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Varying mercury exposure with varying food source in a James Bay Cree community

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Abstract

James Bay Quebec Crees are exposed to methylmercury (MM) through fish consumption. Hair mercury concentrations were measured in women of child-bearing age and men and women 40 years of age and above in a small Cree community of James Bay (with traditionally low exposure to MM) before and after fishing expeditions to inland lakes where fish were contaminated with methylmercury. Median hair mercury concentrations in persons 40 years and above increased from 4.1 mg/kg to 9.9 mg/kg and the highest value from 17.4 to 47.2 mg/kg. A similar increase was seen after a second fishing expedition where the median hair concentration increased from 3.4 mg/kg to 7.2 mg/kg and the highest value from 17.7 to 49.9 mg/kg. Populations with traditionally low exposure to MM can become highly exposed with changes in sources or quantities of fish consumed.

James Bay is in a territory of mid-northern Quebec inhabited by approximately 11,000 Crees living in nine communities (Fig. 1). During the past 20 years there have been several hydroelectric developments in the area. Fish caught in inland lakes and in hydroelectric reservoirs tend to be more contaminated with methylmercury than fish caught along the coast of James Bay (1). As fish still represents a significant part of the Cree diet (2), Crees are more at risk of being contaminated with methylmercury if they fish in the more contaminated areas.

Methylmercury is a known toxin to the neurological system. It causes paresthesias, tremor, incoordination, nystagmus in adults who are exposed (3,4). It causes mental retardation in children exposed in utero (5). Because of the concern about health effects from mercury exposure, the Cree Board of Health and Social Services of James Bay (CBHSSJB) carries surveys in Cree communities on a regular basis and takes hair samples for mercury analysis. These surveys have shown that mercury exposure of Crees varies with their source of fish.

MATERIAL AND METHODS

During the CBHSSJB surveys, Cree men and women 40 years of age and above are sampled. Women of child bearing age (15-39) are also sampled.

Men and women 40 years and over were sampled because earlier surveys done by National Health and Welfare Canada had suggested that mercury exposure was seen mostly in older individuals (6). Women of child bear-

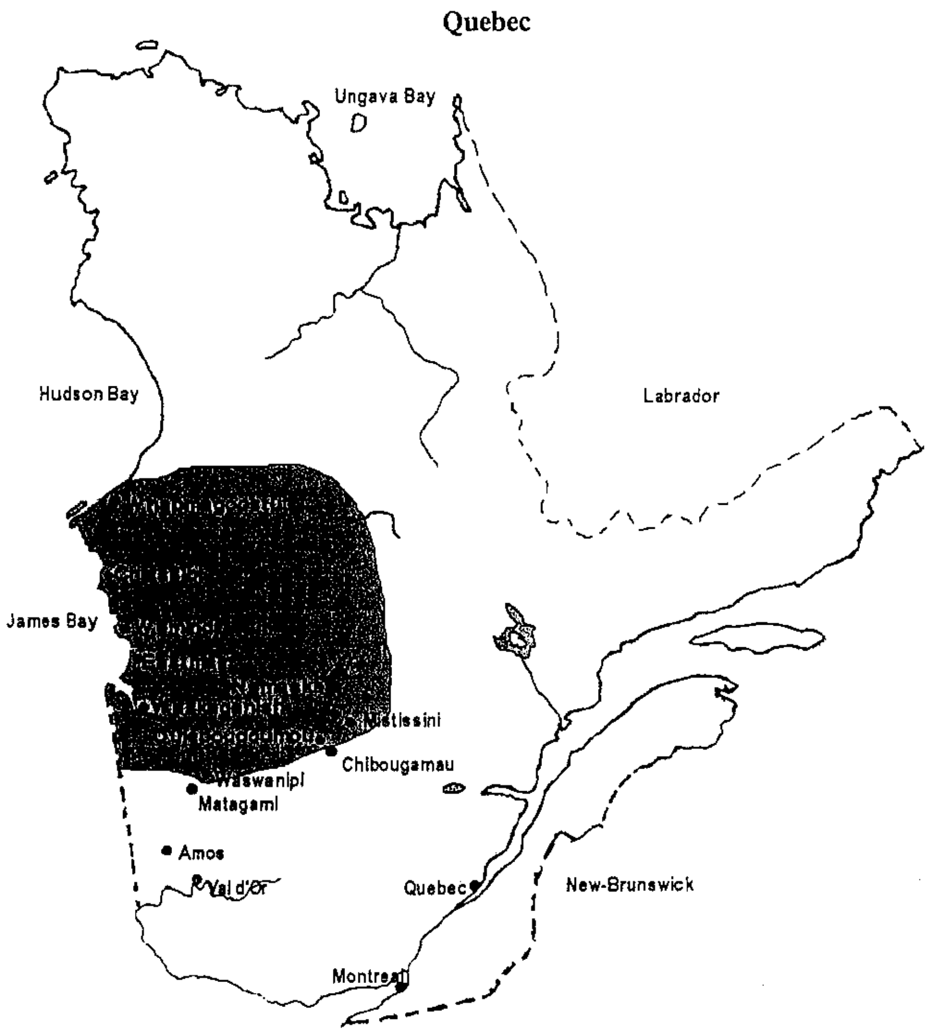

Fig. 1. Map of Quebec. The Cree Territory is located approximately in the shared area.

ing age were surveyed because of the suggestion in the literature that in utero MeHg exposure Mg can be damageable to the foetus at a dose lower than that which affects the adult (5).

Eastmain, a community of 400 persons, along the eastern coast of James Bay has been known as a community with low mercury exposure (7).

During the past two years the population of Eastmain changed twice its source of fish and changes in Hg exposure were noted that were consistent with these changes.

Hair samples were taken in a standardized fashion (8) before and after two fishing expeditions in summer 1992 and fall 1993 in inland lakes where fish is more contaminated by MM from men and women 40 years of age and above and from women of childbearing age. An attempt was made to reach all persons of those age groups belonging to the Eastmain community. Hair Hg was measured in one cm hair segments (corresponding approximately to one month exposure) by atomic absorption at the Laboratoire de santé publique du Québec using the modified method of Magos (9). The detection limit was 2.5 mg/kg. Other methods presently exist that measure hair mercury concentration in shorter segments, but all previous analyses of risk are based on maximums in one cm segments (10).

Hair growth has been assumed to be one cm a month, as in prior studies by others (5, 11). However there are variations in vertex hair growth determined experimentally (between 0.9 and 1.3 cm per month) (12, 13, 14).

Non-parametric statistical methods for comparisons were used as the data was highly skewed, even after log transformation. P-values were calculated using Kruskall-Wallis.

RESULTS

Table I shows the population sampled for each age group and sampling period.

The exposure of Eastmain Crees has been low in the recent past as can be easily seen in the results of a survey done in 1988 (Fig. 2). At that time the median hair Hg concentration was 4.1 mg/kg and the highest value was 17.4 in men and women over 40 (n=80). In women of child-bearing age (between the ages 15-39) the median concentrations was 2.5 mg/kg with a maximum of 5.1 (n=64). A large proportion of the concentrations was 2.5 mg/kg or below, which is the detection limit.

In the summer of 1992 there were many fishing expeditions in inland lakes and large quantities of fish were brought back to the community. The majority of fish caught in these lakes and flown to the community were lake trout (Salvelinus namaycush), pike (Esox lucius) and walleye (Stizostedion vitreum) (10). Those species of fish are predator and are much more contaminated with methylmercury than non-predatory species such as whitefish (Coregonus clupeaformus) or sucker (Catostomus catostomus) (1). This was accompanied by a sizeable increase in Hg exposure as measured by hair mercury concentrations. The median concentration was 9.9 mg/kg and the maximum 47.2 mg/kg for adults 40 years of age and over (n=72). In women of child-bearing age the median was still 2.5 mg/kg, but the maximum was 19.0 (n=70). These values are significantly different from 1988 (Kruskall-Wallis; p=0.001 in both cases). These analyses were repeated for those adults who were sampled both in 1988 and 1992 (n=61). Again the values of 1992 are significantly different from 1988 ($p<0.001$).

Among those persons with hair Hg concentrations of 18 mg/kg and over in August 1992, Hg analysis in segments of hair corresponding to the months prior to August 1992 (in those with long enough hair), showed that hair Hg concentration went up abruptly in August 1992.

During the summer of 1993, fishing expeditions started much later (beginning of August) and went into full swing only during the fall. Fish distribution in the community was extended over a longer period of time and an attempt was made to distribute predatory and non-predatory species more evenly among families (15). Mercury concentrations from hair taken in August were therefore interpreted as being taken before the full effect of these fishing expeditions on Hg exposure took place.

Hair Hg concentrations in August 1993 show a return towards a level close to that seen in 1988, that is prior to fishing expeditions in inland lakes (Fig. 2). Median hair concentrations were 2.5 mg/kg for women of child bear-

Table I. Number of persons samples in each group for each period.

	Aug-1988 s/n*	Aug-1992 s/n	Aug-1993 s/n	Jan-1994 s/n
Women 15-39 yrs	64/93	71/107	71/107	72/96
Men 40 yrs and above	40/44	33/48	38/46	38/48
Women 40 yrs and above	40/42	39/46	45/47	45/48

*s = sampled
n = total number of registered Crees in the group

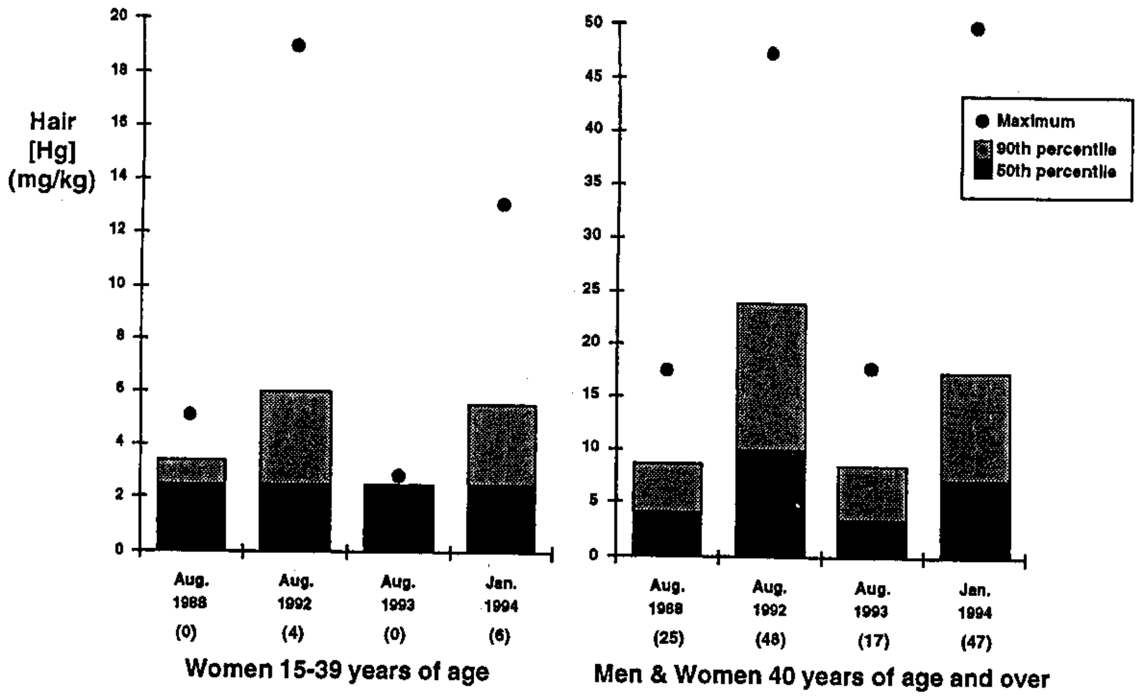

Fig. 2. Variations in mercury concentrations with time. The detection limit is 2.5 mg/kg. Although there is no variation in the median (Hg) for women 15-39 years of age, the 90th percentile and maximum vary considerably. This may represent a small group of women who are more at risk. The number of persons in the group having more than 6 mg/kg is between parenthesis.

ing age and 3.4 for adults 40 years of age and above, and maximums being 2.8 and 17.7 respectively. These are statistically different from the summer 1992 levels ($p<0.001$ in both cases).

Hair samples were taken in late March 1994 when most families were available for testing in the community and the segment of hair corresponding to the month of January 1994 was analysed for Hg concentration. This segment was thought to integrate the effect of the fishing expeditions during the fall 1993. For women of child bearing age the median remained 2.5 mg/kg, but the maximum went up to 13.1 (n=72). For adults 40 years of age and above the median concentration was 7.2 mg/kg and the maximum 49.9 (n=83). These concentrations are significantly different from August 1993 ($p<0.001$ in both cases), and from August 1992 ($p=0.03$ in both cases).

DISCUSSION

During the past 20 years the Crees have experienced changes in their lifestyle, with the new roads, television, regular air routes, flooding of traditional hunting grounds by hydro-electric reservoirs, etc. However fish still represents an important part of Cree diet (2).

Fish caught in hydro-electric reservoirs and certain inland lakes is generally more contaminated with methylmercury than fish caught along the coast of James Bay. For instance in the Eastmain River estuary the mean concentration of mercury in lake whitefish (Coregonus clupeaformis) was 0.12 mg/kg when it was measured in 1984 and it was 0.48 in the Opinaca reservoir which is the closest reservoir to the Eastmain community (16).

Northern Pike (Esox lucius) found in natural lakes is also contaminated by mercury (mean concentration of mercury in a 700 mm pike from natural lakes=0,61 mg/kg). It is even more contaminated in the reservoirs (mean concentration in a 700 mm pike from Opinaca reservoir=2.28 mg/kg) (2).

The significance of these concentrations is better understood in the light of the maximum allowable concentration for commercial fish in Canada, which is 0.5 mg/kg.

Since fish is an important part of their traditional diet, the Crees are more at risk of being exposed to mercury if the fish that they eat is contaminated by mercury.

Hair Hg concentrations observed in the recent years in Eastmain are consistent with changes observed in fishing patterns. Hair Hg concentrations went up when contaminated fish was brought to the community. They went back down a year later, but went back up when there was a second period of fishing expeditions in inland lakes. The second time (in January 1994) the concentrations were not as high as in the summer 1992. This was attributed to a slightly different pattern of distribution of fish in the community where there was a more even mix of predatory and non-predatory species given to the families.

The threshold values above which a neurological effect due to methylmercury appears are uncertain (17). The World Health Organisation recommends a maximum exposure of 6 mg/kg but the threshold is probably between 50 and 100 mg/kg for a subacute exposure (18). Data from the Iraq epidemic of 1971 would suggest a threshold of between 13 and 37 for in utero exposure, but there is considerable uncertainty about this, as the original data shows few cases with abnormalities at these concentrations (19). At these low concentrations, Iraqi children had experienced mild delay in walking.

The significance of the observed rise in hair mercury concentration for the health of the Eastmain population is not defined. The evidence for health effects of a subacute exposure to doses leading to a hair Hg concentration of less than 50 mg/kg is weak. However there may be undefined effects from repeated yearly seasonal exposures over decades to lower doses of methylmercury.

Hg exposure of a population can change very rapidly with changes in fishing patterns and fish distribution patterns. Health authorities must be alert to the fact that populations which traditionally have had a low exposure to mercury may become highly exposed when their source of fish or the quantities of fish change for whatever reason, be it socio-economic reasons, ease of access to contaminated sites by new roads, restriction of other food types because of wild game cycles, or economic conditions which place a greater reliance on fish as a food source.

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References

1. Verdon R et al. Évolution de la concentration en mercure des poissons du complexe La Grande in Les Enseignements de la Phase I du Complexe La Grande. ACFAS, Sherbrooke, Québec 1990.
2. Weinstein M, Penn A. Mercury and the Chisasibi Fishery. Cree Regional Authority, Val d'Or Quebec, 1987.
3. Tsubaki T, Irukayama K. Minamata Disease. Kodansha Ltd, 1977.
4. Bakir F, Damluji SF, Amin-Zaki l, Murtadha M, Khalidi A, et al. Methylmercury poisoning in Iraq. Science 1973; 181(96):230-41.
5. Marsh D, Myers GJ, Clarkson TW, Amin-Zaki

L, Tikriti S, et al. Fetal methylmercury poisoning: Clinical and toxicological data on 29. Ann Neurol 1980; 7 (4):348-353.
6. Wheathly B. Methylmercury in Canada. National Health and Welfare Canada, Ottawa, 1979.
7. Kosatsky T. James Bay Methylmercury Program: Human Exposure to Methylmercury 1989. Cree Board of Health and Social Services of James Bay, Chisasibi, Quebec 1991.
8. Noël F. Manuel de Surveillance de l'Exposition au Mercure Méthylique. Mercury Programme. Cree Board of Health and Social Services of James Bay, 1989.
9. Farran JP, et al. A Improved cold Vapor Atomic Absorption Technique For The Micro Determination For Total and Inorganic Mercury in Biological Samples. J Anal Toxicol 1981; 5: Jan.-Feb.
10. Dumont C. Exposure of Eastmain Crees to Methylmercury, Cree Board of Health and Social Services of James Bay, Chisasibi, Quebec, 1993 March.
11. Kjellström T, Kennedy P, Wallis S, Stewart A, Friberg L, et al. Physical and Mental Development of Children with prenatal Exposure to Mercury from fish, stage 2. National Swedish Environmental Protection Board Report 3642.
12. Barman JM, Pecoraro V, Astore I. Method, Technic and Computations in the Study of the Tropic State of the Human Scalp Hair. J Invest Dermat 1963; 42: 421-425.
13. Munro DD. Hair Growth Measurement Using Introdermal Sulfur 35 Cystine. Arch Dermat 1966; 93:119-122.
14. Saitoh M. Rate of Hair Growth in "Hair Growth", Montagna W and Dobson RL, 1967; 183-201.
15. Dion R, Cheezo D. A preliminary Report on the Eastmain Fisheries Operations 1993: Cree Regional Authority, Val d'Or, 1994 February.
16. Société d'énergie de la Baie James. Evolution du Mercure dans la Chair des Poissons. Réseau de Surveillance écologique du Complexe La Grande 1978-1984, 1985.
17. Kosatsky T. Uncertainty About the LOEL for Methylmercury in Fish-Eating adults, Abstracts of the twelfth international neurotoxicology Conference: Neurotoxicity of Mercury: Indicators and Effects of Low-level exposure. Hot Springs 1994.
18. World Health Organization. Environmental Health Criteria 101. Methylmercury, 1990
19. Marsh DO, Myers GJ, Clarkson TW, Amin-Zaki I, Tidriti S, et al. Dose Response Relationship for Human Foetal Expsosure to Methylmercury. Clin Toxicol 1981; 18(11):1311-8.

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