# POPs IN HUMAN MILK IN CHAPAEVSK, RUSSIA, FIVE YEARS FOLLOWING CESSATION OF CHEMICAL MANUFACTURING AND DECADE OF REMEDIATION PROGRAM, PILOT STUDY

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## Introduction

In October, 2007 the Guidelines for developing a national protocol of the fourth WHO-coordinated survey of human milk for persistent organic pollutants (POPs) in cooperation with UNEP was published, http://www.who.int/foodsafety/chem/POPprotocol.pdf. The human milk is recognized by WHO as preferred biological and noninvasive matrix to generally monitor levels of POPs in the environment because it has several important advantages. Particularly, biomonitoring of human milk data can provide information on the exposure of the mother as well as the infants. In Chapaevsk the basic source of contamination by the polychlorinated dibenzodioxins/furans (PCDD/Fs), hexachlorocyclohexane (HCH) and hexachlorobenzene (HCB), is the chemical plant, which in 1962-87 years produced organochlorine pesticides (OP)[1]. All chemical production at this plant stopped in 2003. In the framework of environmental remediation program, Chapaevsk receives regional and federal funds since 1997[2].

In 1998 in Chapaevsk seven (7) pooled samples of human milk were collected from 40 women[3], and in October, 2007 the repeated collection of human milk has started according to the WHO 2007 Guidelines to monitor the trend in POPs concentrations.

The purpose of this pilot study was to collect human milk samples in Chapaevsk and to estimate the levels of POPs in two pooled samples. One sample was collected from women who lived closer than 3 km from the plant and another sample from women who lived more than 3 km from the plant.

## Materials and Methods

The study protocols were approved by Chapaevsk Medical Association IRB. Recruitment of the women was conducted after delivery on the basis of health charts, containing the information regarding delivery and pregnancy data. The women gave their written consent on the Informed Consent Form at the primary contact. The selection of donors was conducted in the strict accordance with the above mentioned Guidelines: 1) primiparae; 2) under 30 years of age; 3) breastfeeding one child only; 4) residence in Chapaevsk for the last 10 years.

The collection of breast milk (150 ml) was carried out between 3 and 8 weeks after delivery by hand expression in specially prepared collecting jar after feeding an infant. The collected samples were kept not more than 3 days in the refrigerator at about 5°C with further storage in a lab freezer at -35°C. Donors were interviewed by pediatrician and nurse-interviewer, using both questionnaires, recommended by the Guidelines and expanded. In addition mothers collected the urine samples.

Among 305 mothers which had delivery between August 27 2007 and January 31 2008, 145 women (48%) were eligible by the criteria for inclusion in the study. 54 of them (37%) did not breastfeed alone (used milk formula

or a mix of human/formula) and consequently were not invited to participate. Only two mothers have refused (1%). 11% of the women did not participate for other reasons (changed residence, unknown address, etc.). 73 donors (50%) were recruited and have collected milk samples.

Among enrolled women two groups were selected. The group «CLOSE» contained 11 donors, who lived predominantly during the whole life as well as during their pregnancy closer than 3 km from the plant. The second group «DISTANT» contained 10 donors, who lived more than 3 km from the plant.

Appropriate 11 and 10 individual samples were pooled into two samples. Target analytes included 17 congeners PCDD/Fs, 4 non-ortho substituted (coplanar) polychlorinated biphenyls (co-PCBs), 8 mono-ortho substituted PCBs with assigned WHO-TEFs (1998), and HCB, 4 isomers of HCH, DDT and its metabolites (without assigned TEFs). Breast milk samples were analyzed at the laboratory of Severtsov Institute of Problems of Ecology and Evolution using GC-HRMS (Thermo Finnigan MAT95XP).

**Results and Discussion**

The mean age of all donors was 21.9 years, not differing in groups «CLOSE» and «DISTANT», at 21.6 and 22.2 years, respectively. In the study of 1998 the mean age of donors at 22.1 years was also comparable. Weight of the mothers in group «CLOSE», both before pregnancy and after delivery, at 60.2 and 63.8 kg, respectively, was slightly higher, than in group «DISTANT», at 56.8 and 59 kg. Height (164.1 см), donor's breastfeeding (95 %), mother smoking during life (38 %), alcohol consumption during pregnancy (62 %), duration of pregnancy (39.6 weeks), a sex ratio (38 % boys) and age of the child at the moment of sample collection (4.1 weeks) did not differ between two groups (the arithmetic mean for all women are indicated in brackets). There were no vegetarians among the surveyed donors and nobody worked at the plant producing pesticides.

The results of POPs level are presented in Tables 1 and 2. All POPs levels were higher in «CLOSE» sample than in «DISTANT» sample: PCDD/Fs were 2.6-fold higher, dioxin-like PCBs 1.2-fold higher, HCB was 1.2-fold higher and HCH was 1.7-fold higher. Only DDT, which was not produced in Chapaevsk, was distributed equally in the city. The mean WHO-TEQ PCDD/Fs among all donors has declined 3.8 times over the ten year time period, from 41.1 pg/g lipids in 1998 to 10.9 pg/g lipids in 2007.

Although the levels of POPs in human milk in Chapaevsk has decreased over the decade, but both, the concentrations and TEQs of POPs still remain high in the area adjacent to the chemical plant producing pesticides. The further analysis of individual breast milk and urine samples for POPs will allow to investigate the predictors of POPs exposure of Chapaevsk residents living in highly polluted areas near the chemical plant.

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**References**

1. Sergeyev O., Saharov I., Shelepchikov A., Revich B., Sotskov Y., Brodsky E., Denisova T., Feshin D., Zeilert V. *Organohalogen Comp* 2007; 69:1388
2. Program «Social and Economic development and environmental rehabilitation of Chapaevsk, Samara region, for the period 2003-2010».
3. Revich B., Aksel E., Ushakova T., Ivanova I., Zhuchenko N., Klyuev N., Brodsky Ye., Sotskov Yu. *Chemosphere*. 2001; 43:951

**Table 1. WHO-TEQ (1998) levels of PCDD/Fs and dioxin-like PCBs in human milk from Chapaevsk, in relation to the distance of residence from the chemical plant.**

| POPs | «CLOSE» Residence < 3 km from the plant (n=11) | | «DISTANT» Residence > 3 km from the plant (n=10) | |
|---|---|---|---|---|
| | pg TEQ/g | pg TEQ/g lipids | pg TEQ/g | pg TEQ/g lipids |
| Dioxins | | | | |
| 2,3,7,8-TCDD | 0.153 | 2.60 | 0.086 | 1.36 |
| 1,2,3,7,8-PeCDD | 0.191 | 3.24 | 0.087 | 1.39 |
| 1,2,3,4,7,8-HxCDD | 0.014 | 0.242 | 0.009 | 0.134 |
| 1,2,3,6,7,8- HxCDD | 0.036 | 0.610 | 0.017 | 0.272 |
| 1,2,3,7,8,9- HxCDD | 0.007 | 0.115 | 0.003 | 0.045 |
| 1,2,3,4,6,7,8- HpCDD | 0.002 | 0.032 | 0.002 | 0.027 |
| OCDD | 0.0001 | 0.002 | 0.0002 | 0.002 |
| Furans | | | | |
| 2,3,7,8-TCDF | 0.008 | 0.134 | 0.003 | 0.043 |
| 1,2,3,7,8-PeCDF | 0.013 | 0.215 | 0.001 | 0.010 |
| 2,3,4,7,8- PeCDF | 0.347 | 5.88 | 0.136 | 2.14 |
| 1,2,3,4,7,8- HxCDF | 0.107 | 1.81 | 0.023 | 0.359 |
| 1,2,3,6,7,8- HxCDF | 0.024 | 0.403 | 0.007 | 0.107 |
| 1,2,3,7,8,9- HxCDF | 0.001 | 0.022 | 0.003 | 0.054 |
| 2,3,4,6,7,8- HxCDF | 0.002 | 0.040 | 0.002 | 0.036 |
| 1,2,3,4,6,7,8- HpCDF | 0.001 | 0.012 | 0.001 | 0.008 |
| 1,2,3,4,7,8,9- HpCDF | 0.0002 | 0.003 | 0.0003 | 0.004 |
| OCDF | 0.00001 | 0.0001 | 0.00001 | 0.0001 |
| Coplanar PCBs | | | | |
| 3,4,4',5-TCB (81) | 0.00002 | 0.0003 | 0.00002 | 0.0003 |
| 3,3',4,4',5-PeCB (126) | 0.329 | 5.57 | 0.275 | 4.37 |
| 3,3',4,4',5,5'-HxCB (169) | 0.009 | 0.156 | 0.009 | 0.141 |
| 3,3',4,4'- TCB (77) | 0.0002 | 0.003 | 0.0001 | 0.001 |
| Mono-ortho substituted PCBs | | | | |
| 2,3,3',4,4'-PeCB (105) | 0.043 | 0.727 | 0.029 | 0.462 |
| 2,3,4,4',5-PeCB (114) | 0.028 | 0.474 | 0.036 | 0.573 |
| 2,3',4,4',5-PeCB (118) | 0.133 | 2.26 | 0.101 | 1.60 |
| 2',3,4,4',5-PeCB (123) | 0.001 | 0.012 | 0.001 | 0.021 |
| 2,3,3',4,4',5-HxCB (156) | 0.133 | 2.26 | 0.138 | 2.19 |
| 2,3,3',4,4',5'-HxCB (157) | 0.033 | 0.561 | 0.035 | 0.556 |
| 2,3',4,4',5,5'-HxCB (167) | 0.001 | 0.011 | 0.001 | 0.009 |
| 2,3,3',4,4',5,5'-HpCB (189) | 0.001 | 0.016 | 0.001 | 0.015 |
| **Total, TEQ PCDD/Fs** | **0.91** | **15.3** | **0.38** | **6.00** |
| **Total, TEQ co-PCBs** | **0.34** | **5.7** | **0.28** | **4.5** |
| **Total, TEQ PCDD/F/co-PCBs** | **1.2** | **21.1** | **0.66** | **10.5** |
| **Total, TEQ mono-ortho PCBs** | **0.37** | **6.3** | **0.34** | **5.4** |
| **Total TEQ** | **1.6** | **27.4** | **1.0** | **15.9** |

**Table 2. Concentrations of organochlorine pesticides in human milk from Chapaevsk, in relation to the distance of residence from the chemical plant.**

| Pesticides | «CLOSE» Residence < 3 km from the plant (n=11) | | «DISTANT» Residence > 3 km from the plant (n=10) | |
|---|---|---|---|---|
| | ng/g | ng/g lipids | ng/g | ng/g lipids |
| HCB | 4.89 | 82.9 | 4.38 | 69.5 |
| HCH (Sum of 4 isomers) | 11.6 | 196 | 7.25 | 115 |
| DDTs and metabolites * | 12.2 | 207 | 15.4 | 244 |

* - sum of o,p'-DDE, p,p'-DDE, o,p'-DDD, p,p'-DDD, o,p'-DDT, p,p'-DDT