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High Levels of PCBs in Breast Milk of Inuit Women from Arctic Quebec

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In the last twenty years polychlorinated biphenyls (PCB_s) have been identified as major contaminants of the natural environnement (Jensen 1966). More recently, the presence of such toxic compounds was described in arctic regions (Wagemann and Muir 1984). This contamination results mainly from long range atmospheric transport (Norstrom and Muir 1986). In these regions, PCB_s have been found in water, snow, ice and air (Mc Neely and Gummer 1984). The level of PCB contamination was significantly lower than that found at midlatitudes. In the Canadian arctic food chain, the presence of PCB_s has been documented in studies carried out over the past 15 years (Addison and Smith 1974). DDT and PCB_s are the only organochlorines that have been monitored on a systematic basis in arctic marine mammals. In ringed seal, blubber concentration of PCB_s ranged from 0.9 to 3.0 mg/kg (Addison and Smith 1974). Levels of PCB_s of 0.01 to 0.1 mg/kg have been reported in arctic char muscle (Holtz and Sharpe 1985).

PCB levels are often monitored because they could also reflect exposure to several other chemical contaminants such as other organochlorines. More recently, contamination by other organochlorinated compounds such as hexachloro-hexane, chlordane, toxaphene and dieldrine have been described in ringed seal blubber and fish from the east central Canadian arctic (Muir et al. 1988). Other highly toxic compounds such as polychlorinated dibenzo-p-dioxins ($PCDD_s$) and dibenzofurans ($PCDF_s$) were found in the blubber from arctic ringed seals caught near the west coast of Spitzbergen (Oehme et al. 1988). Since the closest known sources of PCDD and PCDF were several thousands of kilometers away, these results were surprising. Concentrations of PCDD/PCFD expressed in 2,3,7,8-TCDD toxic equivalent, as proposed by Eadon (Eadon et al. 1986) ranged from 8.2 to 47.5 pg/g.

The consumption of fish and marine mammals by the Inuit people is markedly higher than in the rest of the Canadian population and in some communities, sea mammals represent a significant part of the diet. It is possible that Inuit are exposed to an undesirably high

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intake of PCB_s and other organochlorinated compounds. Levels of PCB_s in the Inuit diet were assessed in Broughton Island, North West Territories, Canada (Kinloch and Kuhnlein 1986). The major contributors of PCB intake were marine mammals such as narwhal, seal and walrus. Moreover, the estimated PCB_s daily intake exceeded the Acceptable Daily Intake (ADI) (Health and Welfare Canada) of 1 µg/kg of body weight for 19 % of the population studied (Kinloch and Kuhnlein 1986). As far as we know, only two previous studies have documented PCB levels in Inuit (Kinloch and Kuhnlein 1986; Davies and Mes 1987), but results were difficult to interpret.

The present study was designed to assess the PCB levels in the breast milk of lactating Inuit women from the Hudson Bay region of Northern Quebec and of women from Southern Quebec.

MATERIALS AND METHODS

Between September 1987 and September 1988, 24 Inuit women who had delivered at the Hudson Bay Hospital in Povungnituk provided a 30 ml breast milk sample. These women lived in six of the seven settlements of the east coast of Hudson Bay. During the same period, 19 Caucasian women from Quebec City and 29 from Baie Comeau (on the north shore of the St-Lawrence River) provided similar milk samples. All mothers were volunteers and were requested to collect a sample of their breast milk during the first month following delivery. Milk samples were frozen and sent to the laboratory of the Centre de Toxicologie du Québec. A self administered questionnaire in Inuktitut, in French or in English was used to assess dietary intake of selected foods, number of previous pregnancies and duration of past breast feeding.

PCB levels were evaluated in terms of Aroclor 1260, expressed both on a total milk volume (µg/L) and fat (mg/kg) basis. The milk sample was subjected to an alkaline hydrolysis to eliminate fats. PCB_s were then extracted with a hexane-ether mixture. The concentrated extract was purified on a Florisil column and analysed on a Varian 6000 gas chromatograph equipped with a split/splitless injector, a 30 m DB-5 capillary column and an electron capture detector. With 2 ml of milk, the detection limit is 2 µg/L.

Data were analysed using standard statistical methods (Snedecor and Cochran 1980). Mean PCB levels and other characteristics of Inuit and Caucasian women were compared by Student's t test. Statistical association between variables was assessed by Pearson correlation. The influence of parity and previous breast feeding on the PCB levels was taken into account in the analysis using multiple linear regression.

Table 1. PCB levels in breast milk of Inuit and Southern Quebec women

	No of samples	PCB levels: Whole milk (μg/L) Mean	Whole milk (μg/L) Range	Milk fat (mg/kg) Mean	Milk fat (mg/kg) Range
Inuit	24	111.3	(16-514)	3.60	(0.5-14.7)
Caucasians	48	28.4	(5-115)	0.77	(0.3-3.2)

RESULTS AND DISCUSSION

The mean level of PCB_s in breast milk was 111.3 μg/L for the Inuit women compared to 28.4 μg/kg for the Caucasian women ($p= 0.05$) (Table 1). PCB concentrations in milk fat were 3.60 and 0.77 mg/kg respectively for Inuit and Caucasian women. This level among the Inuit was almost 5 times that of the Caucasian women, a highly statistically significant difference ($p= 0.0002$). The PCB levels in the breast milk of the Inuit women are among the highest ever reported. In the North, no significant difference was seen between settlements. For the Inuit women, the mean consumption of marine mammals, fresh water fish and sea fish was respectively 10, 18 and 9 meals per month.

The mean age of Inuit women was slightly lower (25 years) than that of Caucasian women (28 years). Inuit women had more previous children (2.5 on average) than the Caucasian women (0.7). The average cumulative duration of breast feeding was significantly higher among the Inuit (49 weeks) than among the Caucasian women (12 weeks).

Total duration of breast feeding was inversely correlated with the PCB level in breast milk but the association was weak and not statistically significant. The cumulative duration of breast feeding was 119 weeks for women with the lowest PCB concentration (0.5-2 mg/kg fat), 22 weeks for the intermediate concentration (2.1-3.9 mg/kg) and only 13 weeks for the highest level (≥ 4 mg/kg).

Multiple linear regression was used to assess the relationships between potential determinants such as age, duration of breast feeding, and dietary intake of fish and the level of PCB_s in milk fat. Because of the strong association of all above variables with ethnicity, these relationships were studied separately for the Inuit and the Caucasian women. Because of small numbers, no significant association emerged but in both data sets age and fish consumption were positively and breast feeding negatively associated with PCB levels.

Two previous studies have documented the level of PCB exposure in Inuit populations. The first study determined levels of organochlorines in the breast milk of 18 Canadian natives (including Indians and Inuit). Levels of PCB_s in whole milk averaged 12.4 µg/kg for natives compared with 15.9 µg/kg for the general population (Davies and Mes 1987). These low levels could reflect imprecision due to the small number of women selected and to the non differenciation between Indians and Inuit in a data analysis. In this study, the reported fish consumption was similar among natives and in the general population. The second study examined the blood levels among the population of Broughton Island (Kinloch and Kuhnlein 1986). Of the 46 children included in the study, 29 had blood levels of PCB_s above the tolerable level of 4 µg/kg (Health and Welfare Canada). Six samples of breast milk were analysed, and only one had an elevated level (69 µg/kg whole milk). Others had low PCB contents (10 to 18 µg/kg) compared with data from the Canadian Survey (20-30 µg/kg) (Mes et al. 1986).

In the present study, a high consumption of fishes and sea mammals is probably the main route of intake for PCB_s as proposed previously in the Broughton Island study. In Northern Quebec, large quantities of country food are eaten. Moreover, because of the amount of precipitation, Hudson Bay is probably more contaminated than the extreme north (Norstrom and Muir 1986).

An average dose of PCB_s received by infants through breast feeding was estimated assuming an average daily milk intake for infants of 120 ml/kg/day. Weight and body fat were estimated using standard pediatric tables. Elimination of highly chlorinated isomers was considered negligible since PCB blood levels decrease by only 10% over 300 to 500 days after exposure (Chen et al. 1982). Other dietary sources of PCB_s such as seal blubber which is sometimes given to babies were not considered. A gastrointestinal absorption rate of almost 100% (Allen et al. 1974), and a blood/fat partition coefficient of 1/200 (Wolff et al. 1982) were assumed.

Under these conditions, the blood level in a baby receiving milk containing 110 µg/kg of PCB_s would reach 150 µg/kg in about 18 months. If the milk concentration is 500 µg/L these blood level would be attained in three months. A blood level of 150 µg/kg has been recognized as the lowest observed adverse effect level (LOAEL) by NIOSH (NIOSH 1977). At this level, in occupational studies, clinical and biological effects (chloracne, hepatic, enzymatic induction) were observed among the most sensitive workers.

Immunotoxic response to PCB_s, $PCDD_s$ and $PCDF_s$ was described in Yusho and Yusheng accident (Kuratsune et al. 1969; Lü and Wong 1984). Both humoral and cellular immunity have been impaired. The abnormalities described involved mainly the decrease in IgA and IgM, a reduction in the skin response to antigens, a decrease in the total T-cells and active T-Lymphocytes. In the T-Lymphocyte population, the reduction involved essentially the T-Lymphocytes helpers, producing a decrease in the ratio helper/ suppressor.

Immunologic investigations of 40 healthy Inuit infants in Frobisher bay (North West Territories) have suggested that normal Inuit infants have lower total T-cell percentages and lower T-helper than control infants from the South (Reece 1987). Moreover, infection rates among children observed in Northern Quebec are 10 to 15 fold those observed in Southern Quebec.

These results suggest that toxic compounds such as PCB_s could play a role in the impairment of immunity and in the high occurrence infection among Inuit children. These relationships will be investigated in a prospective way during the next year.

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