Polybrominated diphenyl ethers (PBDEs) in dust from primary schools in South East Queensland, Australia

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Abstract: PBDE concentrations are higher in children compared to adults with exposure suggested to include dust ingestion. Besides the home environment, children spend a great deal of time in school classrooms which may be a source of exposure. As part of the "Ultrafine Particles from Traffic Emissions and Children's Health (UPTECH)" project, dust samples (n=28) were obtained in 2011/12 from 10 Brisbane, Australia metropolitan schools and analysed using GC and LC-MS for polybrominated diphenyl ethers (PBDEs) -17, -28, -47, -49, -66, -85, -99, -100, -154, -183, and -209. Σ11PBDEs are the sum of these 11 congeners.

Σ11PBDEs ranged from 11-2163 ng/g dust; with an arithmetic mean of 600 ng/g dust. BDE-209 (range n.d. - 2034 ng/g dust; mean 402 ng/g dust) was the dominant congener in most classrooms. Frequencies of detection were 96%, 96%, 39% and 93% for BDE-47, -99, -100 and -209, respectively. No seasonal variations were apparent and XRF measurements found only two classroom items from two schools containing detectable bromine. PBDE intake for 8-11 year olds can be estimated at 0.094 ng/day BDE-47; 0.187 ng/day BDE-99 and 0.522 ng/day BDE-209 as a result of ingestion of classroom dust. The 97.5% percentile intake is estimated to be 0.62, 1.03 and 2.14 ng/day for BDEs - 47, -99 and -209, respectively. These PBDE concentrations in dust from classrooms, which are higher than in homes, may explain some of the higher body burden of PBDEs in children compared to adults.

19 February 2015

Dear Prof Domingo,

With this letter we are submitting the manuscript **"Polybrominated diphenyl ethers (PBDEs) in dust from primary schools in South East Queensland, Australia"** for publication as a Research Paper in Environmental Research.

Measurement of human body burdens of PBDEs in Australia (and elsewhere) shows PBDE concentrations are highest in children compared to adults with exposure suggested to include dust ingestion. In this article we present the first data on polybrominated diphenyl ethers (PBDEs) in dust samples (n=28) from school classrooms from Australia in 2011/12.

In this study, we found that BDE-209 (range n.d. - 2034 ng/g dust; mean 402 ng/g dust) was the dominant congener in most classrooms. Σ_{11}PBDEs ranged from 11-2163 ng/g dust; with an arithmetic mean of 600 ng/g dust. Seasonal variations and XRF measurements were assessed. We used Bayesian hierarchical linear modelling to predict the PBDE concentrations at a "typical" school with the estimates at this school based on the hierarchical prior which pools all the information from all the classrooms measured during the study. PBDE intake for 8-11 year olds can be estimated at 0.05 ng/day BDE-47; 0.1 ng/day BDE-99 and 0.24 ng/day BDE-209 as a result of ingestion of classroom dust. These concentrations, which are higher than in homes, may explain some of the higher body burden of PBDEs in children.

Ethics approval was not required for this project as no human samples were obtained.

We hope that you find this manuscript suitable for publication in Environmental Research and are looking forward to hearing from you.

Yours sincerely,

Leisa-Maree L. Toms

Polybrominated diphenyl ethers (PBDEs) in dust from primary schools in South East Queensland, Australia

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Abstract

PBDE concentrations are higher in children compared to adults with exposure suggested to include dust ingestion. Besides the home environment, children spend a great deal of time in school classrooms which may be a source of exposure. As part of the "Ultrafine Particles from Traffic Emissions and Children's Health (UPTECH)" project, dust samples (n=28) were obtained in 2011/12 from 10 Brisbane, Australia metropolitan schools and analysed using GC and LC-MS for polybrominated diphenyl ethers (PBDEs) -17, -28, -47, -49, -66, -85, -99, -100, -154, -183, and -209. Σ_{11}PBDEs are the sum of these 11 congeners.

Σ_{11}PBDEs ranged from 11-2163 ng/g dust; with an arithmetic mean of 600 ng/g dust. BDE-209 (range n.d. - 2034 ng/g dust; mean 402 ng/g dust) was the dominant congener in most classrooms. Frequencies of detection were 96%, 96%, 39% and 93% for BDE-47, -99, -100 and -209, respectively. No seasonal variations were apparent and XRF measurements found only two classroom items from two schools containing detectable bromine. PBDE intake for 8-11 year olds can be estimated at 0.094 ng/day BDE-47; 0.187 ng/day BDE-99 and 0.522 ng/day BDE-209 as a result of ingestion of classroom dust. The 97.5% percentile intake is estimated to be 0.62, 1.03 and 2.14 ng/day for BDEs – 47, -99 and -209, respectively. These PBDE concentrations in dust from classrooms, which are higher than in homes, may explain some of the higher body burden of PBDEs in children compared to adults.

Keywords: polybrominated diphenyl ethers, dust, schools, intake, children

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Introduction

Polybrominated diphenyl ethers (PBDEs) are a class of brominated flame retardant (BFR) chemicals that are used to reduce the flammability of commercial and household items. PBDEs may leach or volatilize from products (Darnerud et al. 2001) and enter the environment thus resulting in human exposure to these persistent, lipophilic chemicals. Health outcomes associated with BFR exposure include alteration in thyroid function, diabetes, neurobehavioral, developmental and reproductive disorders (as summarised in Kim et al. 2014). Recently there has been a suggestion that levels of some PBDEs in dust may be associated with risk of childhood acute lymphoblastic leukemia (Ward et al. 2014) while others suggest PBDE levels in dust are associated with risks for depressed behaviour problems and lower personal social developmental quotients (Wang et al. 2015). Future epidemiological studies may uncover the degree of impact of PBDE exposure on health. Penta-BDE, octa-BDE and deca-BDE commercial formulations have been produced. In Australia, importation of the penta- and octa-BDE products ceased in 2005(NICNAS 2007) while manufacture of deca-BDE ceased in the USA in 2013 (U.S. Environmental Protection Agency 2013). Due to the relatively long turn-over times of the products treated with PBDEs, and the potential for emissions once such products enter the waste stream, PBDEs are likely to enter the environment for some time into the future (Harrad and Diamond 2006).

Dust ingestion, inhalation and dietary intake are the suggested pathways of human PBDE exposure (Besis and Samara 2012; Coelho et al. 2014). PBDEs have been detected in household dust samples from Australia, Germany, United States of America (USA), United Kingdom (UK), China and New Zealand (Sjodin et al. 2008; Toms et al. 2009a; Coakley et al. 2013; Wang et al. 2015) and in different types of buildings including offices (Watkins et al. 2013), classrooms in the UK (Harrad et al. 2010) and Korea (Wu et al. 2010), and daycare centres in Sweden (Thuresson et al. 2012). PBDE concentrations in air are higher in indoor than outdoor environments (Toms et al. 2009a) and higher in urban compared to rural areas (Hearn et al. 2012; Stasinska et al. 2013). Some studies show concentrations of PBDEs in dust to correlate with PBDE concentrations in human milk or blood serum (Stapleton et al. 2012; Coakley et al. 2013).

Measurement of human body burdens of PBDEs in Australia (Toms et al. 2009) and elsewhere (Thomsen et al. 2002; Ali et al. 2013; Eskenazi et al. 2013; Linares et al. 2015) shows PBDE concentrations are highest in children compared to adults. The mean ΣPBDE concentration in serum from Australian children aged 6-9 (n=180) and 9-12 (n=240) years are 32 and 21 ng/g lipid, respectively, compared to adults > 16 years where the mean ΣPBDE concentration is 12 ng/g lipid (Toms et al. 2009). It has been suggested that different behaviours between children and adults such as mouthing objects can contribute to the difference in body burden (Stapleton et al. 2012). However, the reasons for higher levels in children are not fully understood and require further investigation, but exposure to dust with higher concentrations could be one explanation.

Besides the home environment, children spend a great deal of time in the school classroom, which may be a source of PBDE exposure and a contributor to the higher body burden.

The objectives of this project were to determine concentrations of PBDEs in dust from primary schools; estimate intake of PBDEs via dust ingestion for these school age (8-11 years) children; and investigate any relationship between PBDE concentrations in classroom dust and putative sources within the classroom.

Materials and methods

Study Design

This project was conducted as part of a large multidisciplinary epidemiological project, titled "Ultrafine Particles from Traffic Emissions and Children's Health (UPTECH)". The UPTECH project seeks to determine the effect of exposure to airborne ultrafine particles (UFP) emitted from motor vehicles on the health of children in schools. State schools in the Brisbane Metropolitan Area, Australia that were not in close proximity to any major local air pollution sources other than vehicular traffic, did not use central air-conditioning system in the classrooms, and had at least two classrooms used by 8-11 year old children were included in the UPTECH project (http://www.ilaqh.qut.edu.au/Misc/UPTECH%20Home.htm). The experimental part of UPTECH commenced in October 2010 and concluded in August 2012 with the dust collection occurring between August 2011 and May 2012. The sample collection for PBDE assessment was conducted in two participating classrooms in a random selection of 10 of the 25 UPTECH

schools (coded as S7, S11, S12, S14, S15, S16, S17, S18, S19 and S21, see (supporting information in Salimi et al. 2013) for details of schools). Observations made during sample collection were that with respect to contents, occupancy levels and duration; classrooms in Brisbane are remarkably similar from school to school. Approximately 24 students and 1 teacher use the classroom for around 5 hours per day (excluding lunch breaks), 5 days per week, 40 weeks per year. Each classroom has an area of around 70 m^2, with 24 desks and 24 hard plastic chairs, 1 foam office chair for the teacher, around 5 computers, an interactive whiteboard, and a combination of carpet and vinyl floor covering. Some have soft pillows/ cushions for sitting on the floor.

Dust collection

Dust was sampled using a Dyson DC26 HEPA vacuum cleaner (1100W) and using specially designed sampling 'socks' (25 μm mesh nylon sampling sock sourced from Allied Filter Fabric Pty Ltd, Australia). Sections of carpet (4 in total) within the classroom were measured out to 1 m^2 and vacuumed for 2 minutes as described previously(Harrad et al. 2008). The dust collected in the sock was then placed into an aluminium foil envelope and transported to the laboratory. Prior to analysis, dust samples were passed through a 500 μm mesh sieve, homogenised thoroughly and stored in the freezer.

Due to the low dust mass collected, in most cases the four sampled sections were combined into one or two samples of dust for PBDE analysis. From three schools (S16, 18 and 19), two

classrooms were sampled with two replicates taken in each classroom to total four samples per school; while at six schools the samples from each classroom were combined to yield two samples per school (S11, 13 -15, 17 and 21). For one school (S12), four samples were analysed but for three, samples from both classrooms A and B were combined and treated as originating from a single room. Overall from 10 schools, 16 classrooms were sampled to afford a total of 28 dust samples for analysis (Table 1).

Chemical Analysis

The PBDEs targeted for analysis were BDE-17, -28, -47, -49, -66, -85, -99, -100, -154, -183, and -209 using a method modified slightly from that described previously(Brommer et al. 2012) and analysed at the University of Birmingham. Internal standards ($^{13}C_{12}$-BDE-28, -47, -99, -153, and -209) were added to accurately weighed aliquots (~ 50 mg) of dust. Samples were extracted three times using 2 mL hexane: acetone (3 : 1 v/v) per extraction with ultrasonication in each case for 5 min and vortexing for 1 min between each sonication. Extracts were centrifuged at 2000 g, the supernatants combined and evaporated to incipient dryness, before the residue was redissolved in 1 mL hexane. Before fractionation, 1 g Florisil glass columns were pre-cleaned with 8 mL methanol and 4 mL hexane. The extracts were quantitatively transferred to the columns by using 3 mL hexane and eluted with 5 mL hexane to elute PBDEs. Additional clean up was conducted on a 44% (w/w) sulfuric acid-impregnated silica gel column (~ 1 g). Elution of PBDEs was achieved with 10 mL of hexane: DCM (1:1). After solvent evaporation, the extract was redissolved in 100 µL iso-octane and $^{13}C_{12}$BDE-100 was added as a recovery determination (or

syringe) standard. Samples were analysed using an Agilent 5975 MS coupled with an Agilent 6850 GC, fitted with Agilent DB-5MS column (30 m x 0.25 mm x 0.25 µm). Helium was used as the carrier gas with a constant flow of 0.5 mL/min. The inlet was run in splitless mode. The GC oven had an initial temperature of 140°C which was held for 2 minutes, then increased by 5°C/min to 200°C, before increased further to 300°C at 2°C/min. Target masses and retention times for the identification and quantification of PBDEs via GC/MS are listed in Supporting Information Table S1. After GC analysis solvent was exchanged to methanol and extracts run on LC-MS/MS for higher brominated PBDEs as described previously(Abdallah et al. 2009). A laboratory blank sample was included in every sample batch (total of 5), which consisted of pre-cleaned sodium sulfate, sieved through the mesh and treated like a sample. No PBDEs were detected in these blank samples. Standard Reference Material (SRM) 2585 was analysed with every batch as an additional control and found to be within 10% of the certified levels.

XRF screening methodology

A handheld Niton XL3t X-ray Fluorescence device (XRF device) was used to analyse items within the classrooms from one school with low levels (S19) and one with high levels (S11) of PBDEs in dust. The XRF has been demonstrated previously as capable of detecting bromine content in furnishings and electronics and to correlate with GC-MS measured concentrations of bromine and PBDEs by Allen et al.(2008). In the present study, the XRF provided an estimation of bromine concentration (as ppm) in the scanned area of the item as an indication of whether any putative source items in the classroom contained PBDEs. XRF is a technique that allows the

rapid, simple and non-destructive detection of bromine in a wide variety of consumer products. A two point calibration was regularly performed throughout the analyses to ensure reliability and validity using internationally certified standards of low-level and high-level bromine-containing polyethylene obtained from the Institute for Reference Materials and Measurements (IRMM), Belgium. The XRF device was operated in the Plastics mode, held to the surface of the item under test and measurement conducted for 30 seconds.

Statistical Analysis

Statistical analysis was undertaken on the data using R. It should be noted that where a congener was not detected, a zero value was used for ∑PBDE calculations and analysis. ΣPBDEs are the sum of BDE-17, -28, -47, -49, -66, -85, -99, -100, -154, -183, and -209.

Bayesian hierarchical linear modelling was used as an alternative approach to the more traditional ANOVA style of data analysis. With small data sets the ANOVA may not have enough statistical power to determine whether there are differences between groups. Additionally, the assumptions of an ANOVA model, such as the data being drawn from a normal distribution, the variance being the same within groups and the observations being independent, may not necessarily be valid and transformation of the data to approximate normality is not feasible (e.g. many zero concentrations), see Appendix in Supporting Information for details of the modeling used for this dataset.

Results and Discussion

BFRs in dust

PBDEs were detected in all 28 dust samples. ΣPBDEs ranged from 11-2163 ng/g dust; with an arithmetic mean of 600 ng/g dust. BDE-209 ranged from <10 - 2034 ng/g dust with a mean of 402 ng/g dust; BDE-99 ranged from <0.83 – 247 ng/g dust with a mean of 102 ng/g dust; and BDE-47 ranged from <0.5 – 122 ng/g dust with a mean of 48 ng/g dust (Table 2).

There is a large degree of variation in the proportions of each congener across the schools (Figure 1). The dominant congener in the dust samples was BDE-209, followed by BDE-99 and BDE-47 contributing between 24–78%, 3.7–45%, and 0.8–34%, respectively to the ΣPBDE concentration. BDE-85 concentrations were detected only in room A at S16 and room A at S19. These rooms also have levels of BDE-100 higher than other schools (Table 2). While BDE-209 is the dominant congener in most schools, concentrations do vary between schools and are discussed in Supporting Information (Figure S1). When pooling all data together, i.e. ignoring any classroom level effect, the 95% credible intervals of the proportion estimates are quite narrow and show that BDE-209 is the most prevalent across all classrooms, 67.1% (95% CI: 66.9–67.3%). The 95% credible intervals for all other congeners indicate that they contribute less than 2.5% of the total PBDE concentration except BDE-99, 17.0% (95% CI: 16.8–17.2%), and BDE-47, 8.0% (95% CI: 7.9–8.1%). The presence of the BDE-209 in dust is likely due to a

greater use of the deca-BDE commercial product compared to the penta- and octa-BDE flame retardant products since the cessation of penta- and octa-BDEs around 2005 (NICNAS 2007).

In homes, others have reported relationships between PBDE concentrations in dust and indices of putative source items within a room such as number of electronics (Allen et al. 2008) or presence of crumbling foam furniture (Whitehead et al. 2013). However, due to the similarities in classrooms from this study, it is not possible to differentiate between schools based on potential PBDE treated products. In addition, all schools were located in metropolitan Brisbane and therefore no urban/ rural differences could be observed. Seasonal variations were considered by adding a season level to the hierarchy such that classrooms were grouped by the season in which they were measured however the 95% credible intervals for the difference between the season level mean and the classroom level mean contained zero for every classroom. This indicates that there is no detectable seasonal variation within the data, likely due to the small number of observations and the small number of replicates of schools in each season.

XRF in classroom samples from two schools

In order to assess the sources of PBDEs into the dust from the classrooms, the XRF was used to investigate bromine content as an indication of BFR content in a number of items in the classroom from two schools, one with high PBDE levels (S11) in dust and one with lower levels (S19) in dust. Items included: carpet, linoleum, room divider (movable wall made from a vinyl type material), foam office chair, whiteboard, interactive whiteboard, noticeboard, computer

keyboard, computer monitor, computer hard drive box, bookshelf, pillow and plastic storage box. Bromine was detected at 5873, 28 and 488 ppm, in a computer keyboard, a computer monitor and in a room divider from the 'low-PBDE' school and at 677 and 123 ppm in a foam chair and pillow, respectively at the 'high-PBDE' school. These results fall into the ranges reported from homes in the USA, where bromine readings from computers (n=30) ranged from non-detected – 109000, in carpet (n=38) ranged from non-detected – 718 and in sleeping pillows ranged from non-detected – 164000 ppm (Imm et al. 2009). No other items in the classrooms had detectable bromine based on the XRF analysis. It is therefore not possible to attribute the PBDE content detected in the dust to any specific item in the classrooms, in addition it is noted that since only two classrooms were selected for XRF analysis inference is limited.

Dust intake per day for school children

Based on the range of PBDE concentrations detected in the schools and using a conservative intake calculation of 8.32 mg (using twice the adult rate for children aged 8-11 year as their mouthing behaviours and in turn dust ingestion would be very different to infants and toddlers where an estimated intake rate of 50 mg/day would be used) and 4.16 mg (for adults) of dust ingestion per day (U.S. EPA 1997), assuming 5 hours per day in the classroom, intake was estimated. The modelled data (Table 3) are used to predict the mean, 2.5% and 97.5% percentile intake for BDEs -47, -99 and -209 for children and the teacher. It can be estimated that children in these schools in Brisbane are exposed to 0.094 ng/day BDE-47; 0.187 ng/day BDE-99 and 0.522 ng/day BDE-209 as a result of ingestion of classroom dust. The 2.5% and 97.5% intake

would be 0.006 and 0.25, 0.108 and 0.62 and 1.03 and 2.14 ng/day for BDEs – 47, -99 and -209, respectively. For the teacher in the classroom, the mean ingestion rates would be 0.08, 0.01 and 0.04 ng/day for BDEs – 47, -99 and -209, respectively. It should be noted that the contribution of dust to the total intake of PBDEs is dependent on the rate of dust ingestion used which typically varies between studies. We chose to make a conservative estimate while others use a range of childhood intake of 50 – 200 mg/day which is a rate for infants/toddlers and would be inaccurate for older children such as the 8-11 years in this study. The rate of dust ingestion for children and adults is an area requiring further investigation. Overall exposure from: (1) dust ingestion in other microenvironment categories, and (2) other pathways like diet, inhalation and dermal exposure to dust would affect their overall daily PBDE ingestion rates.

Comparisons with other building uses in Australia and overseas

From Australia, the most recent data on PBDE concentrations in indoor dust come from homes and offices in 2005 and homes in 2006 all from around Brisbane. In 2005, the mean BDE-47, -99 and -209 concentrations were 24, 36 and 243 ng/g dust, respectively in homes and 107, 151 and 1280 ng/g dust, respectively in offices (Toms et al. 2009a). In 2006, the mean BDE-47, -99 and -209 concentrations in homes were 91, 185 and 377 ng/g dust (Toms et al. 2009) which is higher than in the samples collected in 2005. The reason for this difference is unknown, although sampling techniques were slightly different between these studies. The classroom PBDE concentrations in the current study are around twice that found in homes and half that found in offices in 2005 which is to be expected considering the amount of equipment,

electronics etc in these three building types. In the 2006 homes data, levels of BDE-47 and -99 were higher than in schools while the BDE-209 levels were similar to that found in schools. The congener profile of homes and offices was dominated by BDE-209, followed to a much lesser degree by BDEs-99, -47 and -183 which is as observed in classroom dust in this study(Toms et al. 2009a). Comparisons are made with caution due to the small sample sizes and the time difference between collections (2005/06 compared to 2011/12). There are limited data on PBDEs in classrooms: specifically a study from the UK where the mean concentrations of BDE-47, -99, and -209 in dust from 43 pre-school daycare and primary school classrooms were 32, 54 and 8500 ng/g dust, respectively. These concentrations in UK classrooms compared with ranges of 1.2 – 58 ng/g dust, 2.8 - 180 ng/g dust and n.d. – 2200000 ng/g dust for BDE-47, -99 and -209, respectively in UK homes and 2.6 – 380, 4.2 - 490 and 620 – 280000 ng/g dust for BDE-47, BDE-99 and -209, respectively in UK offices (Harrad et al. 2008). Harrad et al.(2010) did not find any relationships between PBDE dust concentrations and number and type of electrical and electronic items or floor coverings in the classrooms. In Sweden, the mean PBDE concentrations in 10 daycare centres were 120 and 580 ng/g dust for BDE-47 and BDE-209, respectively compared to in homes (n= 10) and offices (n=10) where BDEs -47 and -209 were 42 and 320 ng/g dust and 1.2 and 780 ng/g dust, respectively (Thuresson et al. 2012). In South Korea, the median PBDE concentrations in 17 elementary schools in classrooms of 6-12 year olds (n=24 dust samples) were 4.09 and 12.2 ng/g dust for BDE-47 and 1360 and 833 ng/g dust for BDE-209, grouped into samples with higher-brominated congeners and those with lower brominated congeners, respectively (Wu et al. 2010).

A range of PBDEs were detected in all 28 samples of dust from 10 schools with BDE-209 the dominant congener. The mean concentration of BDE-209 is 401 ng/g dust which is higher than that found in homes but lower than that found in offices. The 97.5th percentile dose of BDE-209 a child will receive as a result of ingestion of classroom dust is 2.14 ng/day, based on 8.32 mg/day dust ingestion. These concentrations, which are higher than in homes, may explain some of the higher body burden of PBDEs in children. However, further investigation of actual dust ingestion rates in children is required to accurately calculate PBDE exposure via this pathway as well as investigation of child-specific foods as a potential source.

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Table 1. List of school codes and classrooms sampled

Schools	Classrooms	No. of samples
S11	S11A (1 & 2)	2
S12	S12A, S12A/B 1, S12A/B 2, S12A/B 3	4
S13	S13A, S13B	2
S14	S14A, S14B	2
S15	S15A (1 & 2)	2
S16	S16A (1 & 2), S16B (1 & 2)	4
S17	S17B (1 & 2)	2
S18	S18A (1 & 2), S18B (1 & 2)	4
S19	S19A (1 & 2), S19B (1 & 2)	4
S21	S21A, S21B	2

Table 2. Range, mean and median PBDE concentrations (ng/g dust) in dust collected from state primary schools

Congener	Minimum	Maximum	Mean	Standard Error
BDE 17	n.d. (0.36)	2.0	0.4	0.1
BDE 28	n.d. (0.38)	4.4	1.0	0.2
BDE 49	n.d. (0.42)	6.0	1.7	0.3
BDE 47	n.d. (0.5)	122	48	5.9
BDE 66	n.d. (0.75)	4.6	1.6	0.2
BDE 100	n.d. (0.75)	114	10	4.2
BDE 99	n.d. (0.83)	247	102	14
BDE 85	n.d. (1.3)	63	5.1	2.9
BDE 154	n.d. (1.5)	19	6.6	1.1
BDE 153	n.d. (1.9)	41	14	2.3
BDE 183	n.d. (2.5)	103	8.3	3.6
BDE 209	n.d. (10)	2035	402	94
ΣPBDEs	11.3	2163	600	100

Table 3 Estimations of intake (ng/day) for children arising from time in classroom, assuming 5 hours/ day at school and ingestion of 8.32 mg dust/day, based on mean, median and 97.5% credible interval for posterior predictive distributions of BDE concentration at an unobserved school 26

	Mean	2.5%	50%	97.5%
BDE-47	0.152	0.006	0.094	0.62
BDE-49	0.029	0.000	0.006	0.23
BDE-66	0.029	0.000	0.005	0.21
BDE-85	0.014	0.000	0.000	0.11
BDE-99	0.268	0.025	0.187	1.03
BDE-100	0.034	0.000	0.007	0.26
BDE-153	0.054	0.000	0.021	0.31
BDE-154	0.044	0.000	0.013	0.29
BDE-183	0.038	0.000	0.009	0.24
BDE-209	0.673	0.108	0.522	2.14
ΣPBDE	1.333	0.969	0.234	4.18

Figure

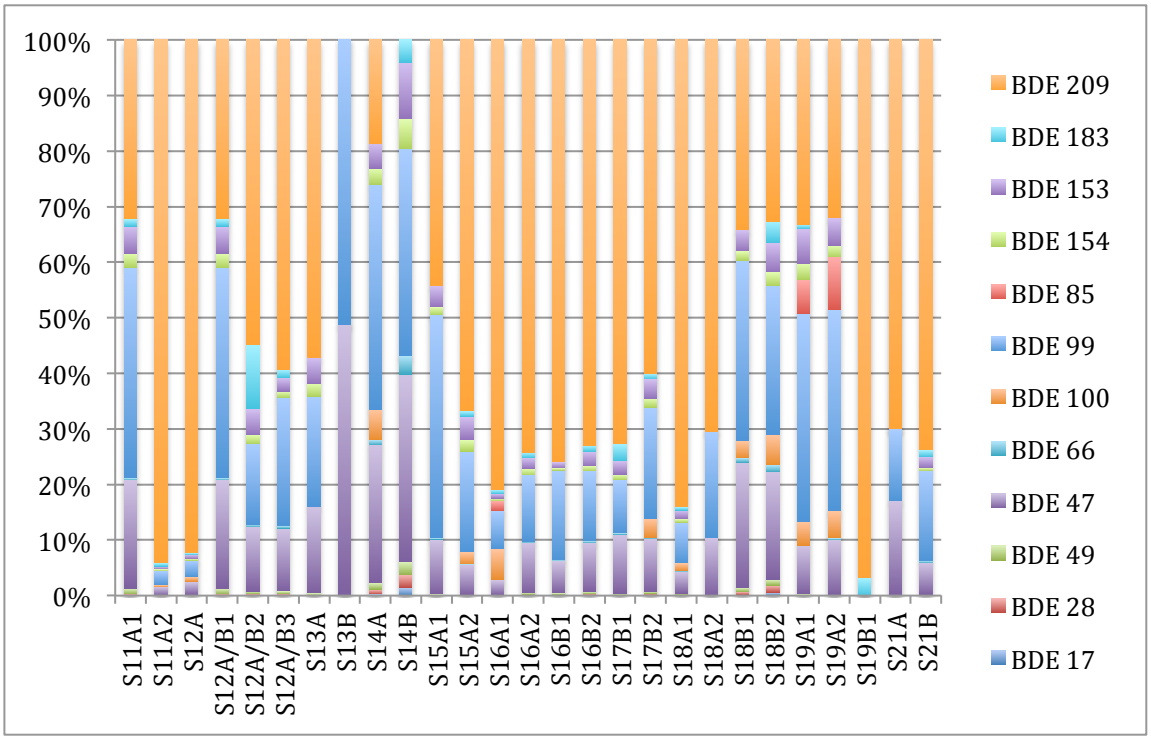

Figure 1. Congener profile distribution (percent) for all dust samples (n=26) from Brisbane metropolitan primary schools (n=10).

Supplementary Material

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