MONITORING OF POLYBROMINATED DIPHENYL ETHERS (PBDEs) IN CORD BLOOD FROM POLISH POPULATION

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Introduction

Anthropogenic halogenated compounds, including some of the persistent organic pollutants (POPs) such as polybrominated diphenyl ethers (PBDEs) have been identified as contaminants with a global distribution and are present in wildlife species in both aquatic and terrestrial ecosystems. Due to their lipophilic nature they have a capacity to bioaccumulate in the fat tissue and to biomagnify in food chains. There is an increasing number of studies which conclude that PBDEs can disrupt thyroid hormones (TH) balance in animals and humans. They are structurally similar to thyroid hormones (thyroxin, T4), and might mimic TH activity and thereby disrupt TH function in the body[1].

It was demonstrated that these compounds are neurotoxic, weaken behavioral reflexes, decrease general activity, lower mobility, influence learning and memorizing processes. They also affect immunological system and induce activity of xenobiotic metabolizing enzymes which in the pre- and postnatal period can lead among others to developmental disorders of central nervous system[2-5].

This study aimed at generation of preliminary results allowing an assessment of prenatal exposure to polybrominated diphenyl ethers (PBDEs). BDE-47, BDE-99, BDE-153, which according to literature data constitute 70 – 80% of the total quantity of PBDEs detected in the human material, were determined in cord blood samples from Poland.

Material and methods

The study material consisted of 89 samples of cord blood which were obtained from women living in Warsaw and the surrounding area. After having obtained a consent of a medical ethical committee the samples were collected in one of obstetric clinics in Warsaw in 2002-2005. The sample donors provided also information about their age, body mass, height, number of deliveries, type of diet and general health condition.

All samples were stored in -20°C until analysis. Extraction was performed according to the procedure described by Päpke et al.[6]. The extracts were cleaned-up by gel permeation chromatography (GPC). The purified extracts were analyzed by GC/ECD and GC/MS. For GC/ECD analyses gas chromatograph (Agilent Technologies 6890N) was used and the following working conditions were applied:

column: HP-5 (30 m x 0.32 mm i.d., 0.25 μm); injector temperature: 260 °C; sample volume: 5 μL; column oven temperature program: 70 ºC (1.7 min), 30 °C min^{-1} – 190 °C, 3 °C min^{-1} – 240 °C, 30 °C min^{-1} – 280 °C.

The results were confirmed using GC/MS technique (Varian 4000) under the following working conditions:

column: DB-5MS (30 m x 0.32 mm i.d., 0.25 μm); sample volume: 10 μL; column oven temperature program: 70 ºC (1 min), 30 ºC min^{-1} – 170 ºC, 8 ºC min^{-1} – 300 ºC (15 min); ion trap temperature: 200 ºC.

Due to very low levels of polybrominated diphenyl ethers the confirmation analyses were conducted using tandem mass spectrometry in order to isolate the PBDEs from the matrix and to increase the measurement system sensitivity. The following ions were selected as typical parent ion for particular PBDE congeners: BDE-47 – 486 m/z, BDE-99 – 564 m/z, BDE-153 – 484 m/z. Parent ions were further fragmented in non-resonant mode of mass spectrometer. For all analyzed congeners, the value of q_z parameter, responsible for effectiveness of ion trapping was set between 0.2 and 0.3 depending on the number of attached brome atoms. The best values of excitation amplitude (EA) for particular congeners were the following: for BDE-47 EA = 66 V, for BDE-99 EA = 73 V, for BDE-153 EA = 81 V. Excitation time was 20 ms for all PBDEs.

Results and Discussion

The characteristics of women participating in presented study (n = 89) are summarized in the Table 1.

Table 1. General characteristics of women participating in this study.

Medical parameters	Mean ± SD	Range
Age (years)	28 ± 3.59	16 - 40
Pre-pregnant body mass index (kg/m^2)	22 ± 3.24	17 - 41
Educational level (%)		
Primary school	1.19	
Vocational education	3.57	
Secondary education	7.14	
Post-secondary education	13.09	
Higher education	75.00	

SD – standard deviation

As shown in Table 1, women in the study population were of age 16 - 40 years and the pre-pregnant body mass index (BMI) was between 17 and 41. Mean lipid value for cord blood samples was 0.042%.
Analytical results of the selected PBDE congeners levels are shown in the Table 2. The method limit of quantification (LOQ) for PBDEs was 0.92 ng/mL. The recoveries ranged from 92% to 130%. Mean concentrations of the analyzed compounds were calculated on the assumption that results below LOQ equal zero.

Table 2. PBDEs concentrations expressed in ng/g lipid weight.

PBBE congeners	% > LOQ	Mean [ng/g lipid weight]	SD	Range [ng/g lipid weight]
BDE-47	100.0	1.00	1.20	0.04 – 5.00
BDE-99	57.7	0.60	2.25	<LOQ – 24.60
BDE-153	32.4	0.40	0.89	<LOQ – 3.80

The profile of PBDE congeners was dominated by BDE-47 followed by BDE-99 and BDE-153.
The concentrations of ΣPBDEs observed in the cord blood samples from Polish women were similar to those reported in other European studies (Table 3).

Table 3. Mean levels of ΣPBDEs (in ng/g lipid weight) found in cord blood samples from Europe.

Country	Year of collection	N	∑PBDEs	Reference
Spain	2003-2005	174	9.6	Vizcaino et al., 2011[7]
Sweden	2000-2001	15	1.69	Guvenius et al., 2003[8]
The Netherlands	2001-2002	12	1.9*	Meijer et al., 2008[9]
	-	12	7.86	Frederiksen et al., 2009[10]
Belgium	2002-2005	22	2.03*	Roosens et al., 2010[11]
Denmark	2007	40	3.7	Frederiksen et al., 2010[12]
Poland	2002-2005	89	2.0	Present study

*Median

This study presents the first data of polybrominated diphenyl ethers in cord blood from Poland. Results of these studies may provide a basis for assessing risks to children, taking into account the impact of these pollutants on the development of the endocrine system.
There is a need for a large scale monitoring of PBDE levels in human specimens in Polish population.

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