Determinants of Polychlorinated Biphenyls and Methylmercury Exposure in Inuit Women of Childbearing Age

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The objectives of this study were to to identify maternal characteristics associated with traditional food consumption and to examine food items associated with polychlorinated biphenyls (PCBs) and mercury body burden in pregnant Inuit women from Northern Québec. We interviewed women from three communities at mid-pregnancy and at 1 and 11 months postpartum. We measured PCBs, Hg, and selenium in maternal blood; Hg was also measured in maternal hair. The women reported eating significant amounts of fish, beluga muktuk/fat, seal meat, and seal fat. Although consumption of fish and seal was associated with lower socioeconomic status, consumption of beluga whale was uniform across strata. Fish and seal meat consumption was associated with increased Hg concentrations in hair. Traditional food intake during pregnancy was unrelated to PCB body burden, which is more a function of lifetime consumption. This study corroborated previous findings relating marine mammal and fish consumption to increased Hg and selenium body burden. Despite widespread knowledge regarding the presence of these contaminants in traditional foods, a large proportion of Inuit women increased their consumption of these foods during pregnancy, primarily because of pregnancy-related changes in food preferences and the belief that these foods are beneficial during pregnancy. *Key words*: Canada, Inuit, methylmercury, polychlorinated biphenyls. *Environ Health Perspect* 109:957–963 (2001). [Online 12 September 2001]
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Polychlorinated biphenyls (PCBs) are a family of lipophilic compounds once used extensively in industry, particularly as heat transfer chemicals in electric transformers and capacitors as well as hydraulic fluids and lubricants in heavy electrical equipment (*1,2*). Although banned in the United States in the mid-1970s and in most of western Europe by the mid-1980s, these compounds were designed to resist biodegradation, and they continue to be ubiquitous in landfills, ocean and lake sediments, and fish and wildlife (*3*). Fatty fish from contaminated bodies of water can be a major source of human exposure, as are fatty meats and dairy products. The toxicity of PCBs and related compounds was first recognized in two industrial accidents—one in Japan in the late 1960s, the other in Taiwan in the late 1970s—when PCBs used as a heat transfer agent leaked into rice oil during its manufacture. Adults who ate the contaminated oil developed skin rashes and peripheral nervous system numbness and tingling (*4*). Infants born to women who had eaten the contaminated oil also had skin rashes and exhibited poorer intellectual functioning during infancy and childhood (*5*). Prospective, longitudinal studies of U.S. and Dutch children exposed prenatally to PCBs have linked this exposure to poorer intellectual function in children exposed at the upper end of general population levels (*6,7*).

Mercury is a natural element in the earth's crust and a major industrial pollutant, particularly from coal-fired utility plants and waste incinerators. In lakes and oceans, Hg is converted by bacteria to methylmercury (MeHg) and bioaccumulates in fish and in the meat of sea mammals who eat MeHg-contaminated fish (*8*). The neurotoxicity of MeHg was first recognized in the 1950s when residents of southern Japan ate fish from Minamata Bay that were highly contaminated by industrial pollution. This exposure led to mental retardation, motor damage, ataxia, and seizures in children born to women who ate the contaminated fish during pregnancy (*9*). Studies of fish-eating populations exposed to MeHg concentrations somewhat above general population levels conducted in New Zealand (*10*) and the Faroe Islands (*11*) have documented subtler cognitive and neuromotor deficits in prenatally exposed children [but cf. Davidson et al. (*12*)]. In addition to MeHg, increased intake of selenium would be expected in a population such as the Inuit, who consume relatively large quantities of fish and marine mammals. Although the effects of Se on MeHg toxicity have not been well documented in humans, there is evidence from animal studies that Se can influence the deposition of MeHg in the body and protect against its toxicity (*8*).

Organochlorines and heavy metals are carried to the Arctic from industrialized regions by long-range atmospheric transport, waterways, and oceanic currents (*13*). Due to their high lipophilicity and resistance to biodegradation, PCBs and other organochlorines bioaccumulate in fatty tissues of organisms and are biomagnified through the food chain, producing relatively heavy concentrations in the fat of predator species, including predator fish and birds, marine mammals, and polar bears (*14*). Among the heavy metals, Hg reaches the highest concentrations in the northern fauna, through acid rain and contamination from hydroelectric power plants. The Inuit residing in northern Quebec receive an unusually high dose of PCBs because they eat the fat from predator marine mammals such as beluga and seal. Collaborative research by circumpolar nations conducted during the past 5 years has documented human exposure to PCBs and Hg, and the Inuit from northern Quebec and Greenland are among the most heavily exposed (*15*). Before contact with the Europeans, the Inuit were nomadic and subsistence hunters; their diet consisted almost exclusively of meat, fish, fat, and wild berries. Rapid changes in the diet of Nunavik Inuit occurred in the mid-1950s with the advent of policies of compulsory schooling and of concentrating native people into permanent, white-style settlements, creating a more sedentary lifestyle and dietary acculturation (*16*). Now there are at least one and often two grocery stores in each of the Nunavik communities, but store-bought foods are very expensive because of the high cost of transportation to the North. Meat, fish, and fat continue to be consumed by the

Inuit and traditional foods continue to contribute significantly to the intake of many nutrients for the Canadian Inuit (*17*).

We are currently studying the effects of prenatal exposure to PCBs and Hg on cognitive and behavioral development in a sample of Inuit infants in northern Quebec. Mothers are recruited prenatally and interviewed in detail about their consumption of native food. Blood and hair samples are obtained to assess maternal body burdens of PCBs, Hg, and Se. The purpose of this article was 2-fold: to examine the sociodemographic characteristics associated with consumption of traditional food and to identify the food items from the traditional Inuit diet that are associated with PCB and Hg exposure.

Methods

Population. We invited pregnant Inuit women from northern Quebec (Nunavik) to participate in a study focusing on infant health and development. The Nunavik region is located north of the 55th parallel; 7,660 Inuit are scattered along a 2,000-km seashore line along Hudson Bay, Hudson Strait, and Ungava Bay, about 1,500 km from Montreal and 2,000 km from the Great Lakes in the United States (Figure 1). The Nunavik Inuit live in 14 villages, with 125 to 1,300 inhabitants per village. The study participants were living in Puvirnituq (51.8%), Inukjuaq (29.7%), and Kuujjuaraapik (8.5%), the three largest communities on the Hudson Bay coast.

Procedures and variables. From November 1995 to November 1998, a midwife or a nurse in each of three targeted communities gave our research assistant the name of each pregnant woman shortly after her first prenatal visit. Our research assistant contacted each potential participant by telephone and invited her to come to the community nursing station to learn about the study's objectives and procedures. Women without telephones were contacted by an announcement on the community's FM radio station asking them to contact our research assistant. Detailed informed consent was obtained from each participating mother. The research procedures were approved by the human subjects committees of Laval University and Wayne State University. Interviews were conducted in the community's nursing station at midpregnancy and at 1 month postpartum by trained research assistants to assess the mothers' socioeconomic and personal characteristics. The sample examined in this study consisted of the 135 mothers who had completed the prenatal and postnatal interviews as of November 1998. Among the women recruited for the study during that period,

84.3% agreed to participate; 6.9% were excluded because of miscarriage or perinatal or postnatal mortality; 5.8% were excluded because of failure to obtain biologic samples to document maternal PCB and Hg body burden; and 2.4% withdrew after the prenatal interview.

Traditional food consumption (meals per month during pregnancy) was assessed in an interview conducted during pregnancy, which covered the period from conception to when the prenatal interview was performed, and in an interview conducted postpartum for the period from the prenatal interview to the end of the pregnancy. Consumption rates for the two periods were weighted by the number of days covered in each period and then summed to provide a measure of meals per month during pregnancy. Consumption rates were obtained for the following items selected for their potentially high levels of PCBs or Hg and because they were likely to be the main fish and marine mammals species consumed in Nunavik: fish (primarily Arctic char, salmon, and lake trout); beluga whale meat, liver, fat, and muktuk (skin with the underlying fat layer); seal meat, fat, and liver; walrus; whale meat and muktuk; and narwhal meat and muktuk.

A 12.5-mL blood sample was obtained from each participating mother at delivery or within several weeks thereafter. Data are

reported here only for the 93 women from whom blood samples were obtained within 1 month of delivery (median = 2.0 days postpartum). Any later sampling took place mostly because samples were not collected at delivery. We measured PCB and Hg concentrations in maternal plasma and whole blood, respectively. Two 5-mm diameter hair samples were collected, one at the prenatal interview and one at the 1-month postnatal interview. Hg concentrations were also determined in the hair sample collected postnatally. The hair was cut in three segments of 3 cm in length, with each segment corresponding to a trimester of pregnancy. The samples were long enough to represent the whole pregnancy for all participants except one, whose prenatal sample was used in addition to her postnatal sample. Hair Hg results were available for 107 participants. Because hair Hg concentrations were highly intercorrelated across the three trimesters of pregnancy (median intertrimester $r = 0.83$), we used the averaged Hg concentration.

Laboratory procedures. Blood samples containing EDTA as the anticoagulant were centrifuged and the plasma was collected in glass vials prewashed with hexane. Hair samples were cut at the scalp and stored in a plastic bag. Plasma samples were frozen at –20°C and sent to the Centre de Toxicologie du Québec for analyses. We first added a 1:1:3

Figure 1. Nunavik Region in northern Québec, Canada.

mixture of ammonium sulfate/ethanol/ hexane to the plasma to extract PCB congeners. The extracts were then concentrated and purified on two Florisil columns (60–100 mesh; Fisher Scientific, Nepean, Ontario, Canada). The 14 most prevalent PCB congeners (IUPAC nos. 28, 52, 99, 101, 105, 118, 128, 138, 153, 156, 170, 180, 183, 187) were measured in the purified extracts with an HP 5890 high-resolution gas chromatograph equipped with dual capillary columns (HP Ultra I and Ultra II) and dual Ni-63 electron capture detectors (Hewlett-Packard, Palo Alto, CA, USA). Quality control procedures were described previously ([18]). Percent recovery for PCB congeners varied from 92% to 98%; the detection limit was about 0.02 μg/L for all congeners. Coefficients of variation ($n = 20$, different days) ranged from 2.1% to 7.5%. Bias—that is, the difference between the concentration of the reference material and the concentration found using the analytic method—ranged from –10.9% to 3.8%. We measured total cholesterol, free cholesterol, and triglycerides in plasma samples by standard enzymatic procedures, and we determined phospholipids according to the enzymatic method of Takayama et al. ([19]), using a commercial kit (Wako Pure Chemical Industries, Richmond, VA). We estimated the concentration of total plasma lipids according to the formula developed by Phillips et al. ([20]). PCB concentrations were expressed on lipid basis because maternal wet-weight concentrations are less reliable due to blood lipid fluctuations during pregnancy, from pregnancy to the delivery, from pregnancy to the postpartum period, and between bottle-feeding and breast-feeding mothers ([21,22,23]). The laboratory of the Centre de Toxicologie du Québec is accredited by the Canadian Association for Environmental Analytical Laboratories.

We determined total Hg concentrations in samples of whole maternal blood and hair by cold-vapor atomic absorption spectrometry. Samples were digested with nitric acid, Hg was reduced with anhydrous stannous chloride, and the reaction was catalyzed with cadmium chloride. Metallic mercury was volatilized and detected by atomic absorption spectrometry (model 120, Pharmacia, Piscataway, NJ, USA). Detection limit for blood mercury analysis was 1.0 nmol/L. Quality control procedures were described previously ([18]). Coefficients of variation ($n = 50$, different days) at levels of 40 and 90 nmol/L (in-house reference materials) were 5% and 5.5%, respectively. Relative bias was 2.4% and –0.4%, respectively. Detection limit for hair Hg analysis was 1 nmol/g. We obtained accuracy and precision data using certified reference material through a hair mercury interlaboratory comparison program organized by Health Canada. Coefficients of variation ($n = 50$, different days) were 4.8% for the 12.3 μg/g reference specimen (CRM 397) ([24]) and 4.3% for the 4.42 μg/g reference specimen (CRM 13) ([25]). Relative biases were –2.2% and +1.9%.

We determined blood Se concentrations by inductively coupled plasma mass spectrometry (ICP-MS) using state-of-the-art instrumentation (Elan 6000; Perkin Elmer, Shelton, CT, USA). Samples were simply diluted and aspirated into the instrument. We performed matrix-matched calibration using a pool of normal blood, and we obtained accuracy and precision data using reference material of our ICP-MS comparison program. The detection limit was 0.1 μmol/L. The coefficient of variation ($n = 37$, different days) at a level of 2.7 μmol/L was 5.9%, and the bias was –0.4%.

Statistical analysis. Consumption of traditional food during pregnancy, blood PCB concentration, hair Hg at first trimester of pregnancy, and blood Se concentration followed lognormal distributions. Therefore, we conducted analyses involving these variables with log-transformed values. We performed Pearson correlations to identify maternal characteristics associated with traditional food consumption as well as traditional food items associated with PCB and Hg body burden. We conducted multiple linear regression analyses to model the sociodemographic characteristics associated with traditional food consumption.

Results

Sample characteristics are presented in Table 1. The sample was predominantly poorly educated and of lower socioeconomic status. Only 4% had completed high school. A large proportion (42%) of the women were receiving more than half of their financial support from parents or step-parents. With respect to age, 16% were younger than 18 years and 4% were older than 35. Among women living with a partner (64%), the partner's fishing and hunting activities ranged from rare (0–6 times/year, 20%) to very frequent (1–7 times/week, 40%), with a median of 30 times/year. Twenty-three percent of the participating women were primiparous, and 33% had already delivered three or more children. Most women (92%) smoked during pregnancy. Most interviews

Table 1. Characteristics of participants.

Characteristics	No.	Percent	Mean	SD	Range
Education (years)	135		8.7	1.6	6–13
Socioeconomic status[a]	135		25.5	10.2	8–50
Unskilled laborers		31.1			
Semiskilled workers		31.1			
Skilled crafts, clerical, and sales		31.1			
Technical, small business, professional		6.7			
Marital status (% single)	135	30.5			
Age (years)	135		24.3	5.8	14–41
Frequency of partner's hunting and fishing[b] (times/year)	73		56.5	61.0	0–361
Number of adults in household	135		2.5	1.6	0–9
Residential crowding[c]	107		1.3	0.3	0.6–2.4
PPVT-R[d]	127		61.7	30.9	11–146
Language of interview (% Inuktitut)	135	19.3			
Smoking (number of cigarettes/day)[e]	125		11.0	6.4	1–25
Adoption status (% adopted infants)	135	14.8			
Live with parents (%)	135	43.0			

SD, standard deviation.
[a]Hollingshead Index ([26]) for the mother and her partner or, if she was not self-supporting, for her primary source of support (usually her parents). [b]Only for women living with a partner involved in fishing and hunting activities. [c]Number of adults and children in house/number of rooms in house. [d]Peabody Picture Vocabulary Test, Revised [PPVT-R ([27])]. [e]Among smokers.

Table 2. Traditional food consumption during pregnancy ($n = 135$).[a]

Food	Meals/week			At least 1 meal/week (%)	At least 1 meal/month (%)
	Mean	SD	Range		
Fish meals	3.3	3.3	0–21.0	77.7	94.1
Beluga meals					
Beluga fat and muktuk	0.5	0.9	0–5.63	17.8	43.0
Beluga meat	0.1	0.4	0–4.16	1.5	14.8
Beluga liver	0.0	0.0	0–0.39	0.0	0.7
Seal meals					
Seal fat	0.3	0.8	0–5.16	9.6	25.9
Seal meat	0.4	0.9	0–6.86	9.6	37.0
Seal liver	0.1	0.3	0–1.96	2.2	14.8

[a]For women who had completed the prenatal and the postnatal interviews.

were conducted in English (68%) or French (13%); 19% of the women were interviewed in Inuktitut through an interpreter.

The women ate fish often during pregnancy (Table 2). Most ate fish at least once per week; 32.6% ate three to six fish meals weekly, and 9.2% ate fish daily. Beluga fat/muktuk was the sea mammal food most frequently consumed, followed by seal meat and seal fat. Beluga meat and seal liver were consumed less frequently. Consumption of beluga liver, narwhal, and walrus was rare; only 1, 2, and 6 women ate more than 3 meals of beluga liver, narwhal, and walrus, respectively, during pregnancy. The intercorrelations among the traditional food items were modest, ranging from 0.11 to 0.45 (median = 0.28). The highest Pearson correlation coefficients were obtained for consumption of products from the same animal; individuals who ate beluga fat/muktuk were more likely also to consume beluga meat ($r = 0.44$, $p \leq 0.000$), and individuals eating seal liver were more likely to consume seal meat ($r = 0.45$, $p \leq 0.000$). Correlations between fish and beluga fat/muktuk were lower ($r = 0.34$, $p \leq 0.000$), as were the correlations between fish and seal meat ($r = 0.11$, $p \leq 0.19$), and between beluga fat/muktuk and seal meat ($r = 0.28$, $p \leq 0.001$). Unexpectedly, a large proportion of women reported increasing their consumption of these foods during pregnancy. As shown in Table 3, the main reasons given for this increase were changes in appetite and food preferences during pregnancy and the belief that traditional food consumption would enhance health during pregnancy. The main reason given by women who decreased their intake of

traditional food during pregnancy was lack of availability. Only one woman reported reducing her intake to avoid exposure to environmental contaminants.

Concentrations of contaminants in maternal blood and hair are presented in Table 4. The intercorrelations among PCBs, Hg, and Se are presented in Table 5. The relative proportion of the individual PCB congeners was uniform across this cohort. The correlations between PCB congener 153 and the other congeners detected in at least 70% of samples were high and ranged from 0.84 to 0.99 (data not shown). As in all other cohorts studied to date, PCB 153 was the most prevalent congener; it represented 35% of the 14 PCB congeners that were measured. Because estimates of total PCB body burden are derived by summing different PCB congeners in different studies, PCB 153 provides the best metric for comparing PCB exposure across studies and was therefore used as a surrogate for total PCB concentration in this cohort. PCB concentrations were moderately correlated with hair Hg concentrations but unrelated to blood Hg and Se. Hair and blood Hg levels were strongly associated, and Hg concentrations in both media were moderately related to blood Se levels.

We examined the demographic characteristics associated with traditional food consumption first in univariate correlational analyses. Characteristics that were associated with a given type of food (at $p \leq 0.10$) we then included as predictors in multiple linear regression analyses (Table 6). When two predictors were moderately correlated to each other ($r \geq 0.40$), only the stronger predictor was included in the model to minimize multicollinearity. With this criterion, maternal

education and PPVT-R ($r = 0.49$) ([24]), socioeconomic status ([25]) and PPVT-R ($r = 0.43$), adoption status and breast-feeding duration ($r = -0.53$), marital status and living with parents ($r = -0.55$), as well as maternal age and living with parents ($r = -0.43$) were too highly correlated to be included in the same regression analysis. The analyses in Table 6 showed that women who ate fish were likely to be less educated, to share their house with a larger number of adults, to live in more crowded households, to smoke more cigarettes daily, and less likely to give their baby up for adoption. This model explained 28% of the variance of frequency of fish consumption during pregnancy.

In contrast, maternal demographic characteristics were worse predictors of beluga and seal consumption (variance explained ranged from 2% to 8%). The number of cigarettes smoked daily during pregnancy was the only significant predictor of beluga meat consumption. Seal fat consumption was associated with residential crowding and was more frequent among women who did not give their baby up for adoption—that is, women who were single, younger, and living with their parents. Seal meat consumption was related to lower socioeconomic status. Finally, seal liver consumption was more frequent among women who spoke English or French well enough to be interviewed in one of these languages, as well as among women who did not give their baby up for adoption.

As shown in Table 7, reported fish and marine mammal consumption during pregnancy was unrelated to maternal PCB body burden. Correlation coefficients that were similar in magnitude were obtained when the sum of 14 PCB congeners was used instead

Table 3. Reasons given for changes in traditional food consumption during pregnancy.

Reasons	No.	%
Increased	51	42.1
Health related		
Baby's health	13	10.7
Mother's health	1	0.8
Recommended by parents and elders	2	1.7
Health, reason unspecified	5	4.1
Appetite and food preference		
Taste for it (craving)	8	6.6
More hungry	11	9.1
Reduces nausea and stomachache	4	3.3
More readily available	4	3.3
Reason not specified	3	2.5
Decreased	15	12.3
Health related		
Avoid contaminants	1	0.8
Appetite and food preference		
No taste for it	1	0.8
Less hungry	1	0.8
Increases nausea	2	1.7
Less readily available	5	4.1
Reason not specified	5	4.1
No change	55	45.6
Total	121[a]	100

[a]Question was not asked of the first 14 women.

Table 4. PCB, Hg, and Se concentrations.

Concentrations	No.	Arithmetic mean	Median	SD	Range
PCB congener 153 (µg/L)	93	1.3	0.8	1.2	0.2–6.1
PCB congener 153 (µg/kg)[a]	93	144.9	102.6	126.8	18.9–709.0
Sum of 14 PCB congeners (µg/L)	93	3.6	2.4	3.2	0.6–15.8
Sum of 14 PCB congeners (µg/kg)[a]	93	414.5	294.1	245.9	71.3–1951.3
Hair Hg (µg/g)					
1st trimester	108	4.3	3.7	3.1	0.2–18.5
2nd trimester	108	4.6	4.0	3.2	0.4–16.3
3rd trimester	109	4.4	4.1	2.6	0.3–12.8
Averaged across trimesters	107	4.5	4.0	2.8	0.3–14.0
Blood Hg (nmol/L)	74	59.1	48.0	36.8	17.0–221.0
Se (µmol/L)	74	4.3	4.0	1.8	2.3–12.4

[a]Fat basis.

Table 5. Intercorrelations among PCB, Hg, and Se concentrations.

Concentrations	PCB congener 153	Hair Hg	Blood Hg	Se
PCB congener 153	1.00 (93)	0.32* (66)	0.13 (73)	0.09 (73)
Hair Hg		1.00 (66)	0.68** (59)	0.39** (59)
Blood Hg			1.00 (74)	0.36** (74)
Se				1.00 (74)

Values are Pearson correlation coefficients; sample sizes are in parentheses.
*$p \leq 0.01$; **$p \leq 0.005$.

of PCB congener 153 (data not shown). Consumption of fish, seal meat, and seal liver during pregnancy was moderately associated with maternal hair Hg concentration. Surprisingly, these food items were not associated with blood Hg concentration, even though blood and hair Hg levels were highly correlated. Beluga fat/muktuk was an important source of Se intake during pregnancy.

Discussion

For several decades, the diet of aboriginal Northerners has consisted of a mix of traditional food and imported, store-bought food. Every community in Nunavik has at least one grocery store and usually two. A large majority of the pregnant women from the three largest Hudson Bay communities reported eating fish weekly, and a significant number ate fish daily. Beluga fat/muktuk was the most frequently consumed marine mammal food, followed by seal meat, fat, and liver and beluga meat. Beluga liver, narwhal, and walrus consumption was rare. More frequent fish consumption was associated with lower socioeconomic status; frequent fish eaters were likely to be less educated, to share their house with more adults, and to live in more crowded conditions. This association probably stems from the fact that fish, which are usually caught by a family member and available at no cost

in a community freezer, are less expensive than store-bought foods.

By contrast, beluga meat and muktuk/fat consumption were unrelated to the mother's socioeconomic circumstances, suggesting that consumption of these foods during pregnancy is valued across socioeconomic strata. Fisheries and Oceans Canada outlaws beluga hunting in the northern river estuaries at certain times of the year and fixes a quota on the number of belugas the Inuit are allowed to hunt per community each year. When a hunter brings back a beluga whale to the community, after his family members have consumed their part of the animal, the whole community is usually invited to the feast on the shore. The animals caught are consumed right away, and beluga is never available in community freezers. Beluga consumption is therefore more likely to be determined by a woman's cultural values, participation in social activities, and belonging to a beluga hunter's family, which may explain why married, older women tend to eat more beluga meat during pregnancy. On the other hand, seal meat consumption is associated with poorer socioeconomic circumstances although to a lesser degree than fish. Because there is no restriction regarding seal hunting, and because consumption of this marine mammal is less culturally valued in Nunavik, seal is readily available in community freezers (*28*).

Surprisingly, except for beluga meat, maternal age was unrelated to fish and marine mammal consumption, which is inconsistent with data from the Inuit Health Survey conducted with Nunavik adult men and nonpregnant women in 1992, where older adults were found to consume these foods significantly more often (*29*). The narrower age range of the women studied here may have reduced the likelihood of observing an association. The increase in consumption of traditional food during pregnancy reported by a substantial proportion of these women is likely to have further reduced the correlation with age. As shown in Table 3, these changes in the diet reflect cultural beliefs about which foods are most beneficial for a pregnant woman and her baby, as well as food cravings and preferences experienced by Inuit women during pregnancy. Despite widespread knowledge in the community about the presence of these contaminants in traditional food, it is clear from the data that the presence of contaminants has little or no impact on the diet of these pregnant women. Community radio programs presented regularly by Inuit midwives promote the consumption of traditional food based on the traditional knowledge that it is the best food for better health.

A correlation between blood PCB and Hg concentrations was expected but not observed in this data set. Moderate to high PCB–Hg correlations have been reported in umbilical cord blood samples from southern Québec ($r = 0.58$), as well as in blood samples collected from Nunavik adult men and nonpregnant women (r ranged from 0.60 to 0.70 depending on the PCB congener) (*18,29*). Dietary changes during pregnancy, in favor of increased consumption of Hg-contaminated foods, would be expected to affect maternal Hg body burdens through the short half-life of Hg in the bloodstream, which could reduce the strength of the PCB–Hg association. Changes in consumption of PCB-contaminated foods are less likely to affect this association because the body burden of the more highly chlorinated PCB congeners found in this population is determined primarily by lifetime consumption (*30*) because of the long half-life and slow excretion rate of these contaminants. Active uptake of Hg from the mother's blood across the placenta (*8*) may also reduce the strength of the PCB–Hg association because it is likely that women vary in rate of transplacental transfer.

Not surprisingly, Hg blood and hair concentrations were moderately correlated. The strength of this association was expected to be in the 0.60–0.80 range but not higher because the hair Hg concentration reflects the average exposure across the 9 months of gestation, whereas the blood Hg concentration

Table 6. Regression analyses to identify demographic characteristics associated with traditional food consumption during pregnancy.

Traditional food	No.	Demographic characteristics	Pearson *r*	Standardized β	Multiple *R*
Fish	107	Maternal education	−0.30**	-0.26**	
		No. of adults in residence	0.18**	0.24**	
		Residential crowding	0.19**	0.24**	
		No. of cigarettes/day	0.25**	0.26**	
		Adoption status	−0.20**	−0.25**	0.53
Beluga fat	135	No. of cigarettes/day	0.15**	0.15*	0.15
Beluga meat	135	Marital status	0.15**	0.11	
		Maternal age	0.17**	0.12	
		No. of cigarettes/day	0.20**	0.18**	0.27
Seal fat	107	Residential crowding	0.17**	0.17*	
		Adoption status	−0.16**	−0.16*	0.24
Seal meat	127	Socioeconomic status	−0.21**	−0.13	
		PPVT-R	−0.23**	−0.16*	
		Adoption status	−0.13**	−0.11	0.28
Seal liver	135	Language of interview	0.14**	0.15*	
		Adoption status	−0.16**	−0.16*	0.22

*$p \leq 0.10$; **$p \leq 0.05$.

Table 7. Correlations between consumption of selected traditional food items during pregnancy and PCB, mercury, and selenium concentrations.

Traditional food	PCB congener 153 (*n* = 90)	Hair Hg (*n* = 107)	Blood Hg (*n* =70)	Se (*n* = 70)
Fish	−0.06	0.20*	−0.09	−0.01
Beluga muktuk/fat	0.13	0.10	0.04	0.29**
Beluga meat	0.15	0.10	0.08	0.15
Seal fat	0.02	0.05	0.07	0.01
Seal meat	0.13	0.28**	0.08	0.02
Seal liver	0.03	0.37**	0.08	0.16

Values are Pearson correlation coefficients.
*$p \leq 0.05$; **$p \leq 0.005$.

primarily reflects exposure during the previous 2 months. The strength of the Se–Hg association obtained is in the expected range and is consistent with the assumption that similar food sources are responsible for Se and Hg intake.

Several lines of evidence suggest that the fish and marine mammal species consumed in the Arctic by the Inuit should affect their PCB body burden. In the Faroe Islands population consuming pilot whale, PCB concentrations from maternal serum analyses collected at 34 weeks of pregnancy were correlated with increased consumption of fish (r = 0.18), whale meat (r = 0.27), and whale blubber (r = 0.40) (*30*). In a group of women consuming PCB-contaminated Lake Michigan fish over an average period of 16 years (*31*), cumulative fish consumption was correlated with PCB concentrations in maternal blood collected after delivery (r = 0.29). The strongest correlation was observed with the highest annual rate of fish consumption (r = 0.38), suggesting that lifetime consumption was the best predictor of PCB body burden. Moreover, PCB analysis performed on seal fat, beluga muktuk/fat, and Arctic char caught in Nunavik indicated that the PCB content was high in beluga fat (1,002 ng/g, n = 16) compared with the levels found in seal fat (527 ng/g, n = 16) and in Arctic char (152 ng/g, n = 9) (*14*). Similar results were obtained in seal fat from eastern Nunavik (762 ng/g, n = 41) (*32*). In light of these findings, it is surprising that fish and marine mammal consumption during pregnancy was unrelated to maternal PCB body burden in this cohort. The information gathered on traditional food consumption during pregnancy did not necessarily reflect maternal lifetime consumption patterns. Moreover, the changes in traditional food intake reported by a large proportion of these mothers (Table 3) further reduced the likelihood of observing this association. These data suggest that food consumption should probably not be monitored during pregnancy to attempt to identify highly PCB-exposed Inuit women.

Whale fat is the food consumed by Nunavik Inuit and the Faroe Islands populations that is most contaminated by PCBs. Even though the monthly whale fat consumption during pregnancy is remarkably similar in these two groups (Nunavik: 1 meal = 18.0%; at least 2 meals = 37%. Faroe Islands: 1 meal = 18.5%; at least 2 meals = 34.3%), our study failed to confirm the whale fat consumption–blood PCB correlation observed in the Faroe Islands study. One important difference between the Nunavik and the Faroe Islands cohorts was the number of food items responsible for an increased PCB body burden. Although pilot whale is the only significant source of PCB

exposure in the Faroese population who did not eat any other marine mammals, other PCB-contaminated marine mammals are consumed in Nunavik. Another important difference between the two cohorts was related to years of education; 97% of the Faroe Islands mothers had at least 9 years of education (*33*), compared with only 54% of the Nunavik women. It may be more difficult for less educated women to quantify and summarize their food consumption patterns. In fact, consumption of beluga fat/muktuk and blood PCB concentrations calculated only for mothers with at least 9 years of education correlated as expected (r = 0.21), although this association was not significant because the sample size was small (n = 37).

As in the Faroe Islands study, maternal hair Hg concentrations were correlated with consumption of fish and sea mammal meat (*30*). As expected, traditional food consumption during pregnancy was more strongly correlated with hair Hg than with blood Hg concentration, presumably because the hair sample reflects the entire pregnancy, whereas the blood sample primarily reflects more recent Hg intake. Moreover, MeHg, which is the main form of the Hg found in fish, accounts for a larger proportion of Hg in hair than in blood (*8*). Dewailly et al. (*34*) also found an association between blood Hg and traditional food consumption, which was not seen in this cohort. The lower frequency of beluga meat and beluga fat/muktuk consumption in this younger group of Inuit pregnant women may have reduced the likelihood of confirming the association found by Dewailly et al. in older Inuit adults. Methodologic differences regarding the assessment of food consumption (24-hr recall and portion size in Dewailly's study vs. food frequency over a longer period in current study) may also explain this discrepancy. Beluga fat/muktuk consumption was associated with increased maternal blood Se concentrations, a relation also seen in the Faroe Islands population (*30*). In a recent study, of 23 traditional food items consumed by the Nunavik women, beluga meat and skin consumption was the most important source of Se intake, and the contribution of fish and seal consumption to Se intake was about 10 times lower than that of the beluga meat and skin (*35*).

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