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Assessment of the exposure of breast milk to persistent organic pollutants in Latvia

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Abstract

According to the National Implementation Plan on persistent organic pollutants (POP) for the years 2004–2020 the situation on POP was actualised in Latvia. The aim of the study was to assess the contamination of breast milk with polychlorinated biphenyls (PCB), polychlorinated dibenzodioxins, dibenzofurans (PCDD/PCDF) and some pesticides. Breast feeding mothers (together 30) were selected from probably polluted area, and a control group on the basis of WHO criteria for donor selection. The concentration of POP in milk was detected by gas chromatography with HRGC/HRMS, HRGC/ECD and GC/ECD detection after extraction of milk fat and purification. The results of the survey show comparability of both groups in age, weight, habits, occupation as well as age of the children and the weight at birth and at the time of collecting the samples. PCB were not observed in 15.9%, PCDD/PCDF in 6.6% and pesticides in 14% analyses of the target group and in 26.3%, 7% and 8.6% analyses correspondingly of the control group. The concentration of 18 detected PCB, 17 detected PCDD/PCDF and 8 chlorinated pesticides and its metabolites varied in wide range and the differences of mean values within groups were not statistically significant ($p > 0.05$). The concentration of POPs corresponds to lowest levels detected in European countries. The concentration of dioxine-like PCBs and PCDD/PCDF according to toxicity equivalents does not exceed the WHO accepted level of 15 TEQ pg/g milk fat.

Keywords: Polychlorinated biphenyls; Polychlorinated dibenzo-*p*-dioxins (PCDD); Dibenzofurans (PCDF); Chlorinated pesticides; Breast milk; Case-control pilot study

Introduction

In Latvia there are no data on the concentration of persistent organic pollutants (POP) in human milk. The National Implementation Plan on POP for the years 2004–2020 indicates the polychlorinated biphenyls (PCB) as the priority category of POP in Latvia. It is planned to dispose all collected pesticide and POP contaminated materials at the Olaine hazardous waste utilisation plant. The aim of the study is to assess the contamination of breast milk with POP in mothers who live in Olaine town, thus forming an estimate opinion on the environmental contamination level prior to constructing the plant.

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Materials and methods

The survey was organised on the basis of WHO criteria for donor selection: the target group – mothers from Olaine and a control group from the area without chemical industry objects. The samples were obtained from 30 mothers (15 mothers in each group) after discussions on the participation in the study with 43 mothers. A survey was carried out on the age, height, weight of the mothers, their smoking and eating habits and occupation, as well as information on the age and the weight of their children.

The concentrations of POP were detected by using WHO recognised standard methods (WHO, 2000). The concentrations of 18 PCBs in all individual and pooled samples were analysed in IOEH with a Gas Chromatograph Varian 3800 with electron capture detector (GC/ECD) after triple extraction of fat soluble substances (including PCB), treatment with sulphur acid, and purification in the chromatographic column. For the quantitative and qualitative measurements certified individual solutions of the detectable 18 PCB compounds and complex solutions of their reference standards were used. Assessing the detection of PCB recovery according to the marker-PCB concentration in reference milk, the obtained result of CB-52 were increased by order (given 1.16 ng/g, detected 12.29–15.92 ng/g). For the remaining CB, the recovery was oscillating within the limits of 68–97%. We link the increased recovery of CB-52 to the probable overlapping of peaks in the given conditions of chromatography.

The detection of seven polychlorinated dibenzo-*p*-dioxins (PCDD), 10 dibenzofurans (PCDF) in pooled samples and seven breast milk samples of each group was performed in SMU by using the method of high-resolution gas chromatography/mass spectrometry (HRGC/HRMS) with the special automated system of dioxin extraction–purification. On the basis of the achieved concentration of dioxins and furans, the total toxicity equivalent for each sample was calculated according to the WHO methodology (WHO-TEQ, pg/g fat). Chlorinated pesticides: HCB, α-, β- and γ-HCH, *p*,*p*′-DDT, *o*,*p*′-DDT and their metabolites *p*,*p*′-DDE and *o*,*p*′-DDE were detected in SMU by using HRGC/ECD. The detection method is analogous to the method used by IOEH in detecting PCB. The concentration of dioxin-like mono-ortho and non-ortho PCBs is expressed in toxicity equivalents WHO-TEQ, pg/g milk, taking into consideration dioxin-type toxic features of each compound (Toumisto et al., 1999).

Results and discussion

The survey data show that the mothers of the target and the control group according to the general indicators do not significantly differ and are mutually comparable. The mothers who participated in the survey of the Olaine group were on average 25.7 ± 4.2-years old, and the average age of the control group mothers was 25.8 ± 5.0 years. The average height of the surveyed mothers was similar: Olaine group 168.1 ± 5.1 cm and the control group 166.9 ± 4.3 cm. However, the weight of the Olaine group mothers prior to pregancy (63.6 ± 10.4 kg) was on average slightly higher than that of the control group (57.9 ± 8.0 kg). Therefore, it is logical that the same trend could be observed in the average weight of the mothers directly before giving birth: Olaine group 77.8 ± 13.8 kg and control group 68.9 ± 9.3 kg. The weight of the children at birth was similar in both groups (Olaine group 3606 ± 623.5 g and control group 3518.4 ± 480.6 g) and remained such during the study. The occupation of mothers in both groups was similar and not linked to possible increased uptake of PCB. The mothers of the Olaine group consumed slightly more sea fish and fish products, beef and cheese with high fat contents, the amount of dairy products they consumed daily is markedly smaller than in the control group; but the consumption of all types of fatty products is not typical of one and the same person according to survey.

The concentration of all POP types in both groups in all milk samples oscillates across a very broad range. In the calculations of the mean values of concentration the PCB concentration limit was used as the minimum concentration, and not the value 0, to avoid intentional decrease of values. PCB were not observed in 15.9%, PHDD/PHDF in 6.6% and pesticides in 14% analyses of the Olaine group and in 26.3%, 7% and 8.6% analyses correspondingly of the control group.

The summary concentration of marker-PCB in pooled samples of the Olaine group was 141.8 ng/g milk fat, but in the pooled sample of the control group 110.9 ng/g milk fat (Table 1), thus corresponding to the lowest summary concentration of marker-PCB compounds in Central Europe as shown by Toumisto et al. (1999). According to WHO research data the summary concentration of marker-PCB 6 compounds in Central Europe is 200–400 ng/g in milk fat (Toumisto et al., 1999). The total concentration of PCBs in milk samples correlates with an increase of body weight of mothers during pregnancy.

Data found in the literature indicate that the concentration of PCB in human milk is different, similarly as in this study the concentrations oscillate in a wide range, there are more representative data that cover a large number of respondents and were performed repeatedly after a period of time, for example, in Germany within the period of 10 years 3500 milk samples were analysed, and it was established that in 1995–1997 the mean PCB concentration in milk of mothers living in northern Germany was 502 ppb (ng/g) in milk fat. The research indicated that