Persistent Organic Pollutants in House Dust in Kuwait

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***Abstract*—**This study reports the concentrations of polybrominated diphenyl ethers (PBDEs) in dust samples collected from 17 homes in Kuwait. PBDEs were measured in all homes investigated. Mean ΣPBDEs concentrations from 0.2 to 124 ng/g with a geometric mean of 9 ng/g. While the average compositions were similar to that in the technical penta formulations, subtle differences were observed between samples from different indoor environments. These differences may reflect the range of sources and commericial mixtures used in treated products. Using the measured concentrations in and dust ingestion rates for children and adults, estimated human non-dietary exposure, based on median PBDE levels were 238 pg /day and 1041 pg/day for adults and children respectively. This vulnerability of younger children is compounded by the fact that compared to adults ; they are growing more rapidly and generally have lower and distinct profiles of biotransformation enzymes, as well as much smaller fat depots for sequestering lipophilic chemicals. The ubiquitous distribution of these chemicals, as noted in this preliminary study, highlights the fact that we are continuously exposed to low doses of chemicals in the indoor environment.

***Keywords*—** Pollutants in House Dust in Kuwait.

I. Introduction

A WIDE range of chemicals are present in indoor environments. Some of these chemicals are there because they are added to consumer products used in homes, where as others are produced in situ by combustion activities like smoking, incense burning, cooking using fuel etc. Some of the chemicals additives are inherently hazardous and can escape from the products to which they are added during normal use, or through wear and tear, and contaminate the indoor environment [3]. Some of these chemicals are also very persistent as well as being inherently toxic. This coupled with limited ventilation, leads to a buildup of indoor pollutants. The analyses of compounds in house dust therefore can give a reliable indication of the extent of indoor contamination [1], [2]. Non-dietary exposure to chemicals via inhalation and dust ingestion may therefore constitute an important exposure pathway for humans. This is particularly important for children because they spend most of their time indoors, most of which is spent in contact with floor, and may ingest dust through the mouthing of hands, toys, and other objects [1]. Due to the extreme weather conditions in Kuwait even adults spend approximately 95% of the day indoors, either in the office or home. There has been little regulatory attention paid to the importance of indoor air contamination, especially by persistent organic pollutants, to human health. Traditionally, environmental regulatory programs focused on outdoor ambient air, surface water, drinking water, and hazardous industrial processes.

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II. Objectives

The primary objective of the study was to assess the extent of indoor exposure to chemicals from dust ingestion. Specific objectives were as follows:

- To provide information about indoor contamination PBDEs in Kuwait.
- To compare the relative significance of human non-dietary exposure of PBDEs via dust ingestion for children and adults.

III. Materials and Methods

A. Sample collection

Dust samples for this study were obtained from vacuum cleaning bags regularly used for the purpose of cleaning homes. The participants were asked to continue cleaning their homes normally over the six week study period. The dust from individual bags was filtered through a 2 mm gauge sieve onto a solvent rinsed aluminum foil to remove debris and other large particles. The samples were transferred to clean solvent rinsed amber glass bottles and kept at -20°C until analysis.

IV. Extraction and Analyses

Dust samples were extracted in a Soxhlet apparatus using 1:1 v/v mixture of acetone:hexane. Prior to extraction, the samples were spiked with PBDE congeners to monitor analytical recovery. The extracts were reduced in volume on a turbovap, solvent exchanged to hexane and interfering compounds removed by column chromatography using 10 g silica and 5 g alumina .Eluted the compounds of interest with 100 ml 1:1 mixture of hexane : dichloromethane. The eluent was blown down under a gentle stream of nitrogen. The volume was reduced to 50 µl in dodecane and spiked with mirex (10 µl of 10 ng/µl) as an internal standard for PBDE

analysis. PBDEs were analyzed with an Agilent 6890N gas chromatograph using splitless injection on a 30m HP5-ms column and helium as a carrier gas. This was coupled to an Agilent 5973 inert mass selective detector, operated in Negative Chemical Ionization(NCI)mode (using selected ion monitoring),with methane as reagent gas.

V. Result and Discussion

The ΣPBDE concentrations measured in house dust during this campaign is summarized in Table 1. The dust samples varied over 3 orders of magnitude, from 0.2 to 124 ng/g, with a geometric mean of 9 ng/g. Compared with the PBDE levels in indoor dust reported from the United States [4], [5], Germany and the United Kingdom [3], the PBDE levels reported in Kuwait are very low. Table 2 presents the mean, median and maximum exposure scenarios together with the 5th and 95th percentile levels for PBEDs. At median levels, for instance, the ΣPBDE non-dietary exposure is 238 and 1041 pg/day for adults and children respectively. These estimates indicate that inhalation and dust ingestion contribute are 6 and 94 % for inhalation and dust ingestion respectively, to overall median daily non-dietary exposure for children, while in the case of adults 41 % of the daily non-dietary uptake is from inhalation with dust ingestion contributing 59 %. The difference in exposure estimates between children and adults in this study supports previous reports that children are at greater risk from pollutants that accumulate indoors.

VI. Conclusions

This study has demonstrated that the use of chemicals in consumer products leads to the contamination of the indoor environment. The extent of contamination varied between homes because of the different set of circumstances in every microenvironment. These may include differences in the types of products used in each household and the lifestyle of the occupants. The children are at a greater risk to dust associated chemicals. This study supports the increasing evidence for the ubiquitous presence of these compounds in indoor air and the potential for continuous, low-level exposure both at work and at home.

Table I
Summary of PBDE Concentrations (ng/g) in House Dust in Kuwait

Congener	Mean	Median	Percentile	Maximum	SD	Total %
28	0.3	0.1	0.8	3.5	4.9	1.4
47	6.6	2.7	20.9	65.2	11.9	32.8
100	1.2	0.7	3.8	8.6	1.5	5.7
99	6	3.4	22.7	35.7	8.3	30
85	0.6	0.3	2.5	3.2	1.8	3
154	1.3	0.8	4.8	6.1	3.6	6.5
153	1.2	0.7	4.3	4.4	3.2	5.8
183	2.9	1.2	14.6	24.6	1	14.7
ΣPBDEs	20.2	9.7	69.9	124.3	13.7	70

PBDES : Polybrominated diphenyl ethers SD : Standard

Table II
Non-dietary Exposure Estimates for ΣPBDEs (pg/day)

Exposure pathway	Group	Mean	Median	Maximum	5th Percentile	95th Percentile	Non-dietary exposure %
Inhalation	Children	173	61	3400	17.3	572	8
	Adults	399	140	7853	40	1321	66.4
Ingestion of dust	Children	2018	980	15239	127	7539	92
	Adults	202	98	1524	12.7	754	33.6
Total exposure	Children	2191	1041	18639	144.3	8111	59
	Adults	601	238	9377	52.7	2075	41

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