

## Polybrominated diphenyl ethers and age: analysis of pooled human blood serum from birth to over 60 years

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### Introduction

Polybrominated diphenyl ethers (PBDEs) are considered to be a cost effective and efficient way to reduce flammability therefore reducing harm caused by fires. PBDEs are incorporated into a variety of manufactured products and are found worldwide in biological and environmental samples (e.g. Hites et al. 2004).

Unlike other persistent organic pollutants there is limited data on PBDE concentrations by age and/or other population specific factors. Some studies have shown no variation in adult serum PBDE concentrations with age (e.g. Mazdai et al., 2003, Meironyte Guvenius et al., 2003) while Petreas et al. (2003) and Schecter et al. (2005) found results to be suggestive of an age trend in adult data but no statistically significant correlation was found. In addition to the data on adult concentrations there is limited data which investigates the levels of PBDEs in infants and young children. Fangström et al. (2005) showed that in seven year olds there was no difference in PBDE concentration when compared to adult concentrations. While Thomsen et al. (2002, 2005) found the concentration of PBDEs in pooled samples of blood serum from a 0-4 years age group to be higher than other age groups (4 to > 60 years). In addition, a family of four was studied in the U.S. and the concentrations were found to be greatest in the 18-month-old infant followed by the 5 year old child, then the mother and father (Fischer et al., 2006).

The objectives of this study were to assess age, gender and regional trends of PBDE concentrations in a representative sample of the Australian population.

### Materials and Methods

Human blood sera was collected and pooled for analysis as a continuation of a preliminary investigation of PBDE concentrations in the Australian population (Harden et al. 2004). In the current study, pools of sera collected in 2002/03 along with pools collected in 2004/05 were used. De-identified serum samples were obtained from Sullivan and Nicolaidis Pathology from surplus stored sera that had been collected as part of routine pathology testing.

Prior to pooling, all samples were stratified according to age, gender and geographical region. The age groups were: 0-4 years (2004/05 samples only); less than 16 years (2002/03 samples only); 5-15 years (2004/05 samples only); 16 to 30 years (2002/03 and 2004/05); 31 to 45 years (2002/03 and 2004/05); 46 to 60 years (2002/03 and 2004/05); and greater than 60 years (2002/03 and 2004/05). Sera were collected

from both males and females. For the 2002/03 samples the five regions were: Northeast Urban, including Brisbane, Tweed, Gold Coast and major population centres in Queensland; Southeast Urban including Sydney, Canberra, Wollongong, Newcastle and other major population centres in New South Wales; South Urban including Melbourne, Adelaide, Hobart and other major population centres in Victoria and South Australia; West including Perth and other major population areas in Western Australia; and Rural including rural areas from all States and the Northern Territory (for map see Figure 1, Harden et al. 2004). The 2005 samples were taken from the Northeast Urban region only.

Up to 200 samples were collected per stratum which was then divided randomly into two pools, with a maximum of 100 samples in each pool. For this study, 8132 individual samples were used in 85 pools. For adult samples 1 ml of each sample was pooled while for samples in the 0-4, 5-15 and <16 years old groups, the volume may have been less than 1 ml, therefore, the entire sample volume (1 ml or less) was pooled.

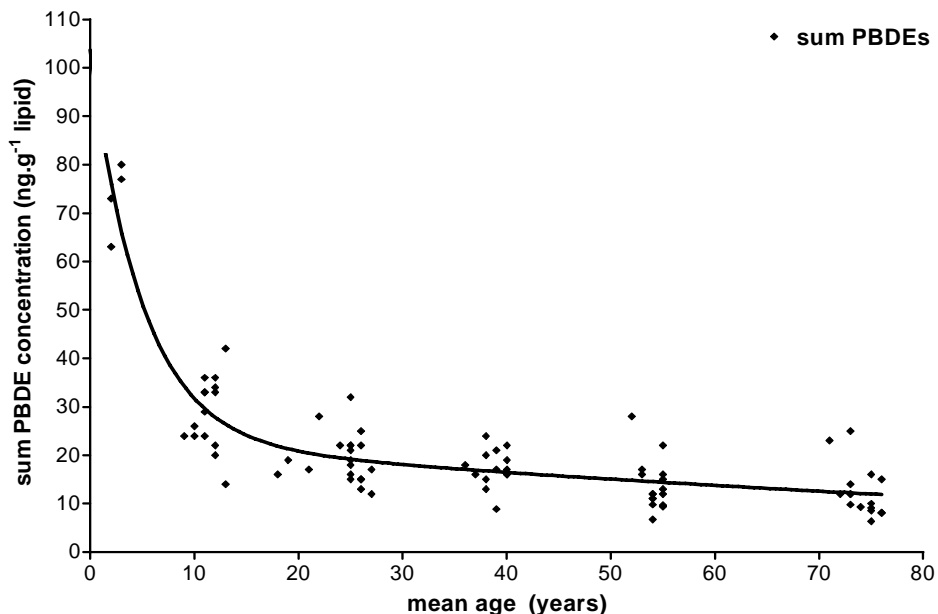
The samples were sent to ERGO/Eurofins, Hamburg, Germany where the following congeners were targeted for analysis: BDE- 1, -2, -3, -7, -10, -13, -15, -17, -25, -28, -35, -47, -49, -66, -71, -75, -77, -85, -99, -100, -116, -119, -126, -138, -140, -153, -154, -155, -156, -181, -183, -197, -203, -207 and -209. The measurement was done by means of isotope dilution technique using HRGC/HRMS (high resolution gas chromatography/high resolution mass spectrometry) (see Toms et al. 2006 for details). The study provided two phases of quality control/ quality assurance including sampling replication and inter-laboratory calibration with 10 duplicate pools sent to Health Canada, Ottawa, Canada. There was good reproducibility between the replicate pools of a given stratum. The inter-laboratory calibration showed no systematic differences between the two laboratories, however two samples showed an elevation of lower brominated BDEs that indicated post-sampling contamination. These 2 datasets were subsequently removed and the remaining set examined for similar contamination. Ethics approval for this study was granted on 20 September 2002 by The University of Queensland Medical Research Ethics Committee.

## Results and discussion

Overall, PBDEs were detected in all 85 pools of human blood serum ranging from 6.4 to 80 ng.g<sup>-1</sup> lipid. A trend by age was observed with elevated PBDE concentrations in the 0-4 and < 16 (5-15) years age groups compared to the >16 years age groups (Table 1). The PBDE concentrations in the youngest groups were around a factor two higher than observed in the 5-15 years - 2004/05 samples and around a factor four higher than in the > 16 years age groups combined - 2004/05 samples. In comparison to this steep decrease from the very young children to the older children, subsequent decreases with age are apparent but much smaller (Figure 1). There is no clear decrease in the concentration between the two oldest groups. No relationship was found between PBDE concentrations and gender or region.

**Table 1. Mean ΣPBDE concentrations (ng.g<sup>-1</sup> lipid) by age group and year of collection.**

Age	Mean ± standard deviation (median)	
	2002/03 (All regions)	2004/05 (Northeast)
> 16 years	15 ± 5 (13)	18 ± 5 (16)
< 16 years (excl. 0-4)	28 ± 8 (29)	29 ± 7 (29)
0-4 years	n/a	73 ± 7 (75)



**Figure 1**  $\Sigma$ PBDE concentration (ng.g<sup>-1</sup> lipid) in each pool by the respective mean age (years) of donors in each pool

The congener profile of PBDEs in both the 2002/03 and 2004/05 samples was dominated by BDE-47 (Table 2). No differences in congener profile by age, gender or region were observed.

**Table 2. Mean and range contribution (%) of congeners to the  $\Sigma$ PBDE concentration by year.**

congeners	2002/03		2004/05	
	Mean (%)	Range (%)	Mean (%)	Range (%)
47	32	18-47	24	14-37
153	14	7-23	12	7-25
99	13	n.d.-24	8	4-13
100	8	5-16	7	4-13
209	6	n.d.-29	4	n.d.-29
154	2	1-3	1	1-2

n.d. – non-detect

The study provides important information on the concentration of PBDEs in a large number of samples across the lifespan from 0-4 years up to greater than 60 years. Unfortunately it cannot be assumed that the study results represent the peak concentration of PBDEs in the Australian population. This is due to the use of pooled samples which means that the reported concentration of PBDEs and the mean age of the pool is an average of the individual donors' PBDE concentrations and ages, respectively. Identifying the likely peak age by the use of individual samples or smaller age brackets at which the concentration is the

highest may make it possible to evaluate routes of exposure at this peak age. This information could then be used to assess factors leading to these elevated concentrations in this age group taking into consideration metabolism and other age specific factors. Additional research including sample collection and analysis is underway to further investigate PBDEs and age.

### **Acknowledgements**

EnTox is co-funded by Queensland Health. This work was funded in part by a grant from the Australian Government Department of Environment and Heritage. The views expressed in this publication do not necessarily reflect those of the Australian Government or the Minister for the Department of Environment and Heritage.

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