MEASUREMENTS OF PBDES ON CHILDREN'S HANDS AND SURFACE OF ELECTRONIC APPLIANCES AND MATS FROM DAYCARE FACILITIES

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Abstract

PBDEs were analyzed in hand wipe samples and the product surface samples collected from 9 daycare facilities. PBDEs were detected in all samples. PBDE concentrations of hand wipes were distributed from 0.12 to 457.25 pg/cm^2. Σ_8PBDE of mats in 9 daycare facilities varied from 4.07 to 208.29 pg/cm^2. The electronic appliances have much higher concentrations than mats. BDE 209 was the dominant congener, contributing over 90% of the total PBDE concentrations measured for almost samples. Similar congener patterns were measured in all hands and the surface of mats and electronic appliances. It is likely that PBDEs may be directly transported to the surface of children's hands from contact with products they touch. It is possible that fine particles and dust on the surface of those products are more important sources to hands of children.

Introduction

Polybrominated diphenyl ethers have been used globally as flame retardants in many products including computers, electronic equipments, plastics, and textiles. Many products containing PBDEs present in the indoor environment and thus the level of PBDEs in indoor air is higher than outdoor. PBDEs was also detected in house dust and dryer lint with very high concentrations [1]. Consequently, PBDEs in the indoor environment are a significant concern related with human health.

Children may be highly exposed to PBDEs in indoor environment because of their behavior such as creeping and mouthing. Previous result showed children received greater exposure to indoor dust than adults [2].

In Korea, many children are committed to daycare facilities such as nursery school, preschool, and kindergarten, indoor playground and they spend their time in those places.

In this study, we measured PBDEs in wipe samples from children's hands and the surface of products such as TVs, computers, and mats to evaluate the relationships between hands and product surfaces.

Matserials and Methods

Sample collection

The 9 daycare facilities (S1-S9) are selected as sampling sites and 19 children (Age 0-8) participate. The information about age, sex, height, weight of each participant was collected and surface areas which are wiped of

the products were measured. The Gauzes (4 inch x 4 inch) were pre-cleaned with Methylene Chloride by Soxhlet over 20h. Isopropanol-dipped wipe gauzes are used to wipe the surface of children's hands and many kinds of products in facilities.

Analysis

The target compounds were 8 PBDE congeners (BDE-28, -47, -99, -100, -153, -154, -183, -209). All samples with ^{13}C labelled internal PBDE standards (28, 47, 99, 100, 153, 154, 183, 209) were separately extracted using Soxhlet apparatus for 24 h with 250 mL of Methylene Chloride. The extracts were treated with multi-layer silica columns (acidic (8g, 44% of H_2SO_4), basic (4g, 30% of 1N NaOH) and neutral (2g) silica). Samples were eluted with 150 mL of Hexane, concentrated with a rotary evaporator (R124-A, Buchi) to 0.5 mL. Subsequently, the ex tracts are loaded into Gel Permeation Chromatography packed with 6g of biobead and eluted with Hexane-DCM (1:1 v/v). The initial 15.5mL of eluate are discarded and 30mL after that are collected. Finally, the sovents were totally evaporated by N_2 purging and then ^{13}C-PBDEs (139) were added as recovery standards prior to instrumental analysis. All compounds were analyzed by a Hewlett-Packard 6890 gas chromatsography/Jeol JMS-700T high resolution mass spectrometry (GC/HRMS). Tri to deca-BDE congeners were separated by a DB-5HT column (15m, 0.25 mm i.d., 0.1 μm film thickness). The HRMS was operated in the positive electron ionization (EI) mode and data was acquired in the selected ion monitoring (SIM) mode operating at 10,000 resolution. The splitless injector and interface temperatures were maintained at 280°C. The carrier gas was helium at a constant flow rate of 1 mL/min. A temperature program of GC was as follows: For non-deca PBDEs, initial at 140°C hold for 1 min, 10°C•min^{-1} to 320°C. For deca PBDEs, initial at 150°C for 2 min, 50°C •min^{-1} to 330°C, hold for 7 min.

Results and Discussion

In order to reduce the effect caused by different surface areas of the hands according to age, surface area of the hands was estimatsed using the following equation:

- Palm Surface Aarea (m^2) = 1% x [0.20247 x Height(m)0.725 x Weight(kg)0.425]
- Surface area of hands(cm^2)=PSA(cm^2) x 2(bottom and top) x 2(right and left)

PBDE concentrations of hand wipes are distributed as shown in Table 1 with concentrations ranging from 0.12 to 457.25 pg/cm^2. BDE 209 is the dominant congener, contributing over 95% of the total PBDE concentration measured. Σ_8PBDE of mats of 9 daycare facilities varies from 4.07 to 208.29 pg/cm^2, with a mean of 34.67 pg/cm^2. The electronic appliances had much higher concentrations than mats. The congener patterns of mats and products were similar to those of hands.

Table 1. Concentration of PBDEs on hands and products

	HANDS (pg/cm^2)				MATS (pg/cm^2)				ELECTRONIC APPLIANCES (pg/cm^2)			
congener	mean	median	min	max	Mean	Median	Min	Max	Mean	Median	Min	Max
BDE 28	0.01	<DL	<DL	0.19	0.08	0.08	0.08	0.08	0.54	0.13	0.03	1.40
BDE 47	0.00	<DL	<DL	0.00	3.48	3.48	1.67	5.29	18.40	13.17	1.39	62.89
BDE 100	0.02	<DL	<DL	0.38	0.72	0.72	0.17	1.26	2.45	1.66	0.28	8.24
BDE 99	0.12	<DL	<DL	2.25	3.07	0.84	0.43	7.94	11.12	5.70	0.69	31.02
BDE 154	0.10	0.11	<DL	0.24	0.11	0.04	0.01	0.47	0.65	0.24	0.05	3.39
BDE 153	0.31	0.00	<DL	4.31	0.77	0.77	0.71	0.83	2.83	0.64	0.09	13.48
BDE 183	2.75	0.77	<DL	25.09	0.51	0.11	0.03	3.25	12.27	0.72	0.11	119.15
BDE 209	118.85	27.76	0.12	456.12	31.91	6.01	3.97	203.88	372.40	82.70	14.47	1936.81
SUM	122.16	30.35	0.12	457.25	34.67	7.85	4.07	208.29	408.26	115.62	20.42	2070.55

Figure 1 shows PBDE concentrations in hand wipes according to age. All age 8-children are from the same site (S7) which had many kinds of computer game machines. They spent much time on furiously thumbing hand-held computer games in this site and thus they have much higher PBDEs on their hands. On the other hand, the babies and toddlers spent their time with sleeping and creeping on the mats which have low concentrations of PBDEs. It is likely that PBDEs may be directly transported to the surface of children's hands from contact with products they touch.

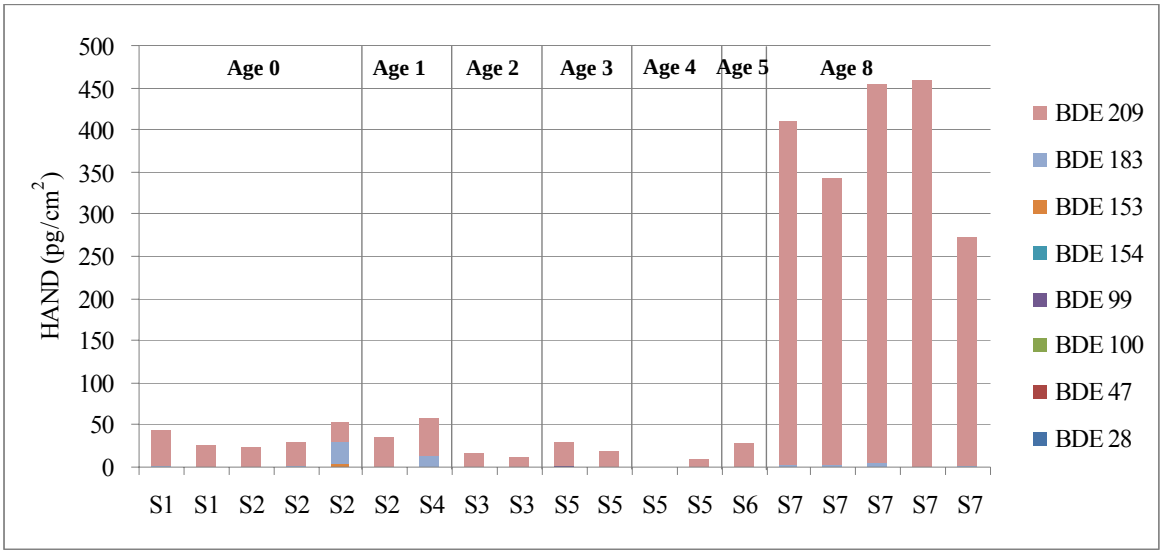

Figure 1. Concentrations of PBDEs in hand wipe samples

Figure 2 shows that Σ_8PBDE are highly detected in TVs and computers. Many reports mentioned that TVs and computers emitted PBDEs. However, there was excessive amount of dust on the surface of those products due to the electrostatic effect. It is possible that fine particles and dust on the surface of those products are more important sources to hands of children.

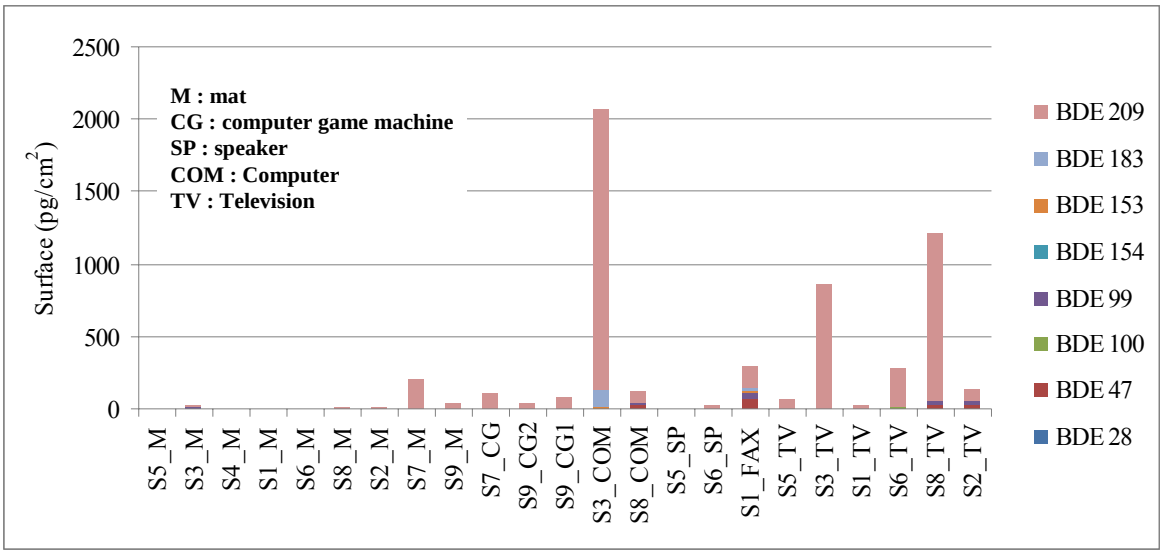

Figure 2. Concentrations of PBDEs in surface of products

Acknowledgements

This study was supported by Korean Ministry of Environment and Brain Korea 21.

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