International POPs Elimination Project

Fostering Active and Efficient Civil Society Participation in Preparation for Implementation of the Stockholm Convention

Study of POPs Levels in the Breast Milk of Women - Residents of Chelyabinsk Oblast (Karabash) and Tyumen Oblast (Tobolsk)

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About the International POPs Elimination Project

On May 1, 2004, the International POPs Elimination Network (IPEN http://www.ipen.org) began a global NGO project called the International POPs Elimination Project (IPEP) in partnership with the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Program (UNEP). The Global Environment Facility (GEF) provided core funding for the project.

IPEP has three principal objectives:

- Encourage and enable NGOs in 40 developing and transitional countries to engage in activities that provide concrete and immediate contributions to country efforts in preparing for the implementation of the Stockholm Convention;

- Enhance the skills and knowledge of NGOs to help build their capacity as effective stakeholders in the Convention implementation process;

- Help establish regional and national NGO coordination and capacity in all regions of the world in support of longer term efforts to achieve chemical safety.

IPEP will support preparation of reports on country situation, hotspots, policy briefs, and regional activities. Three principal types of activities will be supported by IPEP: participation in the National Implementation Plan, training and awareness workshops, and public information and awareness campaigns.

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Relevance of the study

The first measurements of POPs levels in breast milk were made in the early 1970s by M. Baughman (1973) [1]. Numerous research studies in different countries proved that breast milk contains high concentrations of dioxins. Dioxins tend to accumulate in fatty tissues, as a result, they excrete with breast milk, as it has a high lipid content (3.5 - 3.8%). One can reasonably expect that a breastfed child consumes dioxins, resulting in inevitable adverse effects for health and development.

Pollutants levels in breast milk can serve as a biological indicator of local environmental contamination and potential adverse health impacts of environmental factors. Analysis of breast milk samples allows one to assess loads of industrial pollution on human health in a particular area. Levels of dioxins in breast milk exceed the dioxin intake of a nursing mother during the period of lactation. Dioxins concentrate in fat tissues of a human body for a long time, while in the course of lactation, already accumulated dioxins concentrate in milk fat.

In Russia, the tolerable daily intake of dioxins is set at the level of 10 picograms (pg TEQ/kg body weight), or 1000 times higher than in the USA or the European Union (EU) [2]. The World Health Organization (WHO) daily intake limit is set at the level of 1 to 4 pg TEQ/kg body weight (1998) [1]. Some trends of changing levels of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in the course of lactation were identified [1, 2]. If we assume the average level of fat in breast milk of 3%, and the average level of dioxins in fat of 20 pg/g, we may easily estimate how much milk an infant can consume "without adverse effects". One litre of milk contains 30 g of fat and, correspondingly, 600 pg of dioxins (30 g x 20 pg/g = 600 pg). Using the Russian standard and an infant weight of 5 kg, the “tolerable” daily dose should not exceed 50 pg/day (5 kg x 10 pg/kg = 50 pg). Therefore, the infant can consume only 80 g of breast milk in a day "without adverse effects" according to Russian standards. This is approximately 80 ml of milk. If the more protective WHO standard is used, an infant could consume only 8 ml of milk in a day “without adverse effects.” Breast-fed babies typically take in an average of 750 ml of milk each day between the ages of 1 – 6 months.

The above estimate suggests that breastfed infants belong to the "risk group" of particularly high dioxin intake. The risk group also incorporates people who consume large quantities of fish, fatty meat and milk, and veterans of the Vietnam War and Vietnamese peasants who eat food products grown on fields that were sprayed by dioxin-containing "Agent Orange" in the course of the Vietnam War.

The aim of the study

Accounting for a high incidence of cancer, numerous industrial facilities, low environmental quality and potential roles of dioxins in development of malignant tumours, we decided to estimate levels of dioxins and polychlorinated biphenyls (PCBs) in the breast milk of women - residents of Karabash (Chelyabinsk Oblast) and Tobolsk. In addition, measurements of

pollutants' levels in breast milk pursued the following objectives: a) to get reliable and compatible data on levels of polychlorinated dibenzo-p-dioxins/furans (PCDD/F); b) to assess dioxin loads of the regional population without relying on indirect assessments of daily intakes with food and from other environmental media; c) to assess breastfeeding health risks at the base of tolerable daily doses; d) to identify trends of health impacts of environmental factors.

Methods and materials

In the research study, we used an aggregated (population) sample of breast milk of 25 women - permanent residents of Karabash and Tobolsk. Samples were taken according to the WHO recommendations [1], and data lists were completed for every individual donor. The average age of the women reached 22.7 years, and their average weight reached 64.6 kg. Completed data lists suggest that the sampling was conducted adequately. In Karabash, 7 women of the study sample were workers of the key industrial facility of the city - Karabash Copper Smelter and 2 of them were registered as workers under occupational exposure. In Tobolsk, 4 women were registered as workers under occupational exposure at the Chemical Plant. Women with secondary and secondary special education prevailed among the primipara under the study.

Differences in other parameters of the data lists were insignificant (see Table 1).

Table 1. Some parameters of data lists of breast milk donors - residents of Magnitogorsk

Data lists parameters	Karabash	Tobolsk
Places of residence	25	25
Boys/girls ratio of their newborn children	1.7: 1	1.5: 1
Smoking breast milk donors	none	none
Non-smoking breast milk donors	100%	100%
Eat fish 1 time in a week	40%	35%
Do not eat fish	none	2%

Measurements of levels of 17 toxic PCDD/F in breast milk samples were conducted according to recommendations of the US EPA - US EPA Methodology 1613 ("Tetra-through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS" Revision B, 1994) [2]; while measurements of 12 toxic PCBs in breast milk samples were conducted according to US EPA Methodology 1618 ("Chlorinated Biphenyl Congeners in Water, Soil, Sediment and Tissue by HRGC/HRMS" Revision A, 1999) [2]. The laboratory of Bashkir Republican R&D Environmental Centre was certified by the State Committee for Standardisation of the Russian Federation for use of these analytical methods for analysis of biological objects (inc. fat tissues, muscle tissues, blood and breast milk).

The State Committee for Standardisation of the Russian Federation certified US EPA Methodology 1613 and officially registered it as MBI RB E1-01/US EPA 1613 (a full and adequate translation of US EPA 1613 [2].

The aggregated breast milk sample (130 ml), provided by 25 women - residents of Karabash and Tobolsk - was frozen and stored before the analysis at temperature of 18°C. The frozen sample was delivered to Bashkir Republican R&D Environmental Centre. The aggregated sample was made by mixing equal volumes of 25 individual samples.

Immediately before the analysis, the sample was defrosted, homogenised and separated into 2 sub-samples (60 ml each) for parallel analysis.

Results and discussion

Until recently, there were no systemic studies on levels of persistent organic pollutants in biological media. Results of measurements of PCDD/F levels in breast milk were scattered, and relevant publications sometimes failed to specify sampling methods. Based on data of V.V.Khudolei, published in 1999 [1], we calculated average PCDD/F levels in breast milk samples from cities of Russia (12.3 ± 6.4 pg TEQ/g lipids, or by about 40% lower than global averages) [2]. Results of measurements of levels of polychlorinated dibenzo-p-dioxins, dibenzofurans and PCBs in breast milk of women - residents of Karabash and Tobolsk, are shown in Tables 2 and 3.

Table 2. Levels of polychlorinated dibenzo-p-dioxins/furans in the breast milk of women - residents of Karabash and Tobolsk.

PCDD/F	Units of measure			
	Karabash		Tobolsk	
	pg/g fat	pg TEQ/g fat	pg/g fat	pg TEQ/g fat
2,3,7,8-TCDD	2.3	3.7	2.19	2.3
1,2,3,7,8-PCDD	0.5	1.1	0.6	0.51
1,2,3,4,7,8-HxCDD	2.02	0.3	2.15	0.2
1,2,3,6,7,8-HxCDD	4.0	0.6	4.19	0.4
1,2,3,7,8,9-HxCDD	0.94	0.1	0.94	0.09
1,2,3,6,7,8-HpCDD	5.59	0.68	9.27	0.86
OCDD	37.64	0.08	29.9	0
2,3,7,8-TCDF	1.05	0.3	1.08	0.1
1,2,3,7,8-PCDF	0.91	0.4	1.1	0.05
2,3,4,7,8-PCDF	5.67	3.30	6.74	3.13
1,2,3,4,7,8-HxCDF	3.73	0.56	3.72	0.37
1,2,3,6,7,8-HxCDF	0.08	0.03	0.18	0.01
1,2,3,7,8,9-HxCDF	0.08	0.03	0.78	0.01
2,3,4,6,7,8-HxCDF	1.71	0.17	1.72	0.17
1,2,3,4,6,7,8-HpCDF	2.57	0.28	2.96	0.03
1,2,3,4,7,8,9-HpCDF	0.05	0.18	0.08	0.06
OCDF	0.09	0.01	0.68	0
∑ PCDDs	*38.53*	*3.9*	*34.2*	*3.4*
∑ PCDFs	*15.93*	*4.27*	*14.23*	*3.57*
∑ PCDD/Fs	***78.46***	***19.99***	***116.71***	***9.56***

Note: according to WHO recommendations [1], we presented concentrations in pg TEQ/g fat.

Levels of polychlorinated biphenyls (PCBs) in the breast milk of women residents of Karabash and Tobolsk reached 12.6 and 17.9 pg TEQ/g fat.

If we compare these levels with WHO data for other countries, we may conclude that the levels observed in this study are similar to those observed in many other countries.

Results of comparative analysis of PCDD/Fs levels in breast milk of women - residents of Russian cities, according to WHO [1] and relevant data for other countries [1, 2] are shown in Tables 4 and 5.

Table 3. Levels of polychlorinated dibenzo-p-dioxins/furans (PCDD/F) in breast milk of women - residents of regions with different industrial loads, according to WHO [1, 2]

Countries	PCDD/F (pg TEQ/g fat)	Sources
Cambodia	3.1	Schecter, 1991
South Vietnam	8.8	Schecter, 1991
North Vietnam	34.0	Schecter, 1991
Japan	13.1 - 30.8	Hirakawa, 1995
Canada	13.4 - 28.6	Dewailly, 1992; Ryan, 1993; Schecter, 1994a; WHO, 1996; Yrjanheikki, 1989
USA	9.0 - 20.0	Schecter, 1989, 1994, 1996, Hong, 1994
New Zealand	15.0 - 19.0	Buckland, 1990
Poland	20.4 - 21.1	Yrjanheikki, 1989, Koppe, 1992
Norway	9.3 - 15.9	WHO, 1996; Yrjanheikki, 1989; Ciench-Aas, 1992
Sweden	20.6 - 23.8	Yrjanheikki, 1989; Rappe, 1992a; Noren, 1998; Dahl, 1995
France	20.1	Gonzalez, 1993
Germany	16.0 - 33.1	Furst, 1992a; Beck, 1992; Papke, 1994; Malich, 1996
Italy	25.0 - 31.0	Schecter, 1992a
The Netherlands	23.5 - 58.6	Pluim, 1993; Liem., 1995; WHO, 1996; Yrjanheikki, 1989; Cuijpers, 1996; Tuinstra, 1994
UK	21.0 - 39.5	Wearne, 1996; Duarte-Davidson, 1992; Startin, 1989
Spain	11.8	Schumacher, 1998
Belgium	40.2 - 20.8	Yrjanheikki, 1989; WHO, 1996
Israel	12.6 - 15.4	Schecter, 1997a
Thailand	3.0	Schecter, 1991
South Africa	9.0 - 13.0	Schecter, 1994a
Pakistan	12.6	Schecter, 1994a
Denmark	16.7 - 17.7	Hilbert, 1996; WHO, 1996
Hawaii	13.2	Traag, 1997
Albania	3.8 - 4.8	WHO, 1996
Austria	10.7 - 17.2	WHO, 1996
Croatia	8.4 - 13.5	Yrjanheikki, 1989; WHO, 1996
Estonia	13.5 - 21.4	Mussalo-Rauhmaa, 1995
Faeroes	6.7 - 11.7	Abraham, 1995
Finland	12.0 - 21.5	Yrjanheikki, 1989; WHO, 1996
Hungary	7.8 - 11.7	Yrjanheikki, 1989; WHO, 1996
Japan	11.8 - 58.0	Yrjanheikki, 1989; Hirakawa, 1995; Hashimoto, 1995
Jordan	9.38 - 110.0	Alawi, 1996
Latvia	13.3 - 16.1	WHO, 1996
Slovakia	12.6 - 15.1	WHO, 1996
Kazakhstan	20.1	Petreas, 1996
Spain	14.3 - 25.5	Gonzales, 1996; WHO, 1996
Ukraine	11.0 - 13.3	WHO, 1996
The Czech Rep.	12.1 - 18.4	WHO, 1996

Table 5

Table 4. Levels of polychlorinated dibenzo-p-dioxins/furans (PCDD/F) and polychlorinated biphenyls (PCBs) in the breast milk of women - residents of Perm, Magnitogorsk and other cities of Russia, according to WHO [1]

Cities	PCDD/F (pg TEQ/g fat)	PCBs (pg TEQ/g fat)
Suzdal	8.4	13.4
Volgograd	7.46	15.82
Astrakhan	9.36	15.52
Kamyzyak	12.92	22.95
St.Peterburg	11.0	13.03
Anadyr	7.16	12.94
*Perm***	*6.83 - 7.64*	*8.68 - 10.58*
Magnitogorsk*	***7.16***	***11.41***
Karabash	***9.34***	**12.60**
Tobolsk	***12.70***	**17.90**

Notes: * - data for Magnitogorsk, Karabash and Tobolsk were obtained in this research study;
** - data for Perm were obtained by Bashkir Republican R&D Environmental Centre in 2003.

In the course of our research we found that PCDD/F levels in samples of breast milk of women - residents of Karabash reach 9.34 pg TEQ/g lipids, while PCBs levels reach 12.6 pg TEQ/g lipids. In the case of Tobolsk, higher levels were found - 12.7 and 17.9 pg TEQ/g lipids, respectively. Therefore, in Tobolsk, a trend of higher PCBs and PCDD/Fs levels in breast milk was identified.

Conclusions

According to the research results, levels of polychlorinated dibenzo-p-dioxins and dibenzofurans in samples of breast milk of women - residents of Karabash and Tobolsk are similar to average figures for Russian cities. Data for three territories surveyed (Magnitogorsk, Karabash and Tobolsk) are not sufficient for a detailed statistical analysis of individual PCBs fractions and overall PCBs levels, however, there is a marked trend of more significant contribution of a chemical production facility to toxic contents of breast milk lipids.

In order to make a definite conclusion on the contribution of PCBs to health problems, it is appropriate to integrate this research with mapping methods and analysis of spatial distribution of such diseases as breast cancer and ovarian cancer (i.e. malignant tumours in tissues with high fat content).

Dioxin contamination of breast milk poses a dilemma - whether it is appropriate to switch to bottle feeding. Recent studies suggest that it is impossible to exclude breast feeding, as the process is not limited to mere nutrition - breastfeeding develops psychological connections between a mother and her newly born child. Supply of indispensable biological substances with breast milk is a major evolution mechanism that guarantees further development of the human race. Therefore, it is necessary to facilitate elimination of industrial pollutants, including dioxins, from the environment and human body.