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Exposure of the Inuit Population of Nunavik (Arctic Québec) to Lead and Mercury

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ABSTRACT. The authors conducted a survey during 1992 to evaluate blood levels of lead and mercury in Inuit adults of Nunavik (Arctic Québec, Canada). Blood samples obtained from 492 participants (209 males and 283 females; mean age = 35 yr) were analyzed for lead and total mercury; mean (geometric) concentrations were 0.42 μmol/l (range = 0.04–2.28 μmol/l) and 79.6 nmol/l (range = 4–560 nmol/l), respectively. Concentrations of omega-3 fatty acid in plasma phospholipids—a biomarker of marine food consumption—were correlated with mercury (r = .56, p < .001) and, to a lesser extent, with blood lead levels (r = .31, p < .001). Analyses of variance further revealed that smoking, age, and consumption of waterfowl were associated with lead concentrations (r² = .30, p < .001), whereas age and consumption of seal and beluga whale were related to total mercury levels (r² = .30, p < .001). A significant proportion of reproductive-age women had lead and mercury concentrations that exceeded those that have been reportedly associated with subtle neurodevelopmental deficits in other populations.

<Key words: Arctic regions, Canada, Eskimos, food chain, lead, mercury, smoking>

MERCURY AND LEAD are widespread environmental contaminants that originate from both anthropogenic (e.g., mining, smelting, fossil fuel burning, waste incineration) and natural (e.g., local geology, volcanoes, degassing in aquatic environments) sources. In addition to the contribution of local sources, these heavy metals can be transported from distant sources to the Arctic by oceanic and atmospheric transport. Lead and mercury have been found in all components of the Arctic ecosystem.¹ ²

Native people who rely on seafood for subsistence can receive unusually high doses of heavy metals because they are located at a high trophic level of the aquatic food chain, along which biomagnification of persistent contaminants occurs. Few studies have documented lead exposure in Arctic populations. Results from a 1987 survey conducted among Northern Greenland Inuit hunters and their families revealed median blood lead concentrations of 0.46 μmol/l (range = 0.15–1.16 μmol/l) for 35 men and 0.27 μmol/l (range =
Seafood consumption (i.e., ringed seal, narwhal, walrus, and beluga whale) was the likely source of exposure, and age was associated positively with blood lead concentration. In the Faroe Islands, 52 adult women who consumed fish and pilot whale meat had a mean blood lead level of 0.10 μmol/l (range = 0.04–0.17 μmol/l). Mercury is mainly present as methylmercury in fish and marine mammals, and their consumption constitutes an important source of exposure, especially in subsistence populations such as the Inuits. Various surveys have documented the level of mercury exposure in Arctic populations. Analysis of blood samples collected between 1977 and 1982 from 142 Inuits residing in Nunavik (Arctic Québec) revealed a mean blood mercury concentration of 240 nmol/l (range = 21–1,269 nmol/l). Mercury concentrations were associated strongly with consumption of fish and marine mammals. In Nunavut (Eastern Canadian Arctic, formerly part of the Northwest Territories), the mean mercury concentration documented in 286 Inuits between 1972 and 1989 was 97 nmol/l (range = 5–1,000 nmol/l). Mercury concentrations determined in 1982 and 1983 for 76 Dénés from the western part of the Northwest Territories averaged 53 nmol/l (range = 7–332 nmol/l). More recently, the survey conducted by Grandjean et al. among 53 women from the Faroe Islands revealed a mean blood mercury concentration of 60 nmol/l (range = 13–249 nmol/l). In general populations that consume little or no fish or marine mammals, blood mercury values generally exist around 10 nmol/l. For example, a recent survey revealed that blood concentrations in 1,127 healthy American men averaged 10 nmol/l.

In view of the relatively high exposure of the Inuit population of Nunavik to mercury documented in the late 1970s and early 1980s and the lack of data on lead...
exposure, we deemed that a new survey was necessary to (1) obtain data on lead exposure in this population; (2) compare mercury exposure 10 yr later; (3) obtain body burden data in various subgroups of this population, including women of reproductive age; and (4) study in detail the factors modulating this exposure. In this study, we report on the biological exposure to lead and total mercury in 492 Inuit adults from Nunavik and on the associated dietary, life-style, and sociodemographic factors.

Material and Method

Potential participants in this health survey were adults (i.e., ≥ 18 yr of age) who inhabited 400 households that were selected randomly from the 1,378 households located in the 14 villages of Nunavik. The total population at the time of the survey was 7,078. The 14 villages are scattered along the 1,500-km shoreline of Hudson Bay, Hudson Strait, and Ungava Bay, and distances between neighboring settlements vary between 80 and 275 km (Fig. 1). We performed systematic sampling after sorting the survey base by household address to favor a more complete coverage of the territory and to avoid the selection of next-door neighbors. Furthermore, so that each village would be represented, we stratified the sample by village, with quasi-proportional representation of the number of households in each stratum.

Data collection for this survey was achieved between September 17, 1992, and December 1, 1992, by 6 teams, each of which included a nurse and 2–4 Inuit interviewers/interpreters. Informed consent was obtained from all individuals who participated in the survey. After touring each village to inform the population that a survey would be conducted, the interviewers visited each household and asked to speak with a person 18 yr of age or older to complete the identification chart of the survey. With the information thereby obtained, a main respondent was designated, who then completed a household questionnaire. We also administered an individual questionnaire to each participant in the household regarding various topics, including life-style habits, diet, and health problems. Later, we asked participants to attend a clinical visit at the local health center, during which a registered nurse conducted anthropometric measurements and collected blood samples. During a subsequent visit at home, a nurse administered a 24-hr recall to all participants and a food-frequency questionnaire only to women who were neither pregnant nor breast-feeding. Daily intakes of various food items were estimated; participants identified serving sizes, which were presented as plastic models of various sizes that represented traditional food servings.

Laboratory procedures. We used state-of-the-art instrumentation to determine blood lead concentrations with graphite furnace atomic absorption spectrometry (Perkin Elmer, model ZL 4100 [Shelton, Connecticut]). Samples were diluted and injected directly into the instrument. We determined blood mercury concentrations by cold-vapor atomic absorption spectrometry (Pharmacia Mercury monitor [Piscataway, New Jersey]). Samples were microwave-digested with nitric acid, and an aliquot was used for the analysis. We added a stannous chloride/cadmium chloride mixture to the sample to reduce both methyl and inorganic mercury to elemental mercury. Inorganic mercury was measured in 18 samples for which the total mercury concentration was greater than 70 nmol/l. Reduction with stannous chloride alone allowed for selective reduction of inorganic mercury.

We used reference material from the Québec Toxicology Center interlaboratory program (blood samples containing known concentrations of mercury or lead) to verify the accuracy and the precision of analytical methods.8 Duplicates were run every 10 samples. Moreover, 10% of participants provided 2 blood samples, and blind analyses were performed by the laboratory. Matrix-matched (lead) or matrix-free (mercury) calibration was performed daily and reagent blanks were run accordingly. Interlaboratory quality control was secured through Québec Toxicology Center's own program and that of the Centers for Disease Control and Prevention (scores of 100% in 1995, 1996, and 1997, respectively).

Detection limits were 0.05 μmol/l for lead and 1 nmol/l for mercury. The laboratory used 4 reference specimens of 2.8 μmol/l, 2.1 μmol/l, 1.2 μmol/l, and 0.3 μmol/l to calibrate the analytical method for lead, and the corresponding coefficients of variation were 2.4%, 2.9%, 2.3%, and 5.0%, whereas relative biases were +2.0%, +2.2%, –0.8%, and –0.2%, respectively (n = 10). The coefficient of variation was 2%, and the relative bias was –5.5% for the inorganic mercury reference specimen (45 nmol/l; n = 10). The coefficient of variation was 3.2%, and the relative bias was –6.4% for the total mercury reference specimen (90 nmol/l; n = 10). Sixty-one subjects had 2 blood samples analyzed for lead, and Pearson's correlation coefficient between the 2 measurements was 0.996 (p < .001). For mercury, results from 2 separate blood samples were available for 47 participants, and Pearson's r was 0.995 (p < .001).

We used the concentration of omega-3 polyunsaturated fatty acids (N-3 PUFAs) in plasma phospholipids as a biological marker for seafood consumption,9,10 and they were measured by the Lipid Analytical Laboratory at the University of Guelph (Dr. Bruce J. Holub). Plasma samples were extracted with a chloroform/methanol mixture, and the resulting lipid extracts were applied onto thin-layer chromatography plates for isolation of the phospholipid fraction. Following transmethylation, the fatty acid composition of plasma phospholipids was determined by capillary gas-liquid chromatography.

Statistical analysis. Concentrations of heavy metals in blood and fatty acids in plasma phospholipids followed a log-normal distribution. Therefore, we conducted statistical tests on log-transformed values, and geometric means were presented in the descriptive display statistics. Arithmetic means were also displayed; that display facilitated comparisons with results obtained in other surveys. We used weighted values and crude sample sizes to compute means and confidence intervals. We
Blood lead concentration (µmol/l)

Fig. 2. Frequency distribution of lead concentrations in blood samples of 492 Inuits from Nunavik.

Log blood Pb concentration (µmol/l)

Concentration of N-3 PUFA (% plasma phospholipids)

Fig. 3. Correlation between concentrations of lead in blood (log-transformed values) and omega-3 polyunsaturated fatty acids (N-3 PUFA) in plasma phospholipids of 491 Inuits from Nunavik.

designed the weighting scheme to compensate for any distortion introduced by the sampling procedure with regard to the probability of an individual being selected, considering his or her age, sex, and region of residence (Ungava Bay or Hudson Bay/Strait) and the distribution of these variables in the entire Nunavik population.

We used Student’s t test to test for differences in heavy metals concentrations according to dichotomous independent variables (gender or region of residence). We performed one-way analyses of variance to test differences in categorical variables (age, smoking). We used simple correlation analyses (Pearson’s correlation coefficients) to assess relationships between dependent variables and continuous independent variables. We performed analyses of variance to assess multivariate associations between heavy metals blood levels and various sociodemographic, life-style, or dietary variables. These analyses were restricted to women because daily consumption of traditional foods was quantified for this subgroup only. All personal characteristics that were associated significantly with heavy metal concentrations in blood (p < .01) were considered in the model. To be retained in the final model, a variable had to show a statistically significant association (i.e., p ≤ .05) with lead or mercury concentrations in blood.

Results

Of the 382 eligible households, 305 (79.8%) had an eligible respondent who agreed to fill out the identification chart and the household questionnaire; therefore, 766 persons aged 18–74 yr became admissible to the physical examination and biological analyses. Among this group of 766 individuals, 518 (67.6%) agreed to participate in this component of the survey, and blood samples were available for 492 (64.4%) of the eligible participants. The mean age of these participants was 35.7 yr (95% confidence interval [CI] = 33.6, 37.7) for the 209 men and was 35.0 yr (95% CI = 33.5, 36.4) for the 283 women.

Lead was detected in all 492 blood samples, and the
The frequency distribution is shown in Figure 2. The mean (geometric) concentration for the whole group was 0.42 \( \mu \text{mol/l} \) (arithmetic mean = 0.49 \( \mu \text{mol/l} \)), with values ranging from 0.04 to 2.28 \( \mu \text{mol/l} \). Mean blood lead concentrations by gender and age group are shown in Table 1. The mean lead concentration in men (i.e., 0.48 \( \mu \text{mol/l} \)) was 26% higher \((p < .05)\) than that in women (0.38 \( \mu \text{mol/l} \)). Lead concentration was associated with age, as was evidenced by the increasing trend in mean concentrations with age groups seen for both sexes \((p < .001)\). Inuits in the 45–75-yr age group had a mean blood mercury concentration 1.8 times greater \((p < .001)\) than that of younger individuals (i.e., 18–24-yr age group). Smoking was also associated with blood lead levels: mean concentrations were 0.30 \( \mu \text{mol/l} \), 0.40 \( \mu \text{mol/l} \), and 0.43 \( \mu \text{mol/l} \) for never-, ever-, and current-smokers, respectively \((p = .005)\).

One objective of this survey was to investigate the relationship between heavy metal concentrations and dietary habits. In Nunavik, approximately one-half of the population resides in 7 settlements along the Ungava Bay, whereas the other half lives in 7 settlements along the Hudson Bay shore line. People in Hudson Bay communities generally eat more seafood—especially sea mammals and waterfowl—whereas the Ungava Bay population relies more on terrestrial game (e.g., caribou). The mean lead concentration in the 291 participants from Hudson Bay settlements was 0.48 \( \mu \text{mol/l} \), compared with 0.35 \( \mu \text{mol/l} \) for the 201 people from Ungava Bay communities \((p < .001)\). Furthermore, concentrations of N-3 PUFAs in plasma phospholipids—a biomarker of seafood consumption—were correlated weakly with log-transformed blood lead concentrations \((r = .31, p < .001)\) (Fig. 3). We restricted further investigation of dietary sources of lead exposure to women inasmuch as men did not complete the 24-hr recall. Results of dietary surveys are presented elsewhere.

Daily consumption of waterfowl (Canada goose and ducks) was the dietary item that was most highly correlated with blood lead levels \((r = .31, p < .001 [n = 214])\).

To further pinpoint the main factors associated with
lead exposure in this population, we performed analyses of variance, using log-transformed blood lead concentrations as the dependent variable and the independent variables that were found to be associated with lead levels in the univariate analysis. A model that included age (categorical), smoking (categorical), and waterfowl (goose and duck) consumption (continuous) as independent variables explained 30% of the variation of blood lead concentration in Inuit women \( (p < .001) \). All 3 independent variables were associated significantly \( (p < .05) \) with blood lead levels (Table 2).

All 492 samples were analyzed for total mercury, and they contained detectable amounts. The frequency distribution of total mercury concentrations is shown in Figure 4. The mean (geometric) concentration was 79.6 nmol/l (arithmetic mean = 109.3 nmol/l) for the entire sample (range = 4–560 nmol/l). Inorganic mercury concentration was determined in a subsample of 18 individuals with high total mercury concentrations. The mean inorganic concentration was 48.7 nmol/l, which represented 18% of the total mercury concentration in this subsample (264.9 nmol/l). The mean concentrations of total mercury in blood of Inuit participants, by gender and age group, are shown in Table 3. Concentrations of total mercury in men (75.0 nmol/l) were not different from those in women (83.2 nmol/l). Mean total mercury concentrations increased with age in both sexes \( (p < .001) \). The mean value for the older age group (45–74 yr of age) was 2.7-fold greater \( (p < .001) \) than that among young adults (18–24 yr of age). Smoking was not associated with blood mercury concentrations (data not shown).

The mean mercury concentration for Ungava Bay residents was lower than that found in the more traditional Hudson Bay residents (54.6 nmol/l vs. 93.0 nmol/l, respectively; \( p < .001 \)). The 34 non-Inuit participants had a mean mercury concentration of 18.6 nmol/l, compared with 83.1 nmol/l among Inuits—again reflecting the close link between Inuit life-style and exposure to mercury. N-3 PUFA concentrations were correlated moderately \( (r = .56, p < .001) \) with log-transformed blood mercury concentrations (Fig. 5). Among women who completed the 24-hr dietary recall, daily consumption of seal and beluga whale (meat and fat) was the variable most highly correlated with blood mercury concentrations \( (r = .33, p < .001 \) \([n = 213]\)). An analysis of variance further revealed that both age and sea mammal tissue consumption were associated with mercury concentrations in Inuit women \( (p < .001) \), and the resulting model explained 30% \( (p < .001) \) of the variance (Table 4).

**Discussion**

In this study, we aimed to assess mercury and lead exposure in the Inuit population of Nunavik and to identify factors modulating this exposure. Given the large sample size \( (N = 492) \), which represented roughly 10% of the entire adult population in Nunavik, the fairly high participation rate (67%), as well as the weighted sampling scheme used in the present survey, our results should be representative of the whole Inuit adult population from this region of the Arctic. Furthermore, analyses of mercury and lead in blood samples of participants were the object of strict internal quality, as well as interlaboratory controls, thereby providing a high degree of confidence in body burden data documented in the present study.

The median concentration of lead in blood samples from Nunavik adults observed in the present study (i.e., 0.43 μmol/l) was similar to that reported by Milman et al.\(^4\) for 67 adult Greenlanders in 1987 (i.e., 0.39 μmol/l). The mean (arithmetic) concentration was nearly 5-fold greater than the concentrations noted in 53 women from the Faroe Islands\(^4\) and in the general U.S. population during the same time period (i.e., 1991–1994)\(^1\). Moreover, comparisons with concentrations determined in fish eaters from both Canada and the United States during the early 1990s also reveal a relatively high exposure to lead in the Inuit population. Kearney et al.\(^12\) reported a mean blood lead concentration of 4.3 μg/dl among 155 Lake Ontario fish eaters—a level 2.4 times lower than that noted for the 492 Inuit adults in our study (0.49 μmol/l [10.2 μg/dl]). Similarly, Lake Michigan fish eaters also had a lower mean blood lead concentration (3.8 μg/dl) than that of the Inuit population\(^13\).

Blood lead concentrations in the Inuit population increased with age and were higher among men than among women—a result reported previously by others for various adult populations elsewhere in the world.\(^3,14–16\) Lead has a very long half-life and, consequently, the higher concentrations observed in older individuals likely reflect its accumulation with age. Differences in eating habits between age groups may also explain, in part, the association of blood lead levels with age.

Mercury in the form of the organic compound methylmercury is a major contaminant of aquatic food chains. The mean (arithmetic) concentration of total mercury noted in blood samples of the 492 Inuits (109 nmol/l) was 2.2-fold lower than that of 240 nmol/l measured in 142 Inuits from Nunavik between 1977 and 1982.\(^5\) Therefore, mercury exposure appears to have decreased substantially over a 10-yr period in this population. Given that the data on levels of mercury in fish and sea mammals do not suggest decreasing temporal trends,\(^7\) the most likely explanation for the decrease in mercury exposure is a change in the diet (i.e., away from the traditional Inuit diet) of the new generations. Indeed, the mean (geometric) N-3 PUFA concentration in plasma phospholipids of Inuit in the 18–24-yr age group documented in the present survey (6.4% [95% CI = 5.9, 6.9]) was nearly twice lower \( (p < .001) \) than that noted among Inuits in the 45–75-yr age group (12.2% [95% CI = 11.5, 13.0])\(^17\). Nevertheless, mercury exposure in this population remains higher than those encountered during the early 1990s in populations that reside elsewhere in the Arctic.\(^5,5\) For example, the mean concentration observed in women from the Faroe Islands was 60 nmol/l.\(^4\) Differences are even larger in populations that live at more southern latitudes. Comparative data obtained during a 1991 survey that took place in the
Québec City region (analyses performed by the same laboratory that we used in the present study) indicated that 39 (78%) of the 50 adult participants had total mercury concentrations in blood below the detection limit of the analytical method (10 nmol/l). Hence, mean concentrations in the Inuit population were at least 10-fold greater than those found in this population sample from southern Québec.

Various lines of evidence indicate that the traditional diet, which comprises several species from the Arctic aquatic food chain, is partly responsible for the high body burden of lead and mercury in the Inuit population. First, blood concentrations were higher among the more traditional Inuits who live in communities along the shore of Hudson Bay, compared with individuals who reside along the Ungava Bay and whose diet includes increasing amounts of store-bought food. Second, N-3 PUFA concentrations in plasma phospholipids, a biomarker of marine food consumption, were correlated weakly to blood lead concentrations (Fig. 3) and were correlated moderately to blood mercury levels (Fig. 5). Third, daily consumption of marine species was correlated to blood concentrations of heavy metals in Inuit women.

A multivariate analysis further revealed that consumption of waterfowl and cigarette smoking were the main factors that influenced blood lead levels (Table 2). When we included age in addition to these factors, nearly one-third of the variance in blood lead levels was explained. Smoking was previously reported as a determinant of blood lead concentrations. However, the association noted between blood lead concentrations and the consumption of waterfowl was not reported previously in the literature. Lead is neither bioaccumulated nor biomagnified in the marine food web to the same extent as is mercury. Lead has been measured in low concentrations (typically 0.05 μg/gm [wet weight] and, in almost all cases, below 0.4 μg/gm) in various species of fish, marine mammals, and waterfowl. High lead concentrations have been reported occasionally in breast tissue of seabirds when they were killed by lead shot. Additional studies in which measurements of lead-stable isotopes ratios were used suggest that the ingestion of lead shot residues present in birds contributes significantly to lead exposure in Inuits from Nunavik. Other sources of lead exposure common in southern regions (e.g., lead paint, contaminated drinking water) are not encountered in Nunavik.

The best model describing the variation of blood mercury levels (30% of the variance explained) included sea mammal consumption (seal and beluga whale) and age as independent variables (Table 4). Several authors reported an association between sea mammal meat consumption and mercury exposure in Arctic populations. Hansen et al. noted a mean blood level of 62.5 μg/l (312 nmol/l) among Inuit Greenlanders who consumed more than 6 seal meals per week, whereas in the group that ate 1 seal meal or less per week, the mean value was 22.2 μg/l (111 nmol/l). Mercury concentrations increase with trophic levels in the Arctic marine food web, and they reach levels that frequently exceed 0.5 μg/gm (wet weight) in muscle of ringed seal and cetaceans. There are no official recommendations in Canada regarding the acceptable concentration of lead in blood of adults. According to American authorities, blood lead concentrations should not exceed 1 or 1.2 μmol/l. Furthermore, to prevent the occurrence of adverse effects on fetal development, pregnant women should present lead concentrations below 0.5 μmol/l. Blood lead concentrations observed in the course of this survey were on average below these values. Only 5% of the adult Nunavik population displayed lead concentrations equal to or greater than 1 μmol/l, and 2% had concentrations above or equal to 1.2 μmol/l. However, 26% of females in the 18–44-yr age group had blood lead concentrations equal to or greater than 0.5 μmol/l. Nearly 3% had lead concentrations equal to or exceeding 1 μmol/l.

According to recommendations formulated by the World Health Organization (WHO), no more than 5% of individuals in a population should display a methylmercury concentration that exceeds 1,000 nmol/l. Concentrations of total mercury noted in the present study did not exceed 560 nmol/l. In highly exposed individuals, 82% of total mercury was organic mercury (likely methylmercury for the most part). WHO issued more stringent recommendations for pregnant women, stating that not more than 5% of this subgroup should exhibit methylmercury concentrations above 400 nmol/l. In our survey, no women of child-bearing age exhibited concentrations of this magnitude (maximum concentration in the 18–44-yr age group: 397 nmol/l). Nonetheless, even at concentrations below 400 nmol/l, WHO officials warn that subtle neurotoxic effects could be encountered in newborns, and they suggest that research efforts should be stepped up in this area. Recent data from the Faroe Islands suggest that the neurologic status of children can be affected by low-level prenatal exposure to mercury. A modest but statistically significant difference in mean cord blood mercury concentration (2.1 μg/l [10.5 nmol/l]) was observed between 7-yr-old children who performed suboptimally on a finger-opposition test and 7-yr-old children whose performance was deemed normal. Considering the level of exposure to mercury in Inuit women of reproductive age, this study raises the possibility that subtle neurological deficits could be occurring in Inuit children as a result of their prenatal exposure to mercury.

There are, however, major differences between the diet of Faroese and the diet of Inuits, and care must be exerted before one concludes that Inuit children are at risk. Seafood is a good source of selenium (an essential trace element), which provides some protection against methylmercury-induced neurotoxicity in various experimental systems. In the Faroe Islands, the median concentration of selenium in umbilical cord blood was 1.40 μmol/l, and a weak but statistically significant association was noted between selenium concentrations and the number of fish meals consumed per week. Similar median cord blood selenium concentrations of 1.51 μmol/l and 1.14 μmol/l were documented in Norway (Saami) and Russia (Kola peninsula), respectively. However, the median concentration in Nunavik cord blood samples was 3.67 μmol/l—a level 2.4-fold higher than...
that measured in the Faroe Islands. This difference in selenium status likely resulted from mattak (beluga whale skin) consumption, which is part of the traditional diet in Nunavik. Mattak generally contains between 4 and 10 µg/gm of selenium (wt weight) and is the most important source of selenium among all traditional foods in Nunavik. The mean daily selenium intake from traditional foods was estimated at 0.13 mg in Nunavik Inuit women between 18 and 39 yr of age. This unusually high selenium intake may afford protection against methylmercury-induced neurotoxicity.

In summary, results from this survey indicate that lead exposure may constitute a public health problem in Nunavik women of reproductive age. Studies are under way and should better identify sources of lead exposure in this population. Preliminary results indicate that replacing lead shots by steel shots could substantially reduce lead exposure in this population. With respect to methylmercury, a large proportion of women of reproductive age may be at risk as a result of possible fetal toxicity. However, in view of the high selenium intake, which may counteract methylmercury-induced toxicity, local public health authorities did not recommend reducing seafood consumption. A cohort study, which was initiated in 1996, evaluates the potential neurodevelopmental effects associated with methylmercury exposure in this population, while taking into account exposure to other food-chain contaminants (e.g., polychlorinated biphenyls) and nutrients (e.g., selenium, omega-3 fatty acids).

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