PCDDs, PCDFs AND PCBs IN HUMAN MILK OF WOMEN EXPOSED TO A PCB FIRE AND OF WOMEN FROM THE GENERAL POPULATION OF THE PROVINCE OF QUÉBEC - CANADA.

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ABSTRACT

In August 1988, a PCB fire required the evacuation of 5 200 persons. Exposed lactating women were advised to stop breastfeeding during the two first days. This paper presents the evaluation of human exposure to PCDDs and PCDFs resulting from this fire. The levels of these compound in breast milk were more elevated in the exposed group than in the control group but the levels were not statiscally different. Differences between the exposed and control group were not observed for specific congeners measured in the soots found near the fire site.

INTRODUCTION

On August 23, 1988, a fire broke out in a PCB warehouse in St-Basile-le-Grand, Québec, Canada. When the accident occured, the warehouse contained approximately 500 barrels of both liquid and solid PCBs or PCB - contamined wastes. Most of the PCB mixtures were Aroclor 1242. A small number of barrels also contained various solvents resulting from handling and decontamination operations of PCB wastes. The total duration of the fire was 5 hours. As a result of the accident, it was suspected that an unknown amount of PCBs, dioxins and furans had been released from the incomplete combustion of PCBs and chlorobenzenes. About 5 200 persons were evacuated for a total period of 18 days.

The Public Health response included medical and biological follow-up and public health recommendations concerning drinking water, local food, cow milk etc. One of the first actions was to advise 38 women to temporarily stop breast-feeding. Breast milk samples taken during the first three days were analyzed for PCBs. Because levels were with in the normal range, women were reassured and all continued to breast-feed their baby. In the next weeks and months, the biological exposure for PCDDs and PCDFs was evaluated from the analysis of the plasma of 59 firemen (30 exposed and 29 non exposed) and in the milk of 9 mothers exposed to the PCB fire and in 96 control women. Levels of 15 PCB congeners were also evaluated. This paper focuses on results of the mother's milk analysis.

MATERIAL AND METHODS

Study Populations and Milk Sampling

Among the 38 breast feeding women who were evacuated during the PCB fire, only seven were still feeding their baby two months later. Two other women, included in this survey, were pregnant during the fire and breast-fed their baby at the time of the milk sampling.

Each woman provided a 240 ml sample between October 1988 and February 1989. The control group included 96 women who had provided a 50 ml milk sample within a provincial surveillance program on chemicals in human milk. All samples were obtained between December 1988 and February 1989 and came from 10 different regions.

In order to obtain a sufficient quantity of milk (240 ml) and to insure the representativity of the control group, 16 pools of 240 ml of milk were constituted. The 40 ml milk samples were pooled by six and by increasing content of PCBs (Aroclor 1260) in order to minimize the intrapool variation.

PCDD, PCDF and PCB Analytical Methods

The methodology for the analysis of the mother's milk samples included extraction with hexane, chromatography column cleanup and HRGC/HRMS analysis. The milk samples (50 g) were spiked with nine carbon-13 labeled internal standards, mixed with an aqueous solution of saturated sodium oxalate, ethyl ether, ethanol (80 ml, 1:5:2) and extracted with hexane (3 x 30 ml) (1). The hexane exract was recovered, concentrated to constant weight and the percent lipid was determined gravimetrically.

For PCDD/PCDF analysis, the lipid residue was diluted in hexane and subjected to a series of column chromatography steps including neutral/acid silica gel, neutral alumiina, and a carbon based absorbent. The cleaned extracts were analyzed by HRGC/HRMS (2).

For PCB analysis a separate aliquot (5 g) of the milk samples were extracted, cleaned up with neutral/acid silica gel column chromatography, and analyzed by HRGC/ECD.

RESULTS

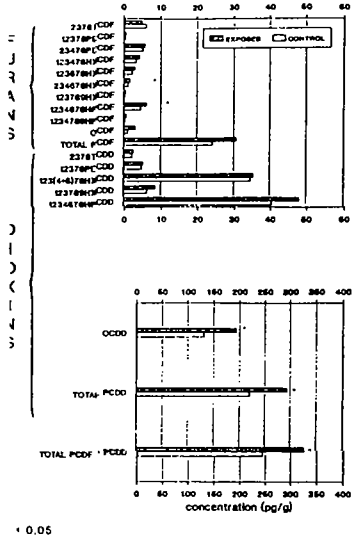
Mean levels of total PCDDs and PCDFs were respectively 327 ng/kg and 245 ng/kg in the milk fat of exposed women compared to control women. As shown in figure 1, this difference is mainly due to octaCDD (293 ng/kg vs 220 ng/kg). Two hexaCDF and heptaCDF congeners were also more elevated in the exposed group and these differences were statistically significant. However the 2,3,7,8-tetraCDF, the most important congener found in soots, was less elevated in the exposed group. Using the International Toxicity Factor (I-TEF), the mean levels of PCDDs/PCDFs expressed in Toxic Equivalent Quantity (TEQ) on fat basis was 15.3 ng/kg and 13.3 ng/kg respectively in St-Basile women and in the control group. One women exposed during the PCB fire had high levels of hepta and octaCDFs. The 1,2,3,4,6,7,8-heptaCDF level was 107 ng/kg compared with 5 ng/kg (mean of both groups). For the 1,2,3,4,6,7,8,9-octaCDF, the level was 17.1 ng/kg compared with nondetected levels (detection limit < 2 ng/kg) for the control group. These specific data points were assumed to be outliers and were excluded from the statistical analysis. It was not possible to find any specific exposure such as wood preservative use through the questionnaire and interview.

No statistical difference was observed in the PCB levels of exposed and non exposed women. The sums of 15 congeners were respectively 229 ng/g and 198 ng/g in the two groups. Congeners 138 and 153 were the main compounds and occupied each 17 to 20% of these sums. The distribution of congeners is similar to those previously reported in Sweden (3).

DISCUSSION

The human exposure assessment was designed to evaluate the exposure of lactating women during the PCB fire of St-Basile-le-Grand. About 8 000 liters (12 000 kg) of PCBs were burned (mainly Aroclor 1242). The maximum emission rate of PCDFs was estimated to be 100 mg of PCDFs per kg of burned PCBs. The estimated PCDF air concentrations at 1,2,3,4 and 5 km from the fire were respectively 15, 6.9, 2.7, 1.76 and 1.29 $\mu g/m^3$. About 50 % of PCDFs were tetraCDFs and 25 % of tetraCDFs were 2,3,7,8-tetraCDF, the main toxic compounds. At 2 km from the fire, the mean air concentration of 2,3,7,8-TetraCDF was estimated to be 0.625 $\mu g/m^3$.

FIG 1: LEVELS OF CONGENERS OF PCDDs AND PCDFs IN BREAST MILK OF EXPOSED AND CONTROL WOMEN (fat basis)



< 0.05

FIG 2: DISTRIBUTION OF DIFFERENT PCDF CONGENERS IN THE MILK FAT OF EXPOSED AND CONTROL WOMEN AND IN FIRE SOOTS

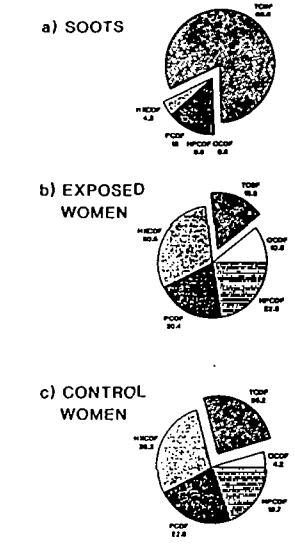
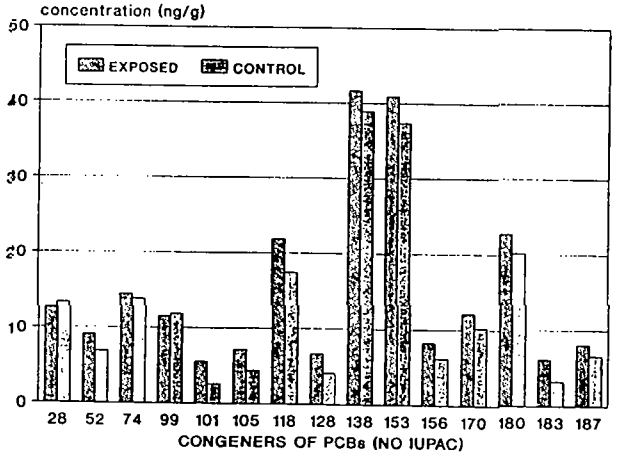


FIG 3: DISTRIBUTION OF CONGENERS OF PCBs IN HUMAN MILK (fat basis) IN EXPOSED AND CONTROL WOMEN



The fingerprint of the fire shows that nearly 81% of PCDFs found in soots were tetraCDFs. The fingerprint of the tetraCDF congeners in the milk of the exposed women shows only the 2,3,7,8-tetraCDF and the absence of the other tetraCDF congeners in the milk indicates no evident exposure from PCDFs from the St-Basile PCB fire. The 2,3,7,8-tetraCDF congener was less elevated in the milk of exposed women compared with control women (figure 2).

Although no differences were observed between the sums of congeners, the general tendency is that the PCDDs/PCDFs levels in the milk of the women from St-Basile are slightly higher than the milk of the control women but even these differences are not statistically significant. The difference observed between the two groups may be due to geographical differences between a suburban area in the south part of Montréal versus two urban regions of Montréal and Québec.

For PCBs, although no significant differences were observed between the two groups, the general tendency of more elevated levels for nearly all congeners in the St-Basile group is possibly due (as for PCDDs/PCDFs) to the suburban situation of St-Basile-le-Grand. Moreover, because the PCB mixtures present and emitted during the fire were principally Aroclor 1242, the specific exposure should had been seen among tri and tetraCBs. As shown in figure 3, levels of congeners 28, 52 and 74 are not different between the two groups and congener 28 is less elevated in the exposed group.

This study established the mean levels of PCDDs and PCDFs in the milk of women coming from nearly all parts of the province of Québec. In Toxic Equivalent Quantity, the mean level of 13.3 ng/kg is in the low ranges of most industrialized countries (4) and is much lower than the estimation of 32.6 ng/kg made by WHO (5). Some specific differences can be pointed out. The main difference concernes 2,3,7,8-tetraCDF which is more than twice that reported by WHO (6.09 vs 2.5 ng/kg). These difference is possibly attributable to the impact of pulp and paper industry in the province of Québec. This study led to the conclusion that the exposure of these women was negligible during the St-Basile-le-Grand PCB fire. Moreover, analytical data on breast milk of control women gives us a good estimation of the PCDDs/PCDFs body burden of the general population in the province of Québec. Except for 2,3,7,8-tetraCDF, levels are below or within the range of other industrial countries.

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