



Signs and symptoms of methylmercury contamination in a First Nations community in Northwestern Ontario, Canada



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HIGHLIGHTS

- Similarities between the prevalence of complaints in Minamata and Grassy Narrows
- Similarities in neurological findings were also found.
- Quantitative sensory measurements gave similar results for impairments.
- Younger Canadians were less severely affected than older ones.
- Results suggest that subjects from Grassy Narrows had methylmercury poisoning.

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ABSTRACT

In 1970, fish caught in the English–Wabigoon River system in northwestern Ontario, Canada, were found to be contaminated with mercury coming from a chlor-alkali plant in the province. In the 1970s, patients exhibiting some of the symptoms of the Hunter–Russell syndrome (e.g. paresthesias, visual field constriction, ataxia, impaired hearing, and speech impairment) were reported by some researchers. However attempts to diagnose the patients as suffering from methylmercury poisoning proved to be controversial. In order to research the presence of methylmercury contamination, and show that the patients, through eating contaminated fish, were suffering from methylmercury poisoning, we studied the results of subjective complaints, neurological findings, and quantitative somatosensory measurements gathered in Grassy Narrows Indian Reservation, Ontario, in March, 2010. At that time, the population of the Grassy Narrows settlement was around 900. Ninety-one residents volunteered to be examined. From them, we selected 80 people who were older than 15 years old, and divided them into two groups. Canadian Younger (CY): 36 residents who were from 16 to 45 years old. Canadian Older (CO): 44 residents who were from 46 to 76 years old. We compared them to Japanese Exposed (JE): 88 methylmercury exposed residents from the Minamata district in Japan, and Japanese Control (JC): 164 control residents from non-polluted areas in Japan. Complaints and abnormal neurological findings were more prevalent and quantitative sensory measurements were worse in the two Canadian groups and the Japanese Exposed group than in the Japanese Control group. Complaints, neurological findings and quantitative sensory measurements were similar in Canadian Older and Japanese Exposed. The results for Canadian Younger fell between those of Canadian Older and Japanese Control. These findings indicate that the clinical signs and symptoms of the residents of Grassy Narrows are almost the same as those recorded for Minamata disease in Japan.

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1. Introduction

Since the 1960s, a chlor-alkali plant had been releasing waste products contaminated with mercury into the waters of the English–Wabigoon River system in northwestern Ontario, Canada. In the first examples of fish, from the river system, that were contaminated with methylmercury (Bligh, 1970) levels of up to 16 µg/g were reported. Fimreite and Reynolds (1973) found highly contaminated fish with a maximum

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methylmercury concentration of 27.8 $\mu\text{g/g}$ in 1970. The contamination in fish there was almost equal to that measured in fish from Minamata Bay, Japan, where a barracuda was recorded as having 23 $\mu\text{g/g}$ in May 1961 (Fujiki and Irukayama, 1979). The average mercury concentrations, measured in 1971, in walleye and northern pike from Ball Lake, English–Wabigoon River, were 1.99 $\mu\text{g/g}$ and 5.05 $\mu\text{g/g}$ respectively (Armstrong and Scott, 1979).

In 2003, results of similar measurements were 0.40 $\mu\text{g/g}$ in walleye and 0.85 $\mu\text{g/g}$ in northern pike (Kinghorn et al., 2007). The concentrations of mercury in fish are declining, but they are still higher than those found in fish in Minamata Bay, Japan, where the average concentration of mercury in fish has been from 0.17 to 0.42 $\mu\text{g/g}$ during the period of 1998–2004. (Kindaichi and Matsuyama, 2005). Residents living in that area of Japan, still continue to be exposed to low levels of mercury from the eating of locally caught fish.

The two First Nations' communities living in Grassy Narrows and Whitedog Indian Reservations became victims of methylmercury poisoning through the consumption of locally caught fish. Patients with some of the Hunter–Russell syndrome symptoms have been reported in these reserves (Harada et al., 1976). Canadian researchers also examined the indigenous residents of the areas. Wheatley et al. (1979) reported that effects associated with methylmercury poisoning were observed, but they concluded that direct impacts on human health were difficult to prove.

Pathological studies of a cat from Whitedog, which exhibited acute neurological symptoms, revealed high mercury levels in the brain similar to those of Minamata disease in Japan (Takeuchi et al., 1977). Another cat from neighboring Grassy Narrows showed no symptoms, but on closer examination it was shown to have high mercury levels in the brain and latent defects caused by methylmercury poisoning (Takeuchi et al., 1977).

Since 2004, more than 60,000 people from the Minamata district have been diagnosed with abnormal neurological symptoms. In many cases, the abnormalities were being reported for the first time since the release of methylmercury contaminated wastewater was stopped in 1968 (Takaoka et al., 2009). In chronic methylmercury poisoning the somatosensory disturbance from cortical damage is specific and sensory disturbance is present either in all four limbs or throughout the body, sometimes with the exception of the face and head. To detect such abnormalities, quantitative sensory measurements are useful (Takaoka et al., 2008). So we carried out a health survey that included the examination of subjective complaints, neurological symptoms, and quantitative sensory measurements in Grassy Narrows, Ontario, Canada, in 2010 and tried to reassess the effect of methylmercury in this area.

2. Materials and methods

2.1. Subjects

The study was carried out in March 2010 in Grassy Narrows, Ontario, Canada. We contacted a Grassy Narrows support group and asked for their help. They informed the indigenous population of our coming survey to detect any health effects from methylmercury poisoning and asked for volunteers to take part in the study. The Chief of Grassy Narrows First Nation went on the local radio to ask for volunteers for our research. Posters, informing of our coming research project and our wish for volunteers, were displayed in the band office and a local store. Of the approximately 900 residents, 91 volunteered to be examined. We selected 80 residents, who were older than 15, for the study. Subjects were informed verbally and in writing about the examination method, how the data would be used and that their confidentiality would be protected. Each participant gave their written consent.

We divided them into two groups. (1) Group Canadian Younger (CY): consisted of 36 residents who were from 16 to 45 years old (M/F = 18/18, 34.4 \pm 9.5 years old). (2) Group Canadian Older

(CO): consisted of 44 residents who were from 46 to 76 years old (M/F = 19/25, 57.5 \pm 8.1 years old).

We studied subjective symptoms, neurological findings and carried out four quantitative sensory measurements (including minimal tactile sensation, vibration, position sense, and two-point discrimination) among the 80 residents. In order to assess the state of health of the residents of Grassy Narrows, we compared them to a group of Japanese residents who had also been exposed to methylmercury as well as a group of Japanese control residents. These residents were the same people we had used as subjects in our previous study (Takaoka et al., 2008).

(3) Group Japanese Exposed (JE): was comprised of 88 randomly selected Japanese subjects. They were chosen from residents of the Minamata area who had been exposed to methylmercury and who had been included in our former study at the Minamata Kyoritsu Hospital and the Kyoritsu Neurology and Rehabilitation Clinic between November 2004 and April 2005. Their ages matched those of the corresponding Canadian group but the genders could not be matched exactly (M/F = 38/50, 59.0 \pm 7.5). They answered a detailed questionnaire and were given a neurological examination including the same four quantitative sensory measurements as we performed in Canada. All of them were born before 1969. In our former study, we separated the subjects into those with and without neurological or neurologically related diseases, but we found that there was little difference between those two groups. So in this study, Group JE included subjects both with and without such related diseases.

(4) Group Japanese Control (JC): consisted of 164 residents who lived in other districts, e.g. around Fukuoka City, Kumamoto City, and Kagoshima City, aged between 40 and 79. In the control group, people who had lived around Minamata City or who suffered from a neurological disease or a neurologically related illness were excluded. The control subjects were examined between February and May 2006 (M/F = 67/97, 58.4 \pm 11.6).

2.2. Epidemiological conditions and questionnaire on complications

The questionnaire, both in Canada and Japan, included questions to determine the subject's exposure to methylmercury and asked for information regarding place of residence, dietary habits, occupational history, medical complications and the health and medical histories of family members.

The questionnaire on complaints for the Canadian groups (CO and CY) consisted of 47 questions related to sensory impairment (7 items), somatic pain (4), visual impairment (3), hearing impairment (3), tasting and smelling problems (3), in-coordination of the extremities (4), other movement impairment (11), vertigo and dizziness (4), general complaints (2), and mental and intellectual problems (6).

The questionnaire on complaints for the Japanese groups (JE and JC) consisted of about 50 questions. We selected 35 relevant questions from the Japanese questionnaire and used them in the Canadian one. They were as follows: sensory impairment (4 items), somatic pain (3), visual impairment (3), hearing impairment (3), tasting and smelling problems (3), in-coordination of the extremities (5), other movement impairment (4), vertigo and dizziness (4), general complaints (2), and mental and intellectual problems (4).

In answer to questions on health complaints, subjects were asked to select one of 4 possible choices. 1) Yes, always, 2) Yes, sometimes, 3) Yes, in the past but not at present, and 4) No, never. The prevalence of each complaint was calculated for each group and then compared between the four groups. All subjects completed the questionnaire before their medical examination. Subjects who could not complete the questionnaire by themselves were asked the questions verbally. All questionnaires were reviewed prior to the examinations.

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