Organohalogen Compounds 67: 654-657 (2005)

Associations of PBDE Levels in Breast Milk with Diet and Indoor Dust Concentrations

Nerissa Wu[1], Thomas Webster[1], Thomas Herrmann[2], Olaf Paepke[2], Joel Tickner[3], Robert Hale[4], Ellen Harvey[4], Mark La Guardia[4], Elizabeth Jacobs[4]

[1]Boston University School Of Public Health
[2]ERGO Research
[3]University of Massachusetts Lowell
[4]Virginia Institute of Marine Science

Introduction

Polybrominated diphenyl ethers (PBDEs) are commonly used as fire retardants in consumer products such as foam cushions, carpets, and computers. Outstanding research questions include impacts on human health and major routes of human exposure. Suspected exposure routes include the indoor environment and diet.[1] We investigated these pathways by collecting breast milk, dietary information, and house dust from a cohort of first-time mothers in the greater Boston, Massachusetts (USA) area.

Materials and Methods

In 2004 – 2005, we collected 50 ml samples of breast milk from first-time mothers, 2-8 weeks after birth. We restricted participation to English or Spanish-speaking women who had lived in the greater Boston area for at least three years. Participants were 18 years or older with normal pregnancy and delivery. We enrolled women from three obstetrics/maternity centers; the sites were selected so that participants from a wide range of socioeconomic background could be recruited. The recruitment protocol included distribution of information on PBDEs and body burden monitoring as well as breastfeeding support and education. We administered a questionnaire to collect information on personal and household characteristics, including diet, furniture, electrical devices, occupation, transportation, and other potential determinants of body burdens. Milk samples were analyzed by ERGO Research. Milk concentrations were calculated on a lipid basis.

We sampled house dust from the homes of a subset of participants using a portable hand-held vacuum (Eureka Mighty-Mite) with a teflon-coated crevice tool and cellulose thimble. Dust was collected from measured areas of floor and furniture in commonly-used rooms. Dust samples were sieved to <125 um, spiked with surrogate standards, subjected to enhanced solvent extraction, purification by size exclusion and silica gel chromatography, and analyzed for PBDEs using GC and EI-MS at VIMS. Dust samples are still being analyzed for PBDE 209. We employed two measures for PBDEs in dust: concentration and mass per unit area.

We analyzed associations between log-transformed PBDE concentrations and covariates using multiple regression and step-wise multiple regression.

Results

We collected breast milk from 46 women. Recruitment at the health center serving the lower income, ethnically diverse community was low; milk donors were primarily white, college-educated women. Total PBDE concentrations were log-normally distributed (Shapiro-Wilks test), ranging from 4 to 263 ng/g with a geometric mean of 28 ng/g (Figure 1). PBDE 47 was the dominant congener in most samples; PBDE 153 predominated in three participants, an unusual pattern also observed elsewhere.[2] PBDE 209 was above detection limits in 11 samples. Congeners 47, 66, 85, 99, 100, 138 and 154 were highly inter-correlated (r>0.70). One participant, a near-vegan since childhood (consuming small amounts of dairy products), had very low PBDE levels. Two participants from the same household had very similar concentrations.

In preliminary statistical analysis of questionnaire data, consumption of frozen dairy products provided the strongest association with log-transformed total PBDE levels in breast milk. Similar results were achieved using a dairy fat index constructed using estimated fat compositions of dairy products. These associations remained after adjustment for other factors. Age, pre-pregnancy body mass index and length of lactation before sampling did not appear associated with PBDE levels.

Dust samples were collected for 12 participants; many participants declined our relatively intensive method of dust sampling. Partial total PBDE concentrations (congeners 47, 66, 85, 99, 100, 138, 153, 154) were approximately log-normal with a geometric mean of 1.9 ug/g; congeners 47 and 99 dominated (Congener 209, typically an important component in dust[1], is not included here; our results may therefore appear low compared to other reports). Preliminary statistical analysis showed high correlations (r~0.8) between log-transformed partial total PBDE levels in breast milk and dust using both dust measures (the correlations were only slightly less for congener 47). See Figure 2. The association between breast milk concentrations and dust was not confounded by diet or other personal factors. Two of the participants with the highest levels of PBDEs in dust had homes undergoing construction.

Discussion

This research is the first systematic examination of PBDEs in humans in New England and one of the only US breast milk studies with participation restrictions similar to WHO studies of PCBs and dioxins (we required only 3 years of residence). PBDE levels in breast milk were approximately log-normally distributed. While much higher than those found in Europe, levels in the Boston area may be lower than those found in the Pacific Northwest of the USA.[3] Concentrations of PBDEs in Boston house dust were also approximately log-normally distributed and similar to those reported in Maryland[1] and Texas[4] (tested using the Wilcoxon nonparametric statistic).

We found an association between PBDE levels and consumption of dairy products, supporting the importance of animal fats (at least dairy) as an exposure route. This does not, however, rule out other dietary sources. The association between breast milk levels and house dust is consistent with exposure by the indoor environment. But it is not clear if direct exposure to dust is important (e.g., via inhalation, ingestion or dermal routes), or if the levels in dust are a marker for some other route of exposure. Exposures with log-normal distributions may provide one possible explanation for log-normal distributions of body burdens. Dust concentration and mass of PBDEs per unit area were similarly effective as predictors of body burden. We know of only one other, slightly smaller study (n=10) that attempted to correlate levels in people and dust.[5] The authors reported no correlation between the two, but provided few details. They used dust from participant-collected vacuum cleaner bags. More research comparing the different methods of sampling house dust is needed: use of dust as an exposure measure is thought to be improved by taking dust loading into account.[6,7]

Our study is limited by a small sample size, small contrasts on some potential exposure factors, and exposure measurement error. If random, the latter should tend to bias results toward the null.

Acknowledgments

This work was supported by a grant from the New York Community Trust. We are particularly grateful to the women who participated in this study. This study could not have been accomplished without the time and effort of the Lowell Community Health Center, Isis Maternity and the office of Dr. Beth Hardiman. Important contributions were made by the members of our Community Advisory Committee, Greater Boston Physicians for Social Responsibility, Medela Corporation, Sue Martin, Ilga Wohlrab, Tami Gouveia-Vigeant, and Stephanie Chulupka. Helpful advice was provided by Susan Woskie, Ruthann Rudel, Michael McClean, Anne Aschengrau, Tom Mangione, and Kim Hooper.

References

1. Stapleton HM, Dodder NG, Offenberg JH, Schantz MM, Wise SA (2005). Polybrominated diphenyl ethers in house dust and clothes dryer lint. *Environ Sci Technol.* 39(4):925-31.

2. She J., Holden A., Sharp M., Tanner M., Williams-Derry C., Hooper K. (2004). Unusual Pattern of Polybrominated Diphenyl Ethers (PBDEs) in US Breast Milk. *Organohalogen Compounds* 66: 3945-3950.

3. Webster T., Wu N., Paepke O., Herrmann T. (2005). Regional comparisons of PBDE body burdens in the USA. Accepted for BFR 2005.

4. Schecter A., Paepke O., Joseph J., Tung K.C. (2005). Polybrominated diphenyl ethers (PBDEs) in U.S. computers and domestic carpet vacuuming: possible sources of human exposure. *J Toxicol Environ Health A*. 68(7):501-13.

5. Sharp R and Lunder S (2004). *In the Dust: Toxic Fire Retardants in American Homes.* Environmental Working Group. www/ewg.org.

6. Colt J., Zahm S., Camann D., Hartge P (1998). Comparison of Pesticides and Other Compounds in Carpet Dust Samples Collected from Used Vacuum Cleaner Bags and from a High-Volume Surface Sampler. *Environ Health Persp* 106:721-4.

7. Lioy P., Freeman N., and Millette J. (2002). Dust: A Metric for Use in Residential and Building Exposure Assessment and Source Characterization. *Environ Health Persp* 110: 969-983.

Fig. 1. PBDE concentrations (ng/g lipid) in breast milk from the greater Boston area

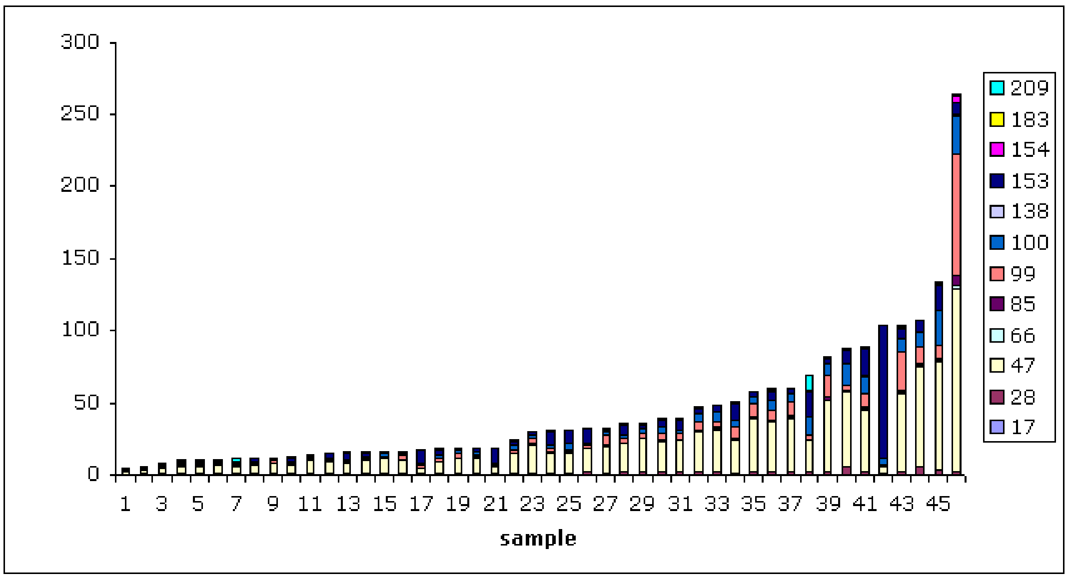

Figure 2. The concentration of partial total PBDEs (congeners 47, 66, 85, 99, 100, 138, 153, 154) in breast milk was associated with the concentration of PBDE in household dust (r~0.8). The graph plots log milk concentrations (ng/g lipid) against log dust concentrations (ug/g).