ).

Materials and methods:

Assessment of DLCs was based on all 10 PCDD and 7 PCDF congeners with chlorine in the 2,3,7,8- positions, as well as the following dioxin-like PCBs: six mono-ortho-substituted PCBs (105, 118, 156, 157, 167, and 189) and three non-ortho-substituted PCBs (81, 126, and 169). Calculations were carried out using both the 1995 and 2005 WHO TEF values (Van den Berg et al., 1998, 2006) to determine total, lipid-adjusted TEQ for full datasets (all congeners) from each available time period (1999-2000, 2001-2002, and 2003-2004). Non-detect concentrations were managed using the default NHANES approach of the limit of detection divided by the square root of 2. Statistical data summaries were generated using the "survey" package (Lumley, 2010) in R version 2.9.1 (R Foundation for Statistical Computing, Vienna, Austria) to account for the complex sampling design as instructed in the NHANES analytical guidelines distributed by the CDC (NCHS, 2005). To eliminate bias imbedded in the NHANES study design, weighted summary statistics, (mean, 95th percent confidence interval around the mean, minimum, median, 95th percent confidence interval around the median, 95th percentile, and max) of TEQ concentrations were calculated using the laboratory subset-specific 2-year weights included in the NHANES dioxin data file. Descriptive statistics were also calculated for each category within a demographic variable. For statistical significance between groups and time periods, the confidence intervals around the mean and median were compared.

Results and discussion:

Referent values for PCDD/F/PCBs serum TEQ levels and specific TEQ subsets in the United States were determined for all samples and across demographic subsets. Although other authors have analyzed these congeners in NHANES data, they have focused only on one survey time period. There has not been a look across surveys until this analysis. In summary, our results demonstrate that total TEQ levels in the US population declined from 1999-2004 using both 1998 and 2005 TEFs. The data also show that across all three periods evaluated and for both TEF sets, age and demographics played the most significant roles in the TEQ concentration in human serum. Furthermore, The 1998 TEFs led to a higher TEQ across all subsets due to higher values than the 2005 TEFs; total TEQ in the 1999-2000 dataset was 28% higher when using the 1998 TEFs, 25% higher in the 2001-2002 dataset, and 22% higher in the 2003-2004 datasets.

In line with other research focused on one time period, differences were observed across the three survey periods with respect to total TEQ based on age, smoking, ethnicity, and congener patterns (no significant differences were noted with respect to gender). Key findings for analyses based on these parameters using both 1998 and 2005 TEFs

included:

- No significant differences were found with respect to gender.
- With the exception of the 12-19 year olds in the 1999-2000 time period, all the sample sets demonstrated an increasing trend in mean total TEQ with increasing age. Percentage decreases in total TEQ levels (From 1999 to 2004, decrease of 49% for the 12-to 19-year-old group, 37% for the 20-to 29-year olds, and 27% for 30-39 year olds) suggest that total TEQ levels in the US population are declining.
- A difference between mean total TEQ for smokers and non-smokers was observed in the two most recent surveys.
- Elevated total TEQ levels were observed in the two non-Hispanic groups compared to all other races.
- Five congeners (TCDD, 1,2,3,7,8-PeCDD, 1,2,3,6,7,8-HxCDD, 2,3,4,7,8-PeCDF, and PCB 126) contributed approximately 73% to total TEQ concentrations for all three periods.

Differences in concentrations between subgroups (i.e, demographics) and time periods demonstrate the importance of these factors when evaluating DLC serum concentrations. Our findings can provide relevant and updated statistics that can be used as reference values to evaluate data concerning DLC concentrations in serum.

References:

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