Polybrominated Diphenyl Ethers Measured in Serum of Children Enrolled In the HOME Study

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Introduction

Polybrominated diphenyl ether (PBDE) serum concentrations are higher during childhood than during adulthood in the United States[1, 2] and Australia,[3] most likely because of children's hand-to-mouth-behavior. It has been shown that decrease in PBDE concentrations observed as the child ages, is more related to age than to changes in body weight;[2] supporting the assumption that hand-to-mouth behavior plays an important role in explaining the exposure to PBDEs at a young age. On the other hand, changes in serum concentrations of polychlorinated biphenyls (PCBs) are better explained by changes in body weight as the child ages; suggesting that other routes of exposure, such as the diet are of greater importance for PCBs than for PBDEs.

Materials and methods

We enrolled pregnant women between 2003 and 2006 (n=468) in Cincinnati, Ohio, United States, and followed their children to eight years of age.[4] Serum samples were collected and analyzed for PBDEs, PCBs, and organochlorine pesticides during pregnancy (16 or 26 weeks, n=437) and at child age one year (n=120), two years (n=95), three years (n=95), five years (n=169) and eight years (n=199) using established methods.[5] We also collected indoor dust samples in children's homes at the one, two and three-year using established methods.[6] We collected dust samples from the main living room of each housing unit using a high-volume small surface (HVS4) sampler equipped with a dust collection bottle (CS3, Inc., Sandpoint, ID). We used a questionnaire to collect information about dietary habits, time spent in the home and observational measures such as home cleaning habits, and body measures for calculating body mass index (BMI).

Results and discussion

We analyzed dust collected on floors for 2,2',4,4'-tetrabromodiphenyl ether (BDE-47), 2,2',4,4',5-pentaBDE (BDE-99), 2,2',4,4',5,5'-hexaBDE (BDE-153), 2,2′,3,4,4′,5′,6-HeptaBDE (BDE-183), and decaBDE (BDE-209). Serum measurements included the congeners measured in dust and six additional PBDE congeners, PCBs (n=24) and organochlorine pesticides (n=9). We categorized the floor surface in the main activity room as hard (wood, linoleum or tile) or carpeted. A trained inspector categorized cleaning habits as "appears clean" or "less clean". There were no significant differences in dust concentrations in the first through third year samples by surface. There was, however, a significant difference in dust concentrations of BDE47 between the two cleaning habit categories in the carpeted homes ($p<0.05$, t-Test, Figure 1).

Childrens' serum PBDE concentrations were correlated (Spearman rank order correlation test; $p<0.05$) with home dust concentration for BDE47 (year one, two, and three), BDE99 (year one and three), and BDE153 (year one and three) suggesting that floor dust is a source of exposure for children (Figure 1).

The median child serum concentration increased from birth to a peak at one year of age, assuming that, at birth the child had a serum concentration equivalent to their mother's serum concentration during pregnancy. After one year of age, the median concentration decreased throughout the study period. An increasing serum concentration from birth followed by a declining concentration is consistent with ingestion of indoor dust

through hand-to-mouth behavior in toddlers. This finding is further supported with the observed correlation between indoor dust and serum concentrations.

The pentaBDE technical product containing the PBDE congeners examined for this study was phased out in the United States in 2004. Further studies are needed to investigate whether the phase-out may affect exposure to PBDES among children born a decade after the phase-out; such an investigation should include homes constructed prior to and after the phase-out of the pentaBDE product in the United States.

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Figure 1. Geometric mean dust concentration (ng/g dust) of BDE47 in homes combining data from home vissits at childs age 1, 2 and 3 years of age stratified by carpeted main living room and hard surface floor types (wood, linoleum or tile) and homes that appeared clean vs. not as clean. The difference between observed cleaning within the carpeted homes was statistically difference ($p<0.05$, t-Test using log10 transformed data).

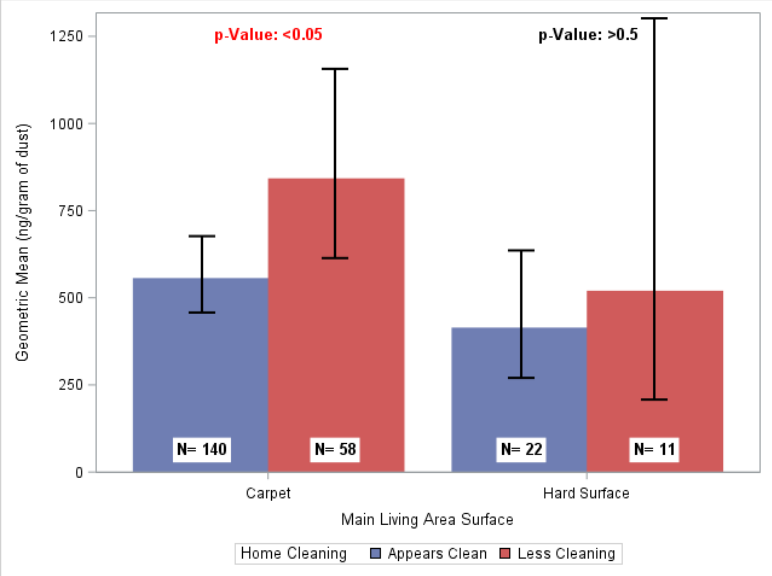


Figure 2. Correlation of BDE47 home dust concentration vs. child serum concentration at one year of age. The correlation was significant ($p<0.05$, Spearman rank order correlation test).

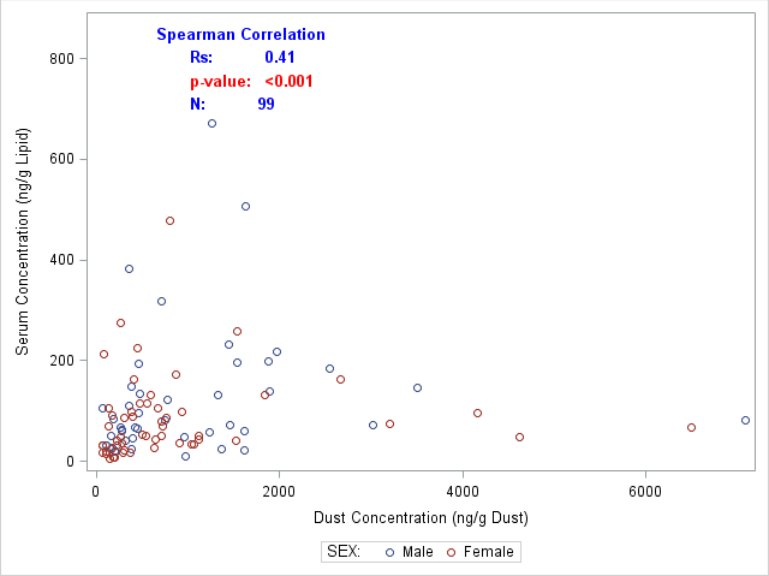
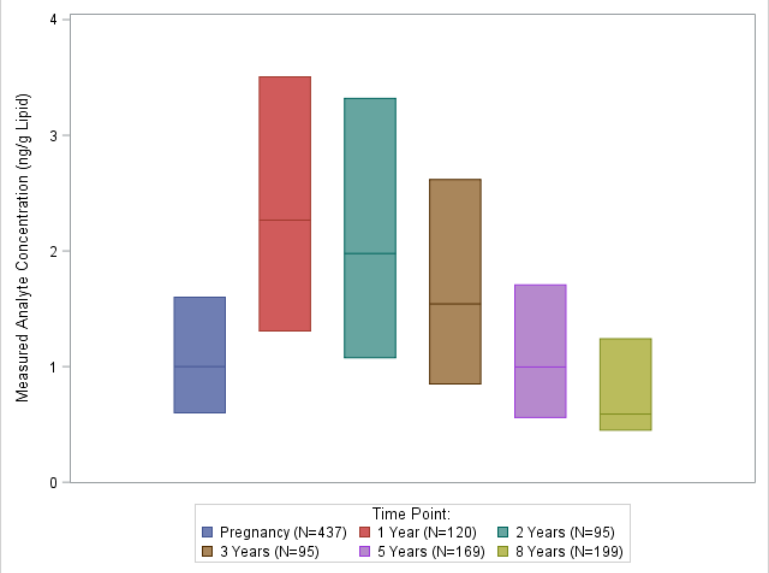


Figure 3. Median and 25th and 75th percentile serum concentration at child ages one through eight years and their mothers during pregnancy (16 or 24 weeks of pregancy).



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