Polybrominated Diphenyl Ethers in Human Milk in Taiwan

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Several studies have linked polybrominated diphenyl ethers (PBDEs) to adverse biological effects in animals, giving rise to concerns that low-level exposure might cause similar effects in human beings as well. This study measured PBDE levels in breast milk samples from Pingtung, Taiwan. Study participants were healthy women recruited from Pingtung between April and October, 2007. Seven congener levels of PBDEs (BDE-47, 49, 99, 126, 153, 191, 209) in 20 breast milk samples were measured by a gas chromatography with a high resolution mass spectrometer (GC/Ms). The mean level of PBDEs in breast milk was 2650 ± 2580 pg/g lipid. The highest spearman correlation coefficient was found to be 0.893 ($p < 0.001$) between BDE-47 and BDE-99 in breast milk. The milk PBDE level was higher in women with the long menstrual cycle length (longer than 40 days *versus* less than 40 days; $p = 0.004$). Women with education level lower than high school had the significantly higher magnitude of BDE-99 compared to women with the higher education level ($p = 0.032$). Body burden of BDE-153 in women was increased with the increased head circumference of their offspring ($r = 0.458$, $p = 0.042$). Owing to few environmental monitoring and epidemiological data of PBDEs, this study encourages more longitudinal data from Taiwan to better understand the impact of PBDEs to human health in the industrialized small island of Taiwan.

Key Words: Polybrominated diphenyl ethers, Endocrine disruptor, Human milk, Toxicity, Taiwan.

INTRODUCTION

Polybrominated diphenyl ethers (PBDEs) are brominated flame retardants (BFRs) which are commonly used in making crusts of electronic, electric and plastic products. The purpose of using flame retardants is to enhance product safety and to reduce flammability of consumer products. Thus, adding flame retardants can reduce casualties caused by fire. Polybrominated diphenyl ethers have occupied the largest market share due to their cheap price and high flame-resistant efficiency. However,

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in recent years, studies have shown that PBDEs may be released into the environment during its chemical life cycle. They are difficult to dissolve, so that they can be detected in various environmental media and organisms, including sediment, air, water, fish, birds, eggs, seals, human fat tissue, breast tissue and blood. Some reports indicate that the density is higher than polychlorinated biphenyl (PCBs)[1].

Polybrominated diphenyl ethers have 209 congeners which are formed by adding Bl to diphenyl, with the help of catalysts. The 209 PBDEs isomers were named by the naming method specified for PCBs by IUPAC[2]. The chemical structures of PBDEs are similar to PCBs, which can be classified into 10 categories of 209 isomers (mono-to decabromodiphenyl ether[3]. The characteristics of PBDEs include high lipid solubility, low volatility and difficult decomposition. Thus it is easy to accumulate high concentration of PBDEs in food and the human body[4]. Since PBDEs are persistent organic pollutants (POPs), they can not be efficiently removed through body metabolism.

In recent years, endocrine disrupting chemicals (EDCs), including estrogenic chemicals, have become a new international issue on health and environment, as they have the potential to change and simulate the endocrine functions of humans and wildlife and cause harmful impacts. Polybrominated diphenyl ethers have been regarded as EDCs and as new pollutants all over the world. In Sweden, a study tested breast milk samples from 1972-1997 and found that the PBDEs values showed exponential growth every five years[5]. In animal experiments, PBDEs showed harmful effects to brains, nervous and reproductive systems and development and it can be carcinogenic if exposed to a high dosage of PBDEs[6].

Studies found that among newborn rats, taking PBDEs may cause toxic impact to nerves and the rats showed hyperactivity, learning and memorizing behaviour damage and decreased nicotinic receptors[7]. Polybrominated diphenyl ethers can be detected in breast milk, lipids, livers and blood samples of chickens, seafood, seals and other aquatic mammals and in experiments on rats, the exposure to high dosage of PBDEs may cause persistent erosions on brains[8,9].

The PBDEs are lipid soluble so that they can accumulate in fat tissues of humans or animals in the food chain. Many countries have prohibited the addition of BFRs in foam, TV cases and plastic food containers. In, 2006, the Environmental Protection Agency in Taiwan announced that pentabromodiphenyl ether of PBDEs belonged to the first category of toxins. For more than 10 years, the concentration of PBDEs in various environmental media, aquatic organisms and human breast milk has increased significantly. Nevertheless, there is still lack of extensive research to understand the impact of PBDEs in Taiwan's environment.

Although PBDEs in human breast milk may be transferred from mother to baby *via* nursing, there are many advantages to breast-feeding. Apart from being economical and convenient, the lipid content of breast milk is higher and can increase babies' resistance against diseases, reduce the chance of respiratory tract infections and digestive tract diseases and chronic diseases like allergies. As for mothers, breast-feeding is convenient and cheap and can help enhance the mother-child relationship and the recovery of a woman's health after giving birth.

Breast milk is high in fat content (3.5-4.0 %) and its collection as samples is both noninvasive and easily done by any pregnant woman without the need of professional staff. Therefore, breast milk is a very suitable sample for monitoring. It can be used to analyze PBDE chemical compounds, lipophilic and persistent organic pollutants. From current global studies on the POPs in breast milk, most POPs, like polychlorinated dibenzo-*p*-dioxin (PCDD)/DFs, PCBs and organic chlorine pesticides have decreased under stricter control or prohibition. However, in recent years, the amount of PBDEs has increased due to the common application of fireproof materials, but little is known about this aspect in Taiwan. Since breast milk is the best baby food at birth, by measuring breast milk, we can understand the exposure amount of babies after birth and the burden on the mother's body. Hopefully, this will be very important information for public health and sanitary policies, which can provide references for relevant institutions, enlarge the databank on PBDEs in breast milk in the Taiwan area and provide better comparisons with other countries around the world for future research.

EXPERIMENTAL

This study investigated the population of healthy pregnant women living in Pingtung, Southern Taiwan. We randomly selected healthy and pregnant women from the list provided by the obstetrics and gynecology department of two major hospitals in Pingtung. The women who were willing to join the research followed the standard procedure required by the study to collect their breast milk after giving birth. This requirement was meant to reduce the risk of contamination of breast milk to the minimum. Demographic data including age, height, weight and number of births were collected. This study was approved by the institutional review board (IRB) of Pingtung Christian Hospital and authorized us to collect the milk samples from the subjects. Women participating in the study read the procedure and signed a letter of consent.

Collection of breast milk samples: The sampling of breast milk was done after the subjects were giving birth (7-30 days). The breast milk collecting procedure was in accordance with the World Health Organization[10]. We provided 3 clean glass bottles containing Teflon spacers and caps and the subjects collected their breast milk at home and placed the bottles in refrigerators. We retrieved the breast milk glass bottles when they reached 70 % capacity. Then moved the bottles to the laboratory for storage in a fridge under -20 ºC. Each subject provided 90-150 mL of breast milk and the samples were stored at -4 ºC before analysis and the pre-handling completed within 3 days.

Analysis of PBDEs in breast milk samples: Samples were placed into the centrifuge (2000 rpm, 15 min, 20 ºC) and sucked out the upper layer fluid to pre-weighed class tube and repeated the extraction to get another upper layer fluid.

Then mixed the fluids together, blew with nitrogen and dried in the oven until dry. C_{18} solid phase extraction was used by 5 mL *n*-hexane, 5 mL methanol and 5 mL double distilled water for preconditioning. NH_2 solid phase extraction and Bond Elut PCB solid phase extraction were pre-washed with *n*-hexane before use. Based on the past research experiments, it was decided to use ERGO lab for analysis and to use gas chromatography/mass spectrometry (GC/MS) to analyze pre-handled breast milk samples[11]. Besides, the SIM model used Br ion mass-to-charge ratio (m/z) 79 and 81 to detect PBDEs. Retention time and rectified isotope ratio were used to measure PBDEs. Inner and outer standards were used as a quantitative measure for the content of PBDEs (Fig. 1).

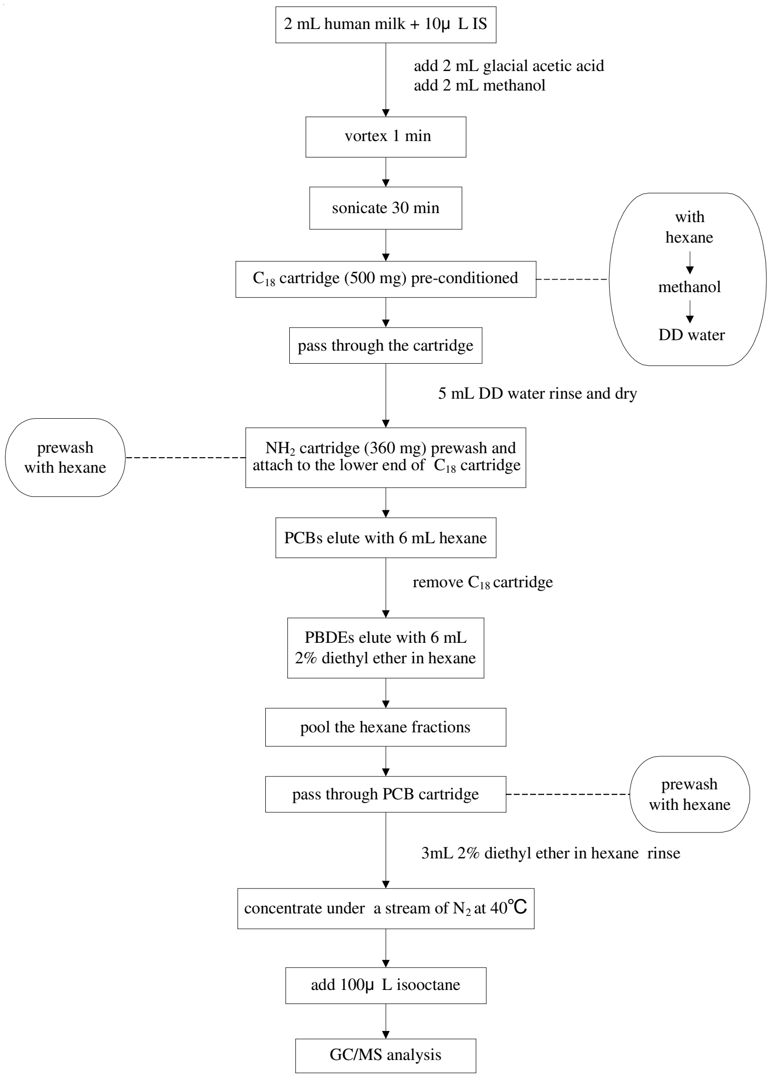

Fig. 1. Milk sample preparation and analysis protocol

Statistic analysis: This study used the mother's physical features and the baby's physical features as parameters to do spearman correlation, in order to investigate if the relationships between PBDEs and various physical features of the subjects are strong enough to conduct the next stage analyses. The physical features include: mother's age, body mass index (BMI) before delivery, parity, household annual income, education level, number of pregnant weeks, birth weight and height of the newborn and the concentration of total PBDEs in the subject's breast milk. Under the analysis of spearman correlation the combinations that reached significant standard (either positive or negative correlation) were chosen to be tested with Mann-Whitney U test (one type of non-parametric statistics). The reason for choosing the Mann-Whitney U test is that the concentration distribution of PBDEs in this study did not match normal distribution; the small sample size was another reason for not using student t-test. We used the statistics package for social science (15.0) for analysis.

Concentration of PBDEs in samples: Due to the differences of data and analyses, indications for figures under the detected limit may also vary; those currently used are detected limit value, 1/2 detected limit value and 0. In this study, the values of the concentration of PBDEs in breast milk samples were not counted if they were under the detected limit. Polybrominated diphenyl ethers basically were dissolved in breast milk lipids which may vary every day, even during the same nursing period. This will cause disruption while measuring the internal exposure of the mother and the intake amount or accumulated exposure amount of the baby from nursing; thus, the content of PBDEs in the samples was indicated with the unit of ng/g lipid.

RESULTS AND DISCUSSION

A total of 20 pregnant women were volunteered to take part in present study. The average age of mothers was 29.1 ± 5.40 (SD) years, the BMI before delivery was 22.4 ± 3.90 kg/m^2, menstrual cycle was 30.2 ± 5.0 days and the age of the first period was 12.6 ± 1.6 years (Table-1). Among the mothers, 3 had abnormal prolonged menstrual cycles (20-180 days). The average parity was 2.2 ± 1.1 births (including induced and natural abortions). Adjusting the age of the mother, BMI before delivery and parity, no significant difference was found[12]. The ethnic groups of the mothers included 75 % Minnan, 10 % Hakka and 5 % aborigines. The 20 newborn babies (sex ratio 1:1) were measured by pediatricians that included the average week of birth (38.5 ± 1.28), weight (3090 ± 396 g), height (49.0 ± 1.18 cm), the Quetelet's index value (12.8 ± 1.38 kg/m^2), head circumference (33.6 ± 1.18 cm) and chest perimeter (32.0 ± 1.58 cm; Table-1). The education level of the mothers was mostly high school/junior college graduates (60 %).

Values of PBDEs in breast milk: We tested the fat content in breast milk (Mean ± SD = 2.50 ± 0.94 %, Md = 2.50 %, range = 0.60-4.00 %) and the concentration of 7 PBDEs (BDE-47, BDE-49, BDE-99, BDE-126, BDE-153, BDE-191 and BDE-209; Table-2). The values of BDE-126, BDE-191 and BDE-209 were lower than the detected limit and thus appear as ND, while the average concentration

TABLE-1
SALIENT FEATURES OF MOTHERS AND INFANTS IN THE PRESENT STUDY

	Mean ± SD or percentage	Range
Mother (n = 20)		
Age (years)	29.1 ± 5.4	19-41
Milk lipid content (%)	2.5 ± 0.9	0.6-4.0
Pre-pregnant BMI (kg/m^2)	22.4 ± 3.9	17.2-32.0
Age at menarche (years)	12.6 ± 1.6	10-17
Menstrual cycle length (days)	30.2 ± 5.0	20-45
The longest length of menstrual cycle (days)	47.4 ± 37.3	20-180
The shortest length of menstrual cycle (days)	25.4 ± 6.0	7-30
Dysmenorrheal in persons (%)	3 (15 %)	–
Parity (times)[a]	2.2 ± 1.1	1-4
Infants (n = 20)		
Gender male in persons (%)	10 (50 %)	–
Gestational age (weeks)	38.5 ± 1.28	36-40
Birth weight (g)	3090 ± 396	2450-3780
Birth length (cm)	49.0 ± 1.18	47-51
Quetelet's index (kg/m^2)	12.8 ± 1.38	10.8-15.1
Head circumference (cm)	33.6 ± 1.18	32.0-35.5
Breast circumference (cm)	32.0 ± 1.58	28.5-34.5

and SD of BDE-47 1460 ± 2020 pg/g lipid (Md = 821 pg/g lipid, range = 551-9700 pg/g lipid), the average concentration of BDE-49 was 62.0 ± 31.0 pg/g lipid (Md = 56.0 pg/g lipid, range = 31.0-112 pg/g lipid, BDE-99 was 365 ± 284 pg/g lipid (Md = 255 pg/g lipid, range = 148-1310 pg/g lipid) and BDE-153 was 662 ± 334 pg/g lipid (Md = 560 pg/g lipid, range = 361-1710 pg/g lipid). The average concentration of Σ_7PBDEs was 2650 ± 2580 pg/g lipid (Md = 1740 pg/g lipid, range = 1270-12800 pg/g lipid; Table-2). Among the distribution of 7 PBDE chemical compounds, it was found that BDE-47 was the highest, followed by BDE-153, BDE-99 and BDE-49, while BDE-126, BDE-191 and BDE-209 were ND (lower than the detected limit; Table-3). BDE-47 and BDE-153, with the highest concentrations, occupied 55.2 and 25.2 % of the total PBDEs, respectively, while BDE-99 and BDE-49 were 13.9 and 2.3 %, respectively. BDE-47 and BDE-153 held 80.4 % of the total PBDEs, which showed that BDE-47 and BDE-153 were the major contributors of PBDEs (Table-3). Since BDE-47 held above 50 % of the total concentration, it can be used as the indicative chemical compound to test PBDEs in breast milk. The result was consistent with literatures of central Taiwan, Australia and USA[11,13].

A comparison with other countries of the value of the concentration of PBDEs in breast milk in the central and Pingtung areas of Taiwan show that the values of central and southern Taiwan are very similar (Table-4). The ratio of BDE-47 in breast milk between the USA and Taiwan and was more than 20 fold, due to more flame retardants added in USA, resulting in more PBDEs in breast milk[13] (Table-4). Comparing Taiwan with Australia, it was found that the concentration of PBDEs in

TABLE-2
CONCENTRATION OF 7 PBDES IN HUMAN MILK SAMPLES
STUDIED IN PINGTUNG, TAIWAN (PG/G LIPID)

	n < LOD[a]	Mean ± SD	Median	Range
Milk lipid content (%)	0	2.5 ± 0.94	2.5	0.6-4.00
BDE-47	0	1460 ± 2020	821.0	551-9700
BDE-49	15	62 ± 31.00	56.0	31-112
BDE-99	0	365 ± 284	255.0	148-1310
BDE-126	20	ND[b]	ND[b]	ND[b]
BDE-153	0	662 ± 334	560.0	361-1710
BDE-191	20	ND[b]	ND[b]	ND[b]
BDE-209	19	ND[b]	ND[b]	ND[b]
Σ_7PBDEs[c]	–	2650 ± 2580	1740.0	1270-12800

a: n < LOD: smaller than detectable limit; b: ND missing value not included; c: Σ_7PBDEs = BDE-sum of 47, 49, 99, 126, 153, 191, 209.

TABLE-3
SPEARMAN CORRELATION AMONG BDE-47, BDE-99,
BDE-153 AND TOTAL PBDES (PG/G LIPID)

	BDE-47	BDE-99	BDE-153	PBDEs
BDE-47	1.000	0.839** (p < 0.001)[a]	0.272 (p = 0.246)[a]	0.782** (p < 0.001)[a]
BDE-99	0.839** (p < 0.001)[a]	1.000	0.533* (p = 0.015)[a]	0.893** (p < 0.001)[a]
BDE-153	0.272 (p = 0.246)[a]	0.533* (p = 0.015)[a]	1.000	0.397 (p = 0.083)[a]
Total PBDEs	0.782** (p < 0.001)[a]	0.893** (p < 0.001)[a]	0.397 (p = 0.083)[a]	1.000

a: p value; *: p < 0.05; **: p < 0.001.

TABLE 4
COMPARATIVE PBDE LEVELS IN HUMAN MILK IN
TAIWAN AND OTHER COUNTRIES

Countries	Taiwan[a, b]	UK[c]	Faroe islands[a]	Sweden[d]	China[d]	USA[a]	Japan[a]
Sample size	20	54	9	15	27	47	105
Sampling year	2000-2001	2001-2003	1999	2000-2001	–	2002	1998-2000
PBDEs							
BDE-17	0.005 (0/20)[e]	0.1	NA[f]	< LOD	NA	0.02	NA
BDE-28	0.085 (14/20)	0.3	NA	0.06	0.44	2.40	0.464
BDE-47	1.52 (19/20)	3.0	1.65	1.15	1.30	40.8	1.880
BDE-66	0.021 (9/20)	NA	NA	0.02	NA	0.65	0.033
BDE-85	0.032 (20/20)	0.5	NA	0.04	NA	1.15	0.001
BDE-99	0.512 (17/20)	0.9	0.925	0.21	0.23	14.0	0.021
BDE-100	0.374 (20/20)	0.6	0.94	0.14	0.19	8.20	0.225
BDE-138	0.008 (3/20)	–	NA	NA	NA	0.60	0.279
BDE-153	0.871 (20/20)	1.4	3.45	0.32	0.80	5.30	0.002
BDE-154	0.151 (20/20)	0.5	NA	0.02	0.11	0.76	0.017
BDE-183	0.072 (6/20)	NA	NA	0.01	0.18	0.13	0.007
BDE-209	0.274 (13/20)	NA	1.20	NA	NA	0.92	NA
Total PBDEs	3.925	7.3	8.165	1.97	3.25	74.93	2.929

a: Arithmetic mean; b: The present study was investigated in central Taiwan; c: Geometric mean; d: Median; e: (Number of measurements higher than LOD/total detected number); f: NA means not analyzed.

Australia was about 3 times higher than in Taiwan. The values tested between Taiwan and the UK, Sweden, China and Japan were similar[14,15] (Table-4).

Investigating PBDEs in breast milk and relevant factors: The relationship between BDE-47 and BDE-99 was the most significant ($r = 0.839$, $p < 0.001$) and the relationship between BDE-99 and BDE-153 was second ($r = 0.533$, $p = 0.015$). There were significant relationships between BDE-99 and PBDEs ($r = 0.893$, $p < 0.001$) and between BDE-47 and PBDEs ($r = 0.893$, $p < 0.001$). Perhaps due to the major source of PBDEs being BDE-47, there were no significant relationships between BDE-47 and BDE-153 ($r = 0.272$, $p = 0.246$) and between BDE-153 and PBDEs ($r = 0.397$, $p = 0.083$). There were no significant differences among BDE-47, BDE-99, BDE-153, PBDEs and mother's age, BMI before delivery and parity. There was a negative relationship between BMI before delivery and BDE-99, BDE-153 and PBDEs, but not significant. Previous studies found that the concentration of PBDEs in breast milk had no significant correlation to the mother's age, BMI before delivery and parity, which is consistent with our study[9]. However, it was found that there was a significant relationship between organic chlorine pesticides and dioxin in breast milk and mother's age[16]. There was no significant relationship between the concentration of PBDEs and mother's age of the first period, average menstrual cycle and average shorter menstrual cycle, but significant positive relationship was found between the longer menstrual cycle and PBDEs ($r = 0.522$, $p = 0.018$). The concentration of PBDEs in breast milk was higher when the menstrual cycle was longer. Besides, the mother's ethnic group had no significant relationship with the concentration of PBDEs. There was a negative relationship between household annual income and concentration of PBDEs, but it was not significant. Regarding the relationship between mother's education level and concentration of PBDEs, there was significant negative relationship between mother's education level and BDE-99 ($r = -0.492$, $p = 0.028$) and also PBDEs ($r = -0.568$, $p = 0.009$). It had a negative relationship with BDE-47 and BDE-153 as well, but it was not significant. So far, there has been no discussion on the relationship between education level and concentration of PBDEs in breast milk and this study found a significant negative relationship between BDE-99, PBDEs and education level. However, further longitudinal research is needed to collect more data.

There was a significant relationship between PBDEs and longer menstrual cycle (Table-5). The average concentration of PBDEs in breast milk of the shorter cycle group was 1730 ± 610 pg/g lipid, the maximum was 3200 pg/g lipid, the minimum was 1270 pg/g lipid, the median was 1470 pg/g lipid and the 95 % confidence interval was 1340-2120 pg/g lipid (Table-5). As for the group with the longer cycle, the average concentration of PBDEs in breast milk was 4020 ± 3730 pg/g lipid, the maximum was 12800 pg/g lipid, the minimum was 1700 pg/g lipid, the median was 2790 pg/g lipid and the 95 % confidence interval was 902-7140 pg/g lipid. From the concentration distribution, it was found that the longer the menstrual cycle, the higher the concentration of PBDEs in breast milk. Spearman correlation analysis showed there was a significant negative relationship between the concentration of BDE-99 and PBDEs in breast milk and mother's educational level. For the group with education level below high school or college, the average concentration of BDE-99 in breast milk was 433 ± 317 pg/g lipid, the maximum was 1310 pg/g lipid, the minimum was 167 pg/g lipid, the median was 297 pg/g lipid and the 95 % confidence interval was 250-616 pg/g lipid. For the group with education level above high school/junior college, the average concentration of BDE-99 in breast milk was 205 ± 43.5 pg/g lipid, the maximum was 276 pg/g lipid, the minimum was 148 pg/g lipid, the median was 297 pg/g lipid and the 95 % confidence interval was 160-251 pg/g lipid. For the group with education level below and including high school/junior college, the average concentration of PBDEs in breast milk was 3140 ± 2970 pg/g lipid, the maximum was 12800 pg/g lipid, the minimum was 1390 pg/g lipid, the median was 1890 pg/g lipid and the 95 % confidence interval was 1430-4860 pg/g lipid. For the group with education level above high school/junior college, the average concentration of PBDEs in breast milk was 1490 ± 203 pg/g lipid, the maximum was 1780 pg/g lipid, the minimum was 1270 pg/g lipid, the median was 1400 pg/g lipid and the 95 % confidence interval was 1270-1700 pg/g lipid. According to the above values, the concentration of BDE-99 and PBDEs in breast milk tended to be lower as the education level was higher.

TABLE-5
SPEARMAN CORRELATION AMONG LONGER MENSTRUAL CYCLES OF WOMEN AND BDE-47, BDE-99, BDE-153 AND TOTAL PBDES IN TAIWAN

	BDE-47 (pg/g lipid)	BDE-99 (pg/g lipid)	BDE-153 (pg/g lipid)	PBDEs (pg/g lipid)
Age at menarche (years)	0.058 (p = 0.809)[a]	0.296 (p = 0.205)[a]	0.314 (p = 0.177)[a]	0.220 (p = 0.352)[a]
Menstrual cycle length (days)	0.082 (p = 0.731)[a]	0.109 (p = 0.647)[a]	-0.172 (p = 0.469)[a]	0.274 (p = 0.243)[a]
The longest length of menstrual cycle (days)	0.332 (p = 0.153)[a]	0.363 (p = 0.116)[a]	-0.027 (p = 0.909)[a]	0.522* (p = 0.018)[a]
The shortest length of menstrual cycle (days)	0.174 (p = 0.464)[a]	0.365 (p = 0.114)[a]	0.366 (p = 0.112)[a]	0.165 (p = 0.487)[a]

a: p value; *: p = 0.05.

Conclusion

Polybrominated diphenyl ethers have spread across the world *via* manufacturing and waste depositing processes and can be found in dust, fish, vegetables, aquatic mammals and terrestrial mammals17-20. In Taiwan, very few studies have focused on PBDEs in the environment or organisms and for example, PBDEs concentration in air surrounding metal recycling plants was estimated to be 23-53 pg/m^3 and PBDEs impact could be found across the island's environment such as air, soil, sediment and organisms[11]. Although the environmental protection agency in Taiwan announced concentrations of PBDEs of the upper, middle and lower sections of six major rivers such as Lanyang, Holong, Dajia, Wu, Bazhang and Fongshan in Taiwan, the academic and research communities know very little on their health to environment and human health.

At present, human exposure to PBDEs is generally considered similar to dioxin and PCB, which is mostly through dietary intake containing high animal lipids, like fish or milk. Reports indicate that PBDEs originating from electronic and computer industries enter the human body through exposure to air[17]. Household dust is another source of exposure and for example, the average concentration of PBDEs in dust in Canadian and American homes was 2-4 ppm, while BDE-209 was the major chemical compound[18] with 50 %.

Due to the extensive use of PBDEs, the accumulated content of PBDEs in breast milk continues to significantly increase through time. However, the figures are still rather limited. The average content of PBDEs in breast milk in Taiwan was about 20 times lower than the USA, which is similar to the UK, Sweden and China[11]. In Taiwan, there is very little attention drawn to the problems of environmental pollution largely due to the lack of strong environmental activism[19,20]. Since Taiwan's Health Ministry supports a breast-feeding policy, the numbers of breast-feeding mothers increased tremendously in recent years. Therefore it is time to set up a breast-feeding monitoring measure research scheme to protect the health and development of the next generation.

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