Summary report on the *Nituuchischaayihtitaau Aschii* Multi-Community Environment-and-Health Study

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Let's learn about our land
Let's learn about ourselves

Conseil Cri de la santé et des services sociaux de la Baie James
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Cree Board of Health and Social Services of James Bay

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Public Health Report Series 4 on the Health of the Population
Cree Board of Health and Social Services of James Bay

September 2013
(Revised 10-02-15)

Summary report on the *Nituuchischaayihtitaau Aschii* Multi-Community Environment-and-Health Study

Chisasibi

Eastmain

Mistissini

Nemaska

Oujé-Bougoumou

Waskaganish

Waswanipi

Wemindji

Whapmagoostui

Conseil Cri de la santé et des services sociaux de la Baie James
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The research protocol for the project was reviewed by a committee of peer researchers especially set up by the Fonds de recherche du Québec–Santé (FRSQ). Our work was made possible through major funding provided by the Niskamoon Corporation, as well as through various in-kind contributions from the Cree Board of Health and Social Services of James Bay (CBHSSJB) and the academic institutions of the project leaders, namely: Axe santé des populations et pratiques optimales en santé, Centre de Recherche du CHU de Québec (SPPOS-CHU), McMaster University (Hamilton, ON), and the Centre for Indigenous Peoples' Nutrition and Environment (CINE) at McGill University.

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Contents

ABOUT THE STUDY

Objectives

This report is one of a series of eight based on the *Nituuchischaayihtitaau Aschii* study. The seven other reports present information for individual communities. Their purpose is to allow health personnel and decision-makers in each community to see the results of the *Nituuchischaayihtitaau Aschii* study for their particular community. This eighth report completes the series by providing a regional overview of the findings. It is intended for staff who work on region-wide programs, and for other interested parties.

The *Nituuchischaayihtitaau Aschii* ("Learn about us and our earth") studies look at how the environment and way of life in *Eeyou Istchee* affect people's health. The studies look at:

- How often people hunt, fish, and eat traditional food, and what this means for their nutrition, their exposure to various contaminants, and their risk of catching illnesses carried by animals (zoonoses);
- What "western" foods people are eating, and what this means for their nutrition and risk of developing illnesses like diabetes and heart disease;
- Where people are getting their drinking water, and how this affects their risk of contracting various water-borne illnesses.

In short, the studies look at the intricate relationship between the environment, hunting and eating habits, and health outcomes. This information helps the Cree Health Board to address people's concerns about contaminants and assist them in making good food choices. It also helps the Board set priorities for health services (CBHSSJB, 2012). Beyond this, the studies had a related objective: to build local capacity in environmental sciences, through communication and training activities.

Origins of the project

Nituuchischaayihtitaau Aschii is in fact a series of similar or identical studies that were carried out in seven communities of *Eeyou Istchee* over the years 2005 to 2009. The studies originated in concerns about mercury levels linked to construction of the hydroelectric dams in *Eeyou Istchee*. The first *Mercury Agreement* between the Grand Council of the Crees and Hydro-Québec was signed in 1986. This agreement provided funds to study and monitor mercury levels in fish. It was followed by a second *Mercury Agreement* in 2001, in connection with construction of the Eastmain and Rupert River Diversion Project. By the time of this second agreement, all parties had realized that the issue of mercury in fish is two-edged: eating fish contaminated with mercury can pose a health risk, but *not* eating fish also poses a risk – in this case, a risk of poor nutrition. When people reduce their fish consumption, they lose the nutritional benefits of fish; and if they substitute "junk" foods instead, their nutrition is further compromised. Consequently, the 2001 *Mercury Agreement* set aside funds for two related purposes:

- To provide technical information to support Public Health Authorities in their efforts to manage the risks associated with human exposure to mercury; and
- To restore and strengthen Cree fisheries, in line with Cree aspirations and needs.

About the same time the 2001 *Mercury Agreement* was signed, concerns about exposure to contaminants from mine tailings in Oujé-Bougoumau (using Nemaska as a control) led to a study of a broad range of environmental contaminants. The Cree Health Board's Public Health Department realized that this study addressed many of the same objectives about risk assessment as those set out in the *Mercury Agreement*, and in 2003 and 2004, the seven other Cree communities were consulted about their interest in a study of the health impact of environmental contaminants. The response was positive and, in 2005, a pilot study took place in Mistissini. The study protocol was then revised to reflect what had been learned in the pilot project, and the study was carried out in Eastmain and Wemindji in 2007, in Chisasibi and Waskaganish in 2008, and finally in Waswanipi and Whapmagoostui in 2009. All told, 1,405 people (between 150 and 288 per community) participated. Participants answered questionnaires, provided samples of nails, hair, blood, and urine, and took part in clinical tests for things like bone density.

The research process

The research was carried out by experts in contaminants, nutrition, and health from three universities – Laval, McGill, and McMaster – in collaboration with the Cree Health Board. Consent to carry out the research was obtained from individual participants, and from each community via a Band Council Resolution. The research protocol follows the principles of Canada's *Tri-Council Policy Guidelines* for research involving First Nations (CIHR/NSERC/SSHRC, 2010). A formal Research Agreement signed by the Executive Director of the CBHSSJB and the three universities stipulates that the Cree own the data file from the study, and the Cree and the researchers jointly own any new data created from the basic file. It also specifies that the research results will be shared with communities first, before being presented at scientific forums, and that no community can be named in research publications without its consent.

Reports of the findings

After the study, the researchers and Cree Health Board staff presented the results for each community at a Council meeting or – more commonly – at a local Annual General Assembly. At these meetings, the researchers also distributed pamphlets or booklets describing the main findings.* Besides this, the results have been published in scientific journals, and in three technical reports: one on the results of the Mistissini pilot study (Bonnier-Viger et al, 2007); a second on the results in Eastmain and Wemindji (Nieboer et al, 2011); and a third on the overall results as well as those in the four remaining communities (Nieboer et al, 2013). Readers in search of details about the various laboratory analyses and clinical procedures will find them in these technical reports. The current report is based on the three technical reports cited above, but it omits some details and contains additional background information. Its purpose is to provide decision-makers and health personnel in the territory with a single source that summarizes the results for all seven communities.

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* As of early 2013, these can be found in the "Documents Centre" portion of the Cree Health Board's website, at www.creehealth.org.

METHODS

Study population, sampling methods, and limitations

The complete set of *Nituuchischaayihtitaau Aschii* studies covered seven of *Eeyou Istchee*'s nine communities – Mistissini, Wemindji, Eastmain, Waswanipi, Waskaganish, Chisasibi, and Whapmagoostui – and extended over the years 2005-2009. Oujé-Bougoumou and Nemaska were studied in 2002, in the context of a research project on the health effects of exposure to mine tailings (Dewailly and Nieboer, 2005). That research was very similar to the *Nituuchischaayihtitaau Aschii* study, and the two communities have since given permission for their data to be combined with the *Nituuchischaayihtitaau Aschii* data set. However, the *Nituuchischaayihtitaau Aschii* study includes a larger number of clinical measures (e.g. bone density, heart rate variability, carotid artery ultrasound) and more contaminants (dioxins, furans, and emerging contaminants).

Potential participants were randomly selected from the Beneficiaries List, and the sample size was set with a view to adequately representing the various age-sex groups. In practice, this meant including a minimum of 150 people in each community, and 20-30 in each age-sex group. For purposes of sampling, the age groups were divided into children under 8; children 8-14; adults 15-39; and adults 40 and over. Readers should note, however, that the age groups actually used in the analyses vary somewhat from topic to topic, in order to be compatible with existing research and standards.

The sampling strategy included provisions to replace people who declined to participate. This ensured a sufficient number of study participants, but had some impact on how random the sample was, and thus how well it represents the total population of the region. Readers should bear in mind that the data presented in this report may be affected by sampling limitations, and by issues relating to the design and administration of the various questionnaires. Readers should also recall that numbers derived from a sample always have some margin of error (confidence interval) around them. In this study, because of small communities and sample sizes, those margins of error are often quite large. This can create the illusion of differences between communities that are not true ones. The research team used statistical tests to determine which inter-community differences were truly significant; these are noted in the text where relevant. The final sample sizes in each community are shown in Table 1 below. The data presented in this report are for the participants in the study; they have not been weighted to reflect the total population of *Eeyou Istchee*. Percentages have been rounded in most cases to make the figures easier to read.

Table 1: Sample sizes in each community

Community (month, year of fieldwork)	Population	Invited	Participants	Participation rate (%)
Oujé-Bougoumou (October, 2002)	622	329	225	68%
Nemaska (November, 2002)	616	242	100	41%
Mistissini (June, 2005)	2679	516	288	56%
Wemindji (June, 2007)	1178	301	202	67%
Eastmain (August, 2007)	561	236	150	64%
Waskaganish (June, 2008)	1967	473	176	37%
Chisasibi (June/July, 2008)	3820	702	266	38%
Whapmagoostui (August, 2009)	798	320	161	50%
Waswanipi (Aug/Sept, 2009)	1473	469	162	35%
All nine communities	13714	3588	1730	48%

Questionnaires and measures

The study used a variety of different questionnaires and clinical measures, along with some chart reviews. Participants were offered a small payment to compensate them for their time.

Questionnaire on demographics and lifestyle habits

This questionnaire dealt with socio-demographics (age, language, education), hunting activities, and lifestyle habits such as drinking and smoking.

Measures of diet

Diet was measured in three different ways. Two food-frequency questionnaires asked participants how often they had eaten various traditional food items in the past 12 months and store-bought foods in the past 30 days. Besides this, each participant completed a 24-hour food recall. The results from the 24-hour recall suggest that participants – especially adult men – appreciably understated their true consumption. The analyses based on these recalls must therefore be treated with caution.

Clinical questionnaire on women's health

Women 15 and over were asked to answer a questionnaire about women's health.

Zoonoses questionnaire (diseases acquired from animals)

This questionnaire asked about contact with animals through cleaning, gutting, and skinning, and inquired about the presence of pets in the home.

Chart review for medications and specific health conditions

With consent from the individuals concerned, the project hired a research nurse to review the medical charts of participants aged eight and over. The purpose of this review was to:

- Verify participants' reports of specific diagnoses, such as cardiovascular disease, diabetes, thyroid disease, musculoskeletal and metabolic illnesses;
- Look at past hospitalizations and their causes;
- Look for medications that could mask specific conditions, and thus affect the clinical and lab results (such as medications for hypertension, diabetes, or thyroid problems).

Chart review for zoonoses

A second chart review, completed after the study, looked at infections in the past 5-10 years in participants who had antibodies to specific zoonotic agents: California virus, Q fever, leptospirosis, trichinosis, tularemia, toxoplasmosis, toxocariasis, and echinococcosis.

Tests of water quality

The researchers tested local water sources – and some of the containers used to store water in the home – for various bacteria and parasites. The results from the first three communities (Mistissini, Wemindji, and Eastmain) provided a clear enough picture that these tests were not considered necessary in the remaining communities.

Collection of biological samples

Depending on their age, participants were asked to provide samples of hair, nails, blood, and urine, and to undergo various clinical measures. These tests provided information on nutritional adequacy, health conditions, and an extensive list of contaminants and biological hazards.

Table 2 summarizes the various tests for each age group.

Table 2: Summary of clinical tests by age group

	0-7 years	8-14 years	15+ years
Informed consent form	x	x	x
Individual questionnaire (including zoonoses)		x	x[1]
Clinical questionnaire (women only)			x
Ultrasound bone densitometry (women 35-74 only)			x
24-hour recall and two food-frequency questionnaires		x[2]	x
Blood sampling: contaminants	Lead only	x	x
Blood sampling: clinical biochemistry		x[3]	x
Blood sampling: zoonoses (diseases from contact with animals)			x
Hair sampling	x	x[4]	x
Toenail sampling		x	x
Urine (arsenic, iodine, creatinine, metabolites of contaminants)		x	x
Blood pressure/pulse		x	x
Height, weight, waist/hip circumferences		x	x
Body composition		x	x
2-hour Holter (cardiac monitoring)			x
Carotid ultrasound			x
Oral temperature			x

1. Section on physical activity for participants 15-69; section on zoonoses for participants 18+ in most communities, but 15+ in Eastmain and Wemindji.
2. From 9 years and over
3. Only plasma glucose and insulin, total lipids and fatty acid profile
4. Added arsenic for 8 years and over (third cm)

Source: Nieboer et al. (2013), Tables 2.2A and 2.2.B.

Feedback of results to participants and their doctors

The procedures for notifying individuals and their doctors of any abnormal results were modified after the pilot study in Mistissini. For the remaining communities, feedback procedures were divided into categories as follows:

Table 3: Categories of feedback procedures

Cat.	Procedure	Tests in category
A	Test results that are known immediately, such as blood pressure. If the result was dangerously high, the person was advised to go to the clinic immediately.	Blood pressure Body measurements (height, weight) Temperature
B	Tests that urgently require a referral if the result is abnormal. These cases were discussed by phone with the doctor or head nurse at the clinic; the patient was also notified by phone.	Holter monitor data (heart rate variability) Carotid Doppler (artery blood flow to the brain) Selected zoonotic antibodies
C	Normal and abnormal lab results. Patients were notified by letter of specific lab results, both normal and abnormal. The clinic was also notified by letter of the results, if the patient had so requested.	Glucose & insulin levels Lipids (cholesterol and other blood fats) Heel bone ultrasound Vitamin D Thyroid blood tests Environmental toxins: lead, cadmium, mercury, PCBs Other zoonotic antibodies
D	Results used for research purposes only, in group reports. Not reported to individuals.	Persistent organic pollutants other than those included in category C above Vitamins Apolipoproteins and CRP (markers of heart disease) PFOs (perfluorinated compounds) Selenium Omega fatty acids Others

Source: Nieboer et al. (2013), Table 2.3

These procedures naturally resulted in the local clinicians receiving reports on a variety of contaminants and zoonoses with which they might have been ill acquainted. Consequently, the study team also developed some algorithms to assist clinicians. The algorithms showed at what level specific contaminants become a "concern" (i.e., no imminent threat to health, but the source needs to be identified), and at what level they require immediate action.

Summary: Introduction and Methods

- *The study looked at the relationship between the environment, land-based activities, eating habits, and health in Eeyou Istchee.*
- *Over the years 2005-2009, it measured many different aspects of health (via both questionnaires and physical measures) in seven communities.*
- *Consent was obtained from the communities and from individual participants. A Research Agreement governs ownership of the resulting data. The findings were returned to the communities in presentations (usually at the AGA) and plain-language brochures.*
- *As with any study, there are some methodological issues that may affect the results: in this case, a rather low participation rate in some communities and difficulties with how some of the questionnaires worked in practice.*
- *Due to the small size of the communities and the sample, many of the apparent variations between communities may not be true differences.*

In short, the study was detailed and comprehensive, but not flawless; readers should bear in mind that the results may be affected by methodological limitations.

WEIGHT AND NUTRITION

This chapter assesses the Nituuchischaayihtitaau Aschii results against various international guidelines, all of which define "adult" in different ways. As a result, the age ranges vary slightly from one section to the next.

- *In the section on weight, "child" means 8-19 years, and "adult" is 20 years and over.*
- *In the section on traditional foods, "child" is 9-17 years, "adult" is 18 and over.*
- *In the three segments on adequacy of diet, "child" is 9-18, "adult" is 19 and over.*

Weight

As the way of life in *Eeyou Istchee* has changed over the past several decades, obesity and diseases related to obesity such as diabetes have become major issues. Accordingly, this study measured weight in three different ways:

1. Body Mass Index or BMI (a measure of weight for height)
2. Percentage of body fat
3. Waist circumference

It is clear that a majority of adults – especially women – in all communities are either overweight or obese (greatly overweight). The results also suggest that most children are already overweight, and on a path that will lead them to be overweight or obese as adults.

Physical activity

Response rates to the physical activity questions were low, and not all the data were usable.

The results suggest that "dedicated" walkers (people who walk more than an hour a day, at least six days a week) are lower on all three measures of obesity. There is some indication that adults in Waskaganish walk more often than those in the other six communities (i.e., excluding Oujé-Bougoumou and Nemaska).

Table 4: Percent of men and women in *Eeyou Istchee* who exceeded the standard cut-off points for various measures of weight (all nine communities)

	BMI			Percent of participants with a % body fat that puts them at risk	Percent of participants with a waist circumference that puts them at risk
	Healthy weight	Overweight (BMI ≥25 but under 30)	Obese (BMI of 30 or more)		
	%	%	%	%	%
Women	5.4	17.3	77.3	96.9	91.2
Men	10.4	26.4	63.2	93.5	72.1

BMI = weight in kilograms / (height in meters)^2. BMI cut-offs drawn from WHO (2005); cut-off points for % body fat drawn from Gallagher et al, 1999; cut-off points for waist circumference from WHO (2000), i.e. 88 cm for women and 102 cm for men.

Source: Nieboer et al. (2013), Table 4.1.1

Table 5: Percent of girls and boys in *Eeyou Istchee* who are over the standard cut-off points for various measures of weight (all nine communities)

	BMI			Percent body fat	Waist circumference (cm)
	Healthy weight	Overweight	Obese	Mean±SD	Mean±SD
	%	%	%		
Girls	36.0	17.8	46.2	37.1±9.07	90.6±16.7
Boys	37.0	26.0	37.0	28.2±11.3	90.6±17.6

Cut-off points for BMI as shown in Cole et al (2000).

Source: Nieboer et al. (2013), Table 4.1.2

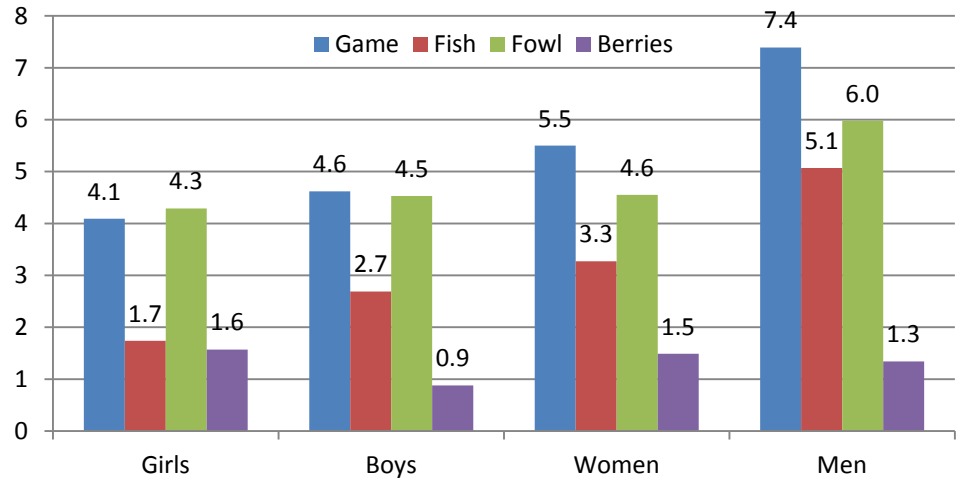
Diet

Traditional foods

What kinds of traditional foods are people eating?

Almost everyone in *Eeyou Istchee* reports eating traditional foods at least occasionally. Moose, beaver, rabbit, geese and land birds (like ptarmigan) and wild berries are eaten by many people in most communities. Apart from this, the communities differ in which traditional foods people eat most often, probably reflecting local availability.

Figure 1: Average number of days per month over the past year that traditional-food eaters in *Eeyou Istchee* eat specific foods (all nine communities)



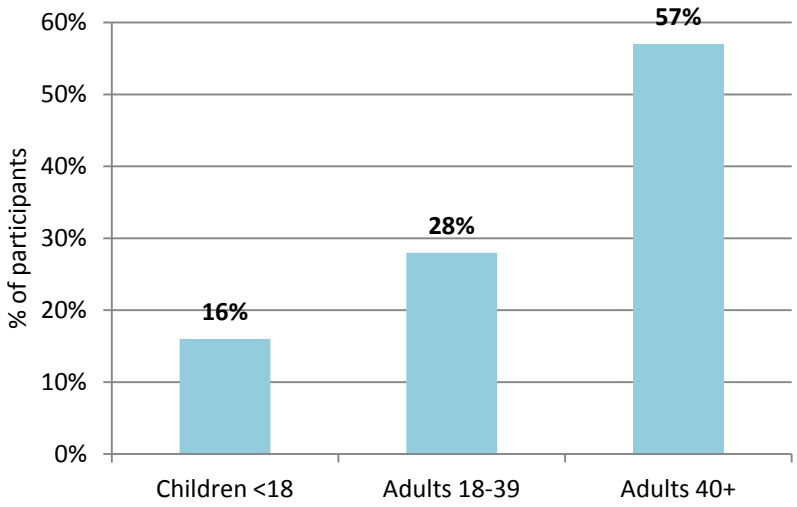
Figures apply only to participants who ate any traditional foods. Data from Nieboer et al. (2013), Table 4.1.5 based on food-frequency questionnaire.

Who is most likely to eat traditional foods?

As shown in Figure 2, older people in *Eeyou Istchee* are more likely than younger adults or children to eat traditional foods: 57% of the older adults in this study had consumed traditional foods in the past 24 hours, while this was much less likely to be true of children or younger adults. This pattern held true in all seven communities studied.

Men were more likely than women to eat traditional foods. Analysis of data for the last four communities showed that time spent in the bush did not correlate with consumption of traditional foods – although between a quarter and a half of participants reported spending a great deal of time on the land (Table 6). This suggests that the amount of traditional food that people eat depends on many factors**,** not just a person's hunting and fishing habits.

Figure 2: Percent of participants who ate traditional foods in the previous 24 hours, by age group: *Eeyou Istchee* (seven communities, 2005-2009)



Source: Nieboer et al. (2013), Figure 4.1.2

Table 6: Number of days spent in the bush, as reported by adult participants (15+ years) in the last four communities studied

Activity	Waswanipi	Whapmagoostui	Waskaganish	Chisasibi
	n (%)	n (%)	n (%)	n (%)
Number of days in bush during the past year				
None	9 (9%)	7 (7%)	34 (32%)	25 (14%)
1-3 days per month	58 (59%)	40 (38%)	47 (44%)	90 (50%)
At least one day a week	32 (32%)	59 (56%)	27 (25%)	66 (37%)

Source: Nieboer et al. (2013), Table 4.1.7

Adequacy of diet

How adequate are people's diets? The researchers used data from the 24-hour food recall to look at this issue through three different lenses. First, they looked at macronutrients – how much fat, protein, and fibre participants were eating, and how this compared to recommended intakes. Next, they zeroed in on specific vitamins and minerals (micronutrients), asking if participants were getting enough Vitamin A, folic acid, iron, and so forth for their age. Finally, they compared people's eating habits to the Canada Food Guide recommendations. The following sections show the results through each of these three lenses in turn.

Dietary guidelines vs the traditional diet

Historically, the Cree seem to have lived healthy lives on a diet that contained few or no vegetables and grains. This raises real questions about the applicability of "western" dietary guidelines in the Cree context. However, since most Eeyouch now rely at least partly on store-bought foods, it seemed reasonable to apply the standard guidelines in this study.

Adequacy of diet as judged by intake of fats, protein, and fibre (macronutrients)

The foods we eat give us energy – which we use to breathe, move around, and repair our bodies. In this part of the study, the researchers looked at what proportion of people's daily energy intake was derived from fats, protein, and fibre. They also looked at how many children and adults fall above or below the recommended values for these things.

Table 7 below shows the results for intake of various types of fats. Overall, participants in *Eeyou Istchee* derived about 32-38% of their energy from fats in general, and 11-12% of their energy specifically from saturated fats. Fats derived from traditional foods generally accounted for a small proportion of this total.

How does this compare to recommended intakes? The U.S. Institute of Medicine (IOM) recommends that adults obtain 20-35% of their energy from fat, and children 25-35%. A majority of adults in *Eeyou Istchee* surpassed this guideline; although the proportions varied somewhat between the communities, overall about two-thirds of adults exceeded the guidelines. For children, the results varied a lot more from one community to the next.

Until recently, Canadian guidelines suggested that saturated fat account for no more than 10% of energy intake. People in *Eeyou Istchee* generally exceeded this guideline. Across the seven communities, more than 78% of participants of all ages exceeded the ten-percent guideline (Table 7). More recent guidelines from the IOM suggest that people eat as little saturated fat as is consistent with a nutritionally adequate diet (IOM, 2005).

Table 7: Proportion of energy derived from fat in *Eeyou Istchee*, for the seven communities in the study, 2005-2009

		% of energy intake that is derived from various types of fat (Mean ±SD)			How these percentages compare to dietary guidelines*	
	n	All types of fat	Fat from traditional foods	Saturated fat	% of pop'n above guideline for total fat intake	% of pop'n above guideline for saturated fat intake
Girls	150	32.4±9.13	1.66±4.78	10.8±4.09	14.1±42.3	81.4±325
Boys	157	33.6±9.98	1.39±5.46	11.0±4.08	21.1±60.5	79.0±67.5
Women	477	36.7±10.2	2.93±7.13	11.3±3.87	67.2±9.82	81.6±15.1
Men	333	38.2±9.53	3.62±7.73	11.7±3.89	71.3±6.70	85.4±15.3

*The guideline for total fat intake is to the Institute of Medicine's "Acceptable Macronutrient Distribution Range" AMDR, which suggests that adults obtain 20-35% of their energy from fat, and children 25-35%. The comparison for saturated fat intake is to an older Canadian guideline that suggests that at most 10% of energy should come from saturated fat.

Source: Nieboer et al. (2013), Table 4.1.9

Intake of fibre appears to be low throughout *Eeyou Istchee*: it was low among participants in all seven communities, all age groups, and both sexes. All told, 99-100% of participants were judged to have insufficient intake of fibre (Table 8). In contrast, the results for protein are positive. Protein intake is similar across the various communities, and fewer than 1% of participants – of any age – got less than the recommended amount.

Table 8: Fibre intake in *Eeyou Istchee*, seven communities, 2005-2009

	n	Mean intake (in grams) ±SD	% of pop'n with insufficient intake*
Girls	150	12.0±7.61	99.9
Boys	157	13.0±9.05	100
Women	477	11.9±7.23	98.9
Men	333	13.1±8.60	100

* Adequate intake as defined by the Institute of Medicine's Dietary Reference Intakes (2000)

Source: Nieboer et al. (2013), Table 4.1.9

Adequacy of diet as judged by intake of vitamins and minerals (micronutrients)

- **Vitamin A**: Vitamin A is an antioxidant needed for many purposes, including vision, bone growth, reproduction, and immunity. It is found in colourful fruits and vegetables, in liver, and in whole milk. Vitamin A intake seems to be low in residents of *Eeyou Istchee*: in the four most recently surveyed communities (Waskaganish, Chisasibi, Whapmagoostui, and Waswanipi), nearly a third of all adults fell below the recommended intakes (Table 9).
- **Folate**: Folate is needed for healthy red blood cells, and plays a part in preventing anemia. It is especially important for women who are (or might become) pregnant, as it seems to help prevent malformations of the baby's spine and brain – particularly neural tube defects like spina bifida and anencephaly. The usual sources of folate are leafy vegetables or fortified cereals and bread; women of childbearing age may also be prescribed folate supplements. In *Eeyou Istchee*, the Maternal and Child Health Program has an explicit policy of prescribing folate to all pregnant women, and of encouraging supplements among women who might become pregnant. Across the seven communities in the study, anywhere from 0 to 47% of participants reported diets that provide less folate than is considered optimal.
- **Vitamin C**: This antioxidant is important for healthy skin, bones, and connective tissue; it promotes healing and helps the body absorb iron. Vitamin C is found in many fruits and vegetables, and in some meats such as liver. In many communities at least one person in four ingested less vitamin C than recommended. (This seemed to be particularly true of men.)
- **Vitamin D**: This vitamin is needed for bone health, and also plays a role in maintaining healthy nerve, muscle, and immune systems. Although our bodies make vitamin D in response to sunlight, people living in northern areas need to get most of their supply through food or supplements. Vitamin D is added to milk in Canada, and is also found in egg yolks, some saltwater fish, and liver. The recommended amount of vitamin D has recently been revised upwards, and many Canadians fall short of the new guideline. This also holds true in *Eeyou Istchee*: in the last four communities, at least half of participants did not consume enough vitamin D to meet the new standard.
- **Calcium**: Calcium is needed for healthy bones and teeth, and to prevent osteoporosis (loss of bone density) in older women. It is found in milk products and in some vegetables, nuts, and beans. More than half of participants in *Eeyou Istchee* consumed less than the recommended amounts of calcium.
- **Iron**: The body uses iron to produce red blood cells, so a lack of it can lead to iron-deficiency anemia (too few red blood cells). Sources of iron include game, other red meats, poultry, fish, leaf vegetables, fortified bread, and fortified cereals. In contrast to the other micronutrients, intake of iron appears to be high among *Eeyouch*: no men, and only a tiny proportion of women, ingested less than the

recommended amounts. (This is consistent with the finding that most participants were eating enough meat.)

- **Magnesium**: This mineral is essential to a large number of body processes. It also protects against hypertension, and may play a role in preventing Type 2 diabetes (Champagne, 2008). It is found in vegetables (especially leafy greens), nuts, cereals, coffee, tea, and cocoa. The results suggest that large proportions of people in *Eeyou Istchee* do not ingest foods that would provide the recommended amounts of magnesium. Because of the links to hypertension and diabetes, it is worth acting on this finding.
- **Zinc**: Zinc is needed for the immune system, and for our sense of smell and taste. High-protein foods – especially beef, pork, and lamb – are good sources, as are whole grains and nuts. (Fruits and vegetables are not good sources of zinc.) In *Eeyou Istchee*, almost all adults seem to have a sufficient intake of zinc in their diets.

Table 9: Percent of adult participants in each community whose daily intake of various vitamins and minerals is below the recommended* amounts (as reported on the 24-hour food recall)

				% with less than recommended intake													
	Age	Recommended intake		Chisasibi		Eastmain		Mistissini		Waska-ganish		Waswanipi		Whapma-goostui		Wemindji	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Vit A (RAE)		625	500	62	45	30	31	na	na	40	62	33	54	58	37	60	55
Folate (DFE)		320	320	25	16	19	17	3	47	15	9	8	9	14	13	5	0
Vit C (mg)		75	60	45	27	35	24	41	3	30	13	22	9	47	35	60	20
Vit D (µg)		10	10	71	80	na	na	na	na	60	80	72	85	72	54	na	na
Calcium (mg)		800-1100	800-1100	74	84	na	na	na	na	55	82	58	87	67	76	na	na
Iron (mg)	19-50	6	8.1	0	5	0	6	na	2	0	4	0	6	0	5	0	4
	51+		5	0	0	0	0	na	0	0	0	0	0	0	0	0	0
Magnesium (mg)	19-30	330	255	60	74	70	58	93	29	50	40	50	43	75	33	85	55
	31+	350	265	76	46	86	31	100	42	63	40	50	34	75	53	75	40
Zinc (mg)		9.4	6.8	12	5	0	5	3	4	8	0	0	2	17	0	1	6

* Estimated Average Recommendations (EAR), Acceptable Macronutrient Distribution Range (AMDR) or Adequate Intake (AI), as defined by the IOM's *Dietary Reference Intakes*.

Percentages have been rounded.

Sources: Nieboer et al. (2013), Tables A7.3.1 and A7.3.2; Nieboer et al. (2011), Tables 5.2.5, 5.2.6 and 5.2.7; Bonnier-Viger et al. (2007), Tables 5.2.5 and 5.2.7.

Recall that figures based on samples have a margin of error around them. This should be considered when comparing differences between communities or between men and women.

Adequacy of diet as judged by Canada Food Guide recommendations

As shown in Table 10, participants in *Eeyou Istchee* were getting enough animal foods, which provide iron and zinc. However, they generally ate fewer fruits and vegetables, grain products, and milk products than recommended by Canada's food guide. This probably explains the findings described in the previous sections with respect to fibre, folate, calcium, vitamin D, and magnesium.

Table 10: Daily servings of various food groups as reported by residents of *Eeyou Istchee* (all age groups, seven communities) on the 24-hour food recall (mean and standard deviation)

	No. of participants	Vegetables and fruit	Grain products	Milk and alternatives	Meat and alternatives
Recommended servings:		5-10	5-12	2-4	2-3
Community					
Chisasibi	214	3.02±3.1	4.86±3.3	1.09±1.1	3.44±2.7
Eastmain	228	3.05±3.04	5.38±3.57	1.22±1.28	4.02±3.07
Mistissini	228	3.65 ± 3.36	5.23 ± 3.05	0.85 ± 0.88	3.80 ± 3.11
Waskaganish	135	3.50±3.72	6.15±3.98	1.26±1.14	3.81±2.94
Waswanipi	122	4.37±3.86	6.02±3.33	1.38±1.28	3.87±3.04
Wemindji	131	2.85±3.52	6.46±4.21	1.14±1.71	4.90±4.07
Whapmagoostui	133	2.75±2.94	4.69±3.06	1.08±1.25	3.69±2.99

Sources: Nieboer et al. (2013), Table A7.4.1; Nieboer et al. (2011), Tables 5.2.13A and B; Bonnier-Viger et al. (2007), Table 5.2.13.

Instead, it seems that many people in *Eeyou Istchee* are deriving much of their energy from "junk" foods – foods high in fat and sugar that could be removed from the diet with no appreciable loss of nutrients. According to the 24-hour food recall (which, as noted, actually understated consumption), at least 72% of participants in all communities consumed high-sugar foods or drinks. Appreciable proportions also ate high-fat snack foods (Table 11). In fact, as Figure 3 shows, from 23-30% of people's calories come from these kinds of foods – and this proportion is probably understated.

***High-sugar foods**: Ones in which at least 25% of the calories come from sugar (fruits and vegetables are excluded).*

***High-fat foods**: Fast foods, snacks, and baked goods in which over 40% of the calories come from fat.*

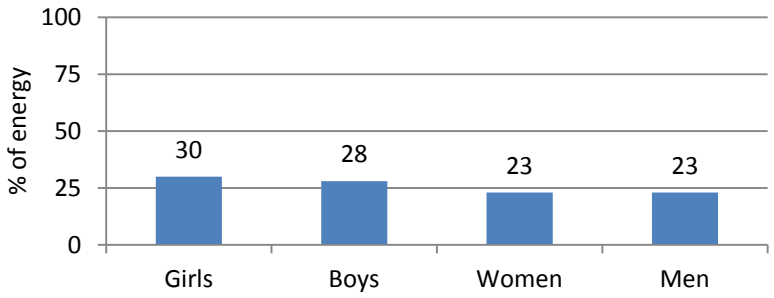
Table 11: Percent of respondents in *Eeyou Istchee* who reported eating junk foods in the past 24 hours, by age group and sex (seven communities/four communities)

	Girls	Boys	Women	Men
High-sugar junk foods				
Chisasibi	96	100	94	91
Eastmain	95	73	91	92
Mistissini	88	100	88	87
Waskaganish	100	100	98	98
Waswanipi	100	100	100	97
Wemindji	72	94	94	89
Whapmagoostui	88	100	93	92
High-fat junk foods*				
Chisasibi	78	58	41	52
Waskaganish	72	77	71	45
Waswanipi	62	68	47	61
Whapmagoostui	62	68	33	53

*Data on high-fat junk foods not available for Eastmain, Wemindji, or Mistissini.

Sources: Nieboer et al. (2013), data drawn from Figures A7.4.1 and A7.4.3; Nieboer et al. (2011), Fig. 5.2.12; Bonnier-Viger et al. (2007), Figure 5.2.8.

Figure 3: Percent of energy derived from all types of junk foods in *Eeyou Istchee*, according to the 24-hour recalls (seven communities)



Source: Nieboer et al. (2013), Figure 4.2.1. Junk food figures in this chart also include the energy from fats such as butter, margarine, and oil.

Summary: Weight and nutrition

- *Most people in* Eeyou Istchee *are overweight or obese. This is particularly true of women.*
- *Almost everyone in* Eeyou Istchee *eats traditional foods at least occasionally. People over age 40 eat traditional foods far more often than younger people.*
- *The traditional Cree diet apparently met people's needs, even though it contained few vegetables and grains. But now that people are relying on store-bought foods, it seems reasonable to apply western dietary guidelines. Comparison against these standards suggests that:*
    - *People in* Eeyou Istchee *are eating plenty of meat, but fewer fruits, vegetables, milk products, and grains than recommended by the Canada Food Guide. Most people regularly eat "junk" foods that are high in sugar and/or fat.*
    - *As a result, almost everyone is getting enough iron and zinc (found in meat and fish), but intakes of magnesium, vitamin D, calcium, and some other vitamins are low. Low magnesium levels are a particular concern, as there is believed to be a link to diabetes.*
    - *Broadly speaking, most adults are eating more total fat and saturated fat, and less fibre, than recommended by standard guidelines. However, almost everyone in the territory gets sufficient protein.*

In short, although traditional foods are still common, many people in Eeyou Istchee *(especially the younger ones) are eating a mainly "western" diet. This diet tends to include enough meat, but to be low in vegetables/fruits, grains, and milk products, and high in fats and sugar. The result seems to be high levels of obesity, and low intake of specific vitamins found in fruits, vegetables, grains, and milk products.*

ENVIRONMENTAL CONTAMINANTS

The *Nituuchischaayihtitaau Aschii* study looked at a wide range of contaminants and essential elements in *Eeyouch*, analyzing levels in blood, urine, or hair. The elements and compounds studied are tabulated below.

Toxic elements*	Lead Mercury Cadmium Nickel Arsenic
Essential elements† (i.e., ones required for good health, but that may be harmful in high doses)	Selenium Copper Zinc Magnesium Molybdenum Iodine Cobalt
Persistent Organic Pollutants (POPs)‡	Organochlorine compounds (various PCBs, pesticides and similar chemicals, dioxin and dioxin-like compounds). These are the compounds that have been of greatest concern over the years.
	Organofluorine and brominated compounds such as: • Surfactants to lower the surface tension of a liquid, used in detergents and similar products • Organobromine fire retardants such as polybrominated biphenyl ethers (PBDEs) and polybrominated biphenyls (PBBs) • Other related compounds found in a wide range of household goods These are now considered as "emerging" persistent organic pollutants.

* Arsenic, cobalt, and nickel were measured in all communities except Mistissini.

† Copper, molybdenum and zinc were measured in all communities except Mistissini.

‡ Persistent Organic Pollutants: Organic compounds that persist in the environment, accumulate in human and animal tissue, and may biomagnify along the food chain. These pollutants may originate in southern regions as they can be carried long distances by wind and water.

Wherever possible, the results were compared against standard guidelines for how much of a particular element can be tolerated before there is a risk to health. These guidelines generally set two levels: a "level of concern" and an "action level." A result above the "level of concern" indicates that there is no immediate risk to the person's health, but it would be good to identify the source of contamination and reduce future exposure. A result above the "action level" suggests that intervention may be needed. All the levels have safety margins built in, so that action can be taken long before a person reaches the point at which actual illness is known to occur. Generally speaking, these toxins are most dangerous to children and babies (including babies *in utero*). Consequently, the standards are more conservative for children and women of childbearing age than for other groups.

Toxic elements

Lead

Lead can affect health in both adults and children. In adults, it may affect blood pressure, concentration, and memory, and may also cause irritability, nerve disorders, and joint pain. In children, large amounts of lead can create serious health problems, including anemia, muscle weakness, and brain damage. Even low levels of lead are linked to lower IQ scores in children. Accordingly, lead is of most concern in children and women of childbearing age (under 40); for this reason, the bar is set lower for those groups, i.e. a level that is only of "concern" for an older woman or an adult male requires action in a child or a woman under 40.[*]

In the general population, common sources include lead that leaches out of older plumbing systems into drinking water, and indoor dust – particularly in houses that have lead-containing paint. In *Eeyou Istchee*, a more likely offender is lead shot. Simply firing a gun can expose a hunter to lead fumes. Lead may also come from eating or smoking after handling lead ammunition, and from eating birds that contain lead pellets and fragments. (In fact, abdominal X-rays of people in some communities on the west coast of James Bay have shown lead pellets.)

In *Eeyou Istchee*, lead levels varied significantly between the communities, with Whapmagoostui having higher levels than the others. In most communities lead levels rose with age, and an appreciable number of older adults were over the "concern" bar; however, only a few people (12 in Whapmagoostui, and 6 in other communities) were in the "action" range (Table 12). Levels for children and women under 40 were generally in the safe range. Statistical analysis suggests that lead shot is a likely suspect: in this study, hunters who reported using lead shot were almost three times as likely as others to have blood-lead readings in the "concern" range. This suggests that efforts to reduce use of leaded shot would reduce lead exposure to what is seen in the general Canadian population.

[*] Recent research suggests that it takes less lead than previously believed to produce an effect in children and young women. As a result, some jurisdictions are now lowering the bar.

Generally speaking, it is encouraging that so few people needed follow-up for exceeding the recommended levels of lead. Indeed, the lead concentrations are already quite low in some communities such as Waswanipi.

Table 12: Lead levels of participants in the seven communities (as measured in whole blood, using the acceptability thresholds established for the current study)

Age Group	Level (micromol/L)*		Chisasibi	Eastmain	Mistissini	Waskaganish	Waswanipi	Wemindji	Whapmagoostui
0-7 years	Acceptable	≤0.48	100%	100%	98%	100%	100%	100%	100%
	Action level	>0.48	**0%**	**0%**	**2%**	**0%**	**0%**	**0%**	**0%**
8-14 years	Acceptable	≤0.48	100%	100%	100%	97%	100%	100%	100%
	Action level	>0.48	**0%**	**0%**	**0%**	**3%**	**0%**	**0%**	**0%**
15-39 years	Acceptable	<0.5	96%	100%	97%	94%	100%	95%	74%
	Concern	0.5-0.9	4%	0%	3%	4%	0%	5%	25%
	Action	≥1.0	**1%**	**0%**	**0%**	**1%**	**0%**	**0%**	**2%**
≥40 years	Acceptable	<0.5	66%	90%	96%	87%	100%	84%	49%
	Concern	0.5-0.9	29%	11%	4%	13%	0%	11%	23%
	Action	≥1.0	**5%**	**0%**	**0%**	**0%**	**0%**	**6%**	**28%**

Sources: Nieboer et al. (2013), Table A8.1.8; Nieboer et al. (2011), Table 5.3.4; Bonnier-Viger et al. (2007), Table 5.3.4. Percentages have been rounded, so may add to slightly over 100.

Mercury

At the extreme, excess mercury can cause problems with hearing, vision, speech, or memory, and symptoms like dizziness, numb or tingling fingers and toes, and difficulty doing things like writing or fastening buttons. However, very few people in *Eeyou Istchee* exceeded the standard guidelines for mercury – and those guidelines are set far below the point at which people actually develop symptoms.

People who eat fish and game typically have higher mercury levels than others (Robinson, 2003). This may explain why levels in *Eeyouch* were higher than those reported for Canadians in general (Table 13), but comparable to those seen in other northern indigenous groups. Hair mercury concentrations are summarized in Table 14, and are compared to those reported for each community for the years 1993-94. It is clear that mercury levels in both blood and hair (not shown) increased markedly with age, probably because of higher consumption of traditional foods (especially fish) by older adults. A further reason may be that as the total burden of mercury increases in the body, the turnover rate declines, thereby slowing its release.

Table 13: Mercury levels in *Eeyouch* (all nine communities) compared to other Canadians

Age group	Median concentration of mercury in blood			
	Expressed in nmol/L		Expressed in micrograms/L, i.e. parts per billion*	
	Canada (2007-2009)	*Eeyou Istchee* during the years 2002-2009	Canada (2007-2009)	*Eeyou Istchee* during the years 2002-2009
6-11 years	1.4	4.3	0.28	0.9
12-19 years	1.6	5.9	0.32	1.2
20-39 years	3.8	12.0	0.76	2.4
40-59 years	5.6	33.0	1.12	6.6
60-79 years	4.8	110.1	0.96	22.0

*This is the same information as in the first columns, but expressed in parts per billion (ppb) to facilitate comparison with previous studies (ppb = nmol/L divided by 5). Appendix 1 contains a conversion table that shows the various ways that mercury levels may be expressed, and compares the standards used by various health agencies.

Source: Nieboer et al (2013), text of Section 5.2.2

Research shows that, generally speaking, mercury levels are falling in Arctic animals and people (AMAP, 2009; AMAP, 2011). In *Eeyou Istchee*, mercury levels have been stable in fish in natural lakes since the 1970s; levels in fish in reservoirs increased, then decreased over time. As illustrated in the footnote to Table 14, comparisons over the years are complicated by the fact that detection methods have improved. In 1993-94, hair mercury levels under 12.5 nmol/g were not detectable with certainty using the laboratory methods available at that time. Nonetheless, the data suggest that *Eeyouch* today have lower mercury levels than they did in the 1993-94 survey (Dumont et al., 1998a,b).

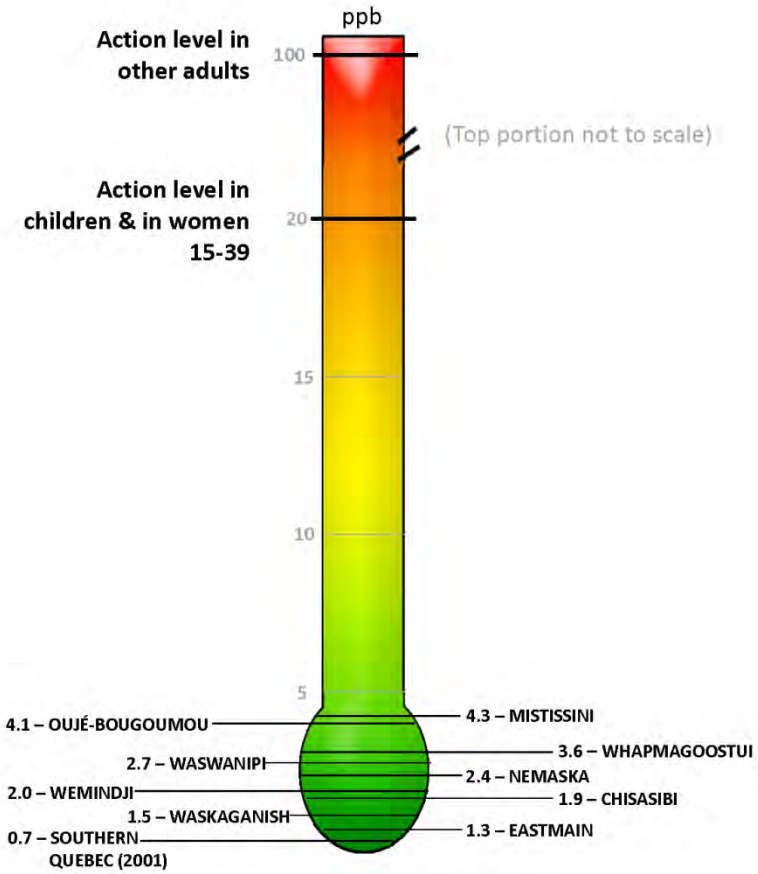
Table 14: Mercury levels in hair, people age 15 and over, 1993-94 (Dumont study) compared to 2002-2009 *(Nituuchischaayihtitaau Aschii* study)

Community	Year studied		n in sample		Median mercury level (nmol/g)		Maximum mercury level (nmol/g)	
	Dumont	*N. Aschii*	Dumont	*N. Aschii*	Dumont	*N. Aschii*	Dumont	*N. Aschii*
Mistissini	1993	2005	295	175	≤12.5	5.3	136	101
Wemindji	1994	2007	469	129	≤12.5	1.4	117.5	68.6
Eastmain	1994	2007	228	101	≤12.5	1.2	97.5	37.0
Waskaganish	1994	2008	345	94	≤12.5	0.9	87	25
Chisasibi	1994	2008	605	172	≤12.5	1.5	278.5	80
Whapmagoostui	1994	2009	248	101	18	3.9	186.5	210
Waswanipi	1993	2009	257	96	15	4.7	161	98
Ouje-Bougoumou	1993	2002	174	164	≤12.5	5.7	140.5	69.3
Nemaska	1993	2002	212	68	16	3.0	117	43.9

Source: Earlier data from Dumont et al. (1998b), Appendix 8A; later data from *Nituuchischaayihtitaau Aschii* study, provided by O. Drescher, Public Health Research Unit, CHUQ. Note that the 12.5 nmol/g concentrations shown in column 6 correspond to the 1998-reported detection limit, which is considerably higher than that in the current study (0.41 nmol/g).

How many people had mercury levels over the "action" bar? As with lead, the tolerable amount is much lower for children and women of childbearing age than for other adults, so that the "concern" level actually requires action for these more susceptible groups. No children were found to be at risk, and only a small number of reproductive-age women and other adults were at levels that required action.*

Figure 4: Average mercury levels in blood among *Eeyouch* (age 8 and over) in each community, various years 2002-2009



Slightly adapted from a presentation by Nieboer, Tomatuk, George, and Atikessé entitled "Results for the Cree Nation of Whapmagoostui," August 2011.

In sum, it is encouraging that very little follow-up was needed for people exceeding the mercury guidelines. It is clear that mercury levels among *Eeyouch* have declined since the 1990s.

* Note, however, that Health Canada has recently lowered its "action" level for children and women of reproductive age even further (see Appendix).

Cadmium

Cadmium damages the kidneys, and the recommended tolerance level for this element has been set with an eye to limiting occupational exposure. However, for most people in Canada, the primary source of exposure to cadmium is cigarette smoking.

In *Eeyou Istchee*, cadmium levels are highest in the middle age group. It is clear, however, that there are people over the recommended levels in *all* age groups except children under eight. Statistical modelling, and a comparison of cadmium levels among smokers and non-smokers, strongly suggest that smoking is responsible for the elevated cadmium levels (Table 15).

Table 15: Percent of participants in each community with cadmium levels in the "action" range, by age group and smoking status

Age group	Smoking status	Chisasibi	Eastmain	Mistissini	Waskaganish	Waswanipi	Whapmagoostui	Wemindji
8-14 years	Non-smoker	0%	0%	0%	0%	0%	0%	0%
	Smoker	0%	0%	20%	0%	0%	0%	0%
15-39 years	Non-smoker	0%	0%	0%	0%	0%	0%	0%
	Smoker	5%	27%	19%	6%	2%	2%	8%
≥40 years	Non-smoker	0%	0%	0%	0%	0%	0%	0%
	Smoker	12%	5%	20%	14%	20%	6%	0%

The non-smoker category includes both lifelong non-smokers and former smokers.

Percentages have been rounded off.

Sources: Nieboer et al. (2013), Table A8.1.3; Nieboer et al. (2011), Table 5.3.2; and Bonnier-Viger et al (2007), Table 5.3.2A

Arsenic

This study measured arsenic in both urine and hair. The levels in urine were mainly in the expected range, comparable to those found elsewhere; only three people in this study exceeded the "action" bar. Levels in hair were also in the expected range. Interestingly, there is very little relationship between arsenic levels as measured in hair and urine; this is because arsenic found in hair may come either from the body or from external contamination. The most likely suspect is the arsenic known to leach from pressure-treated wood (which used to contain arsenic). However, past research suggests that arsenic from wood contributes very little to people's internal levels of arsenic. The results of the current study support that conclusion, since some people had much higher levels of arsenic in their hair than in their urine. This being said, it is important not to *burn* pressure-treated wood, as this releases arsenic fumes that may then be inhaled.

Nickel

Nickel is neither essential to the diet nor particularly harmful (as compared to mercury, lead, and cadmium). The levels seen among people in *Eeyou Istchee* appear to constitute normal background exposure.

Essential elements

Selenium

Selenium is found in wheat, cereals, and especially fish. It is an essential element that plays a part in processes such as immune function, thyroid function, and protection against oxidation, and it also seems to mitigate mercury's toxic effects (Berry and Ralston, 2008). Despite its essential role, too much selenium is believed to be harmful – although the evidence is that people can tolerate quite a bit without damage. This study found that selenium levels are higher in *Eeyouch* than in southerners, as you would expect from a fish-eating population. However, neither excess selenium nor a dietary deficiency of selenium seem to be issues in *Eeyou Istchee*. Only six adults – and no children – exceeded the level of concern, and none exceeded the action level.

Some elements that are desirable or even essential to health can nonetheless be toxic at higher doses.

Whereas the Nutrition chapter looks at whether people are getting enough *of various elements in their diet, this chapter asks if their levels – as measured in body fluids or hair – might be* too high.

Other essential elements: copper, zinc, magnesium, molybdenum, iodine, and cobalt

- **Copper** is essential to many bodily processes, and obtained mainly through diet. Although copper toxicity is rare, some congenital disorders result in under- or over-accumulation of copper. The values seen in *Eeyou Istchee* are as expected, with females having higher blood concentrations than males.
- **Zinc**, like copper, is crucial to good health, and only minimally toxic in excess. The values found in *Eeyou Istchee* are comparable to those seen in other regions.
- **Magnesium** is crucial to many biochemical processes, especially those relating to the use of energy. The concentrations observed in this study were not excessive.
- **Molybdenum** plays a role in a number of complex biochemical processes. It too seems to be at normal levels.
- **Iodine** is essential for proper thyroid function. It was measured in six of the communities in this study, and levels appear to be satisfactory. (The section, *Risk factors for selected chronic diseases*, p. 37, looks at the iodine results in more detail, in the context of its discussion of thyroid function.)
- **Cobalt**: The levels seen among people in *Eeyou Istchee* appear to constitute normal background exposure.

Correspondence analysis (statistical modelling) of the results for these various metals and elements shows that cadmium, lead, and mercury stand apart from the remaining elements, suggesting different sources of

exposure. As discussed earlier, the primary source of exposure to lead seems to be hunting with lead shot. Since most hunters also fish and eat fish, there is some relationship between lead levels and mercury levels. Cigarettes appear to contribute the bulk of the cadmium exposure, and may also make a small contribution to lead levels. In adults over 40, lead and mercury seem to be the main contaminants, while in adults 15-39, cadmium is a greater concern. Levels of all these contaminants are low in children.

Persistent Organic Pollutants (POPs)

Organochlorine compounds

The results for the various organochlorine compounds varied between communities. There was a tenfold spread between communities for certain PCBs,* and a threefold spread for some of the organochlorine pesticides. None of the organochlorine compounds was found in every single participant, but some were common, being found (at detectable levels) in at least 70% of adults in the study. The observed concentrations of PCBs and organochlorine pesticides were from two to twenty times higher than those seen in non-Aboriginal people, but comparable to those reported for other indigenous peoples in Canada, Greenland, and Russia. When we consider all the PCBs and organochlorines together, only a few people were over the level of concern. Unfortunately, no treatment can reduce the levels of these compounds, and their half-life is so long that it would take 25-75 years for the body to eliminate them by natural processes.

There is a clear age pattern for these compounds: older *Eeyouch* generally show higher concentrations of the PCBs and organochlorine pesticides than younger people. This is partly because older people eat more of the traditional foods that expose them to organochlorines, and partly because the compounds have such a long half-life.

Recall that the POPs in this study fall into two classes:

1. *The "traditional" POPs: Organochlorine compounds such as PCBs, some pesticides, dioxin and related compounds.*
2. *The "emerging" POPs: organofluorine and brominated compounds found in fire retardants, detergents, and a variety of household products.*

* PCBs have been banned in many countries, and their level in the environment is decreasing. The most common source of exposure to PCBs is eating fish (especially predatory fish), and marine mammals like whales.

Organofluorine and brominated compounds: the "emerging" POPs

We know that fat-soluble POPs tend to biomagnify in Arctic food chains. At present, levels of some of the historically observed POPs (such as PCBs) are dropping in the air and in arctic animals; but levels of some of the fluorinated and brominated organic compounds are rising. We expect that the same patterns would be found in humans.

Fluorinated and brominated organic compounds are ubiquitous in household products. They are used as surfactants in detergents and similar products, as fire retardants, and for a variety of other purposes. They are found in:

- foods (via the packaging)
- upholstery
- textiles
- building materials
- appliances
- plastic products
- electronics

Because of this, we often get exposed to these products via house dust. This is especially true of toddlers, who ingest more dust than adults. Generally speaking, harvested foods are not a significant source of these fluorinated and brominated compounds.

Why monitor these compounds?

The fluorinated and brominated organic compounds are generally far less toxic than the "traditional" pollutants like PCBs, and much less is known about them. In many cases, there is no firm evidence of danger to health, and no standard for assessing tolerable levels.

Nonetheless, questions about these compounds have recurred in the scientific literature in recent years. It therefore seemed worth adding measurements of these compounds in the last six communities to be studied.

Note that the fluorinated compounds discussed in this section are not the same as the fluoride that is added to drinking water to prevent dental caries.

Whereas levels of PCBs and organochlorine pesticides were highest in older *Eeyouch*, the highest concentrations of fluorinated and brominated products were found in children 8-14. This is consistent with an explanation in terms of household dust. Levels of these compounds varied between communities, but the spread was generally narrower than in the case of the PCBs and other organochlorine compounds.

Because there is no established standard for how much of these compounds is safe, the results in *Eeyou Istchee* had to be compared to those of other areas. The first comparison looked at levels of the brominated halogen compounds in *Eeyou* women of reproductive age as compared to Danish women. In this instance, whether the *Eeyou* women were above or below the Danish level depended on which specific compound was being considered. A second comparison – this one for older women – found that *Eeyou* women generally had lower levels than women in Quebec City. Finally, levels of one family of brominated compounds (PBDEs) seemed to be somewhat lower in *Eeyou Istchee* than in Nunavik or in Cree people living on the west side of James Bay.

Summary: Contaminants

Toxic elements

- *Few people were at the "action" level for lead, although the fact that 12 of them lived in Whapmagoostui is of some concern. Leaded shot is a likely suspect.*
- *Mercury levels are higher than for southern Canadians, but still well within the safe range for almost everyone. Mercury levels have clearly dropped since the 1990s, either because people are eating less fish or because they are eating low-mercury content fish. Levels tend to be higher in older adults, presumably because they eat more traditional food.*
- *Some people are over the "action" bar for cadmium, and this is a concern; the source appears to be cigarette smoking.*
- *Arsenic levels were in the expected range.*

Essential elements

- *Levels of all the essential elements were in the safe range.*

Persistent organic pollutants

- *Only a few people—mostly older adults—were over the level of "concern" for organochlorine compounds such as PCBs. Levels were comparable to those seen in other Aboriginal groups, although they were higher than in southern Canadians.*
- *Little is known about whether or not brominated and fluorinated compounds pose a real risk to health, but the study results at least provide a baseline. Comparisons to other groups give mixed results.*

In sum, with the possible exception of lead in Whapmagoostui, there is little to be concerned about in terms of the contaminants measured in this study. Some people are over the "action" bar for cadmium, but this seems to be due to smoking rather than environmental exposure. Although levels of mercury and PCBs are higher than in southern Canadians, they are still well below the "action" levels for most people in Eeyou Istchee. *Generally speaking, these findings should encourage the eating of fish, which is known to be good for health.*

ZOONOTIC DISEASES

Introduction and methods

Zoonoses are diseases that are carried by animals and may be transmitted to humans through contact, handling, and consumption of meats and organs. In some instances, these diseases may also be passed from animals to humans by insects such as mosquitoes or ticks.

People in *Eeyou Istchee* remain attached to their traditional practices of hunting, fishing and trapping. These activities keep them in close contact with wildlife but also expose them to some risk of zoonotic diseases. When a person has had one of these diseases, markers (i.e., antibodies) can often be detected in their blood for years after they have returned to health. The *Nituuchischaayihtitaau Aschii* study asked adult* participants to provide a blood sample, and analysed these samples for the presence of various antibodies. When they found a positive result, they checked the person's medical chart for symptoms that might have been related to the zoonosis in question. Information on risk factors was obtained through a Zoonoses questionnaire, which asked about pets in the home and about hunting and trapping practices such as:

- handling of meat and furs;
- wearing gloves;
- number of years of hunting;
- camping activities;
- type and number of animals killed over the past year.

Table 16 lists the types of zoonoses tested for in the study.

* Age 18 and over in most communities; age 15 and over in Eastmain and Wemindji.

Table 16: List of zoonotic pathogens that the *Nituuchischaayihtitaau Aschii* study looked for

Type	Pathogen	Details about this pathogen	
Bacterial infections	*Coxiella burnetti*	Transmitted via exposure to products (urine, feces, fur, etc.) from infected animals. Can cause "Q fever." The most common form is a mild, temporary illness involving fever. More severe symptoms can include atypical pneumonia, hepatitis, and endocarditis.	
	Francisella tularensis	Can cause tularemia or "rabbit fever" – although it is also found in animals other than rabbits. Caught *via* contact with an infected animal, bites of insects such as mosquitoes, ticks, or deerfly, or ingestion of contaminated water or food. Usual symptoms include fever, headaches, joint pain; in some forms, can also be associated with more serious conditions such as pneumonia.	
	Leptospira sp.	A family of bacteria that can cause leptosprirosis. Humans become infected through ingestion of food or water contaminated by infected animals. Infections range from mild illness (flu-like symptoms and rash), to severe illness involving the liver, kidneys, or central nervous system.	
Parasitic infections	*Echinococcus granulosus*	A tapeworm that in its adult form is found in dogs or wolves. Humans acquire it through contact with canines, or with contaminated soil, plants, fruits, or vegetables. The parasite causes cysts, and these in turn can cause different symptoms depending on where in the body the cyst is located; liver and lungs are common locations. Infections are often temporary and asymptomatic.	
	Toxocara canis	A roundworm found in dogs and other canines, but that can also infect humans and other animals. Can cause a range of illnesses. These are usually mild, but occasionally involve more serious problems of the eyes, liver, or lungs.	
	Toxoplasma gondii	A common parasite that can infest various animals, especially cats. Humans contract it from undercooked infected meats, or by contact with cat feces or soil or water contaminated with infected cat feces. Can also be passed across the placenta to the fetus. Usually causes only minor and temporary illness, but is a concern for fetuses and immunocompromised people.	
	Trichinella sp.	A roundworm, usually picked up by eating undercooked infected meat that causes trichinosis. The severity of illness depends on the number of larvae ingested; most infections are unapparent.	
Viruses	California serogroup viruses	Jamestown Canyon (JC)	Viruses transmitted *via* mosquito bites. Most infections are asymptomatic, but more severe symptoms (aseptic meningitis, encephalitis, seizures) are possible.
		Snowshoe hare (SSH)	
		Sin Nombre virus*	A virus carried by deer mice that can cause hantavirus cardiopulmonary syndrome.

* Tests for Sin Nombre virus were carried out only in Mistissini, Eastmain, and Wemindji.

Source: Nieboer et al. (2011), Chapter 6 text.

Results

In the seven communities covered by the study, over three-quarters of all adults tested positive for at least one zoonotic pathogen. Older people were especially likely to test positive for these pathogens, probably because they have had more years of exposure to game animals. Generally speaking, rates of infection were lower for the parasitic diseases than they were for the bacterial and viral ones. The most common pathogens varied by community, although in the absence of a regional total it is hard to draw conclusions about which pathogens are the most common across the territory. The community-specific figures do suggest, however, that *F. tularensis* is among the top two or three zoonoses in most communities, while other pathogens are common only in certain areas (Table 17).

Table 17: Percent of participants with antibodies to various zoonotic pathogens in their blood, by community

Caution: Large confidence intervals around these numbers, i.e., figures are imprecise.

Pathogen	Chisasibi	Eastmain	Mistissini	Waskaganish	Waswanipi	Wemindji	Whapmagoostui
Coxiella burnetii	6%	1%	18%	2%	0%	2%	0%
Leptospira sp.	27%	21%	14%	16%	10%	25%	19%
Francisella tularensis	16%	20%	26%	22%	24%	14%	37%
Echinococcus granulosus	1%	4%	0%	1%	4%	3%	3%
Toxocara canis	1%	5%	4%	10%	6%	1%	0%
Toxoplasma gondii	12%	5%	10%	4%	12%	5%	12%
Trichinella sp.	0%	0%	0%	0%	0%	2%	1%
California serogroup (all)	17%	10%	--	29%	65%	9%	44%
JC virus	13%	10%	--	23%	19%	9%	24%
SSH virus	3%	3%	--	6%	42%	1%	14%
Sin Nombre virus	--	0%	0%	--	--	0%	--
One or more of above zoonoses	51%	50%	46%	60%	82%	42%	75%

"--" indicates that the pathogen in question was not tested for that particular community.

Caution: Large confidence intervals around these numbers, i.e. figures are imprecise. Many of the apparent differences between communities may not be true ones.

Source: Nieboer et al. (2013), Table 7.3.1.

The study turned up some interesting findings about specific pathogens. First, no instances of *Sin Nombre* were found in the three communities where the study looked for this virus. *Trichinella* was also very rare, leading the researchers to conclude that *Eeyouch* are rarely exposed to this parasite. And rates of *T. gondii* (a parasite contracted from undercooked meat) were far lower in *Eeyou Istchee* than they are in Nunavik, where people regularly eat raw meat. Finally, although *F. tularensis* can cause serious illness, including pneumonia, this did not seem to be happening in *Eeyou Istchee*. The researchers speculate that the local subspecies of *F. tularensis* bacteria are less virulent than those found in other areas.

Are these diseases making people seriously ill? When the researchers checked the medical charts of people with zoonotic antibodies in their blood, they found symptoms consistent with exposure for some of the bacterial infections (*F. tularensis*, *Leptospira* sp., *C. burnetti*), but few of the parasitic or viral ones.

Many of these zoonotic diseases are reportable by law in Quebec, yet over the years 1990-2006 there were no reports of any of them from *Eeyou Istchee*. This indicates that the people who contracted these diseases:

- had few or no symptoms; and/or
- did not seek medical care for their symptoms; and/or
- were incorrectly diagnosed.

Zoonotic diseases that are reportable by law in Quebec:

- *Leptospirosis*
- *Tularemia*
- *Q fever*
- *Trichinellosis*
- *Hantavirus*
- *Encephalitis caused by arthropods (insects such as mosquitoes or deerfly)*

The results strongly suggest that a large proportion of Eeyouch *have been exposed to at least one of the targeted zoonotic agents. The* Eeyouch *and the medical staff living in the region should be aware of these diseases. Greater awareness would help to decrease exposure and ensure that suitable diagnostic testing is carried out.* Physicians should consider these infectious agents when confronted with difficult or confusing diagnoses, or otherwise unexplained non-specific symptoms such as:

- Severe headache (some of the infections transmitted by insects);
- Unexplained or prolonged fevers (tularemia, leptospirosis, Q fever);
- Atypical pneumonias (Q fever, tularemia);
- Long-lasting pharyngitis (tularemia);
- Severe ocular pathologies (tularemia, leptospirosis).

Summary: Zoonoses

- *Most of these zoonoses typically cause mild, non-specific illness such as flu-like symptoms, infections, or rash; but in exceptional cases, they have the potential to cause more serious illness.*
- *Over three-quarters of adults in* Eeyou Istchee *tested positive for at least one zoonotic pathogen. Despite this, a review of notifiable-disease reports and patient charts suggests that people either have few or no symptoms, don't seek care, or were being misdiagnosed.*
- *Some of the pathogens were confined to specific areas, but* F. tularensis *seemed to be among the more common pathogens in most communities. Although* F. tularensis *can cause serious illness, it does not seem to be doing so in* Eeyou Istchee. *The researchers speculate that the local sub-species of bacteria are less virulent than usual.*

In sum, although most adults have been exposed to one or more of these pathogens, the study found no evidence that serious illness resulted. However, physicians should consider these diseases when faced with otherwise-unexplained symptoms.

RISK FACTORS FOR SELECTED CHRONIC DISEASES

The *Nituuchischaayihtitaau Aschii* study looked at chronic diseases that are of interest to the communities, and that have possible links to environmental contaminants. This included a series of risk factors for cardiovascular disease; indicators of bone health (osteoporosis risk); indicators of thyroid disorder; and diabetes and its risk factors.

Risk factors for cardiovascular disease (heart disease and stroke)

A wide range of factors were investigated related to cardiovascular disease. The research team focused on:

1. Hypertension (high blood pressure)
2. Levels of blood lipids and fatty acids
3. Indicators of atherosclerosis (blocking of the arteries)

Besides this, they also looked at several measures that are emerging as indicators of heart disease, such as:

- Variability in heart rate
- Low-grade inflammation
- Size of LDL cholesterol particles in blood plasma

Hypertension (high blood pressure)

Across all nine communities, a total of 30 youth (out of 262 whose blood pressure was measured) met the criteria for high blood pressure. This translates to 12% of youth.

Over a third of adults in the region* had high blood pressure, and nearly a third of them were not adequately controlling it. This translates to about 14% of all adults in the region who are either undiagnosed, or whose blood pressure remains high despite diagnosis.

*Youth were considered to have **hypertension** if (a) their medical chart mentioned it; or (b) the child's blood pressure was above the 95th percentile for children of comparable age, sex, and height.*

These data are for youth age 8-17.

*i.e., the seven communities included in the *Nituuchischaayihtitaau Aschii* study

Table 18: Hypertension among adult participants (age 18+) in *Eeyou Istchee* (seven communities)

Key	Hypertension			%
A	**Diagnosed hypertension**			28%
B		*% of the people with diagnosed hypertension who had it under control*	*69%*	
C	**Undiagnosed hypertension**			6%
	TOTAL WITH HYPERTENSION (diagnosed or undiagnosed)			**34%**
D	% of participants who had either uncontrolled or undiagnosed hypertension			14%

(A) Diagnosis of hypertension appears in the person's medical chart.

(B) Medical chart shows person was diagnosed with hypertension, but their blood pressure was normal in this study.

(C) Person's blood pressure was high on measurement (140/90 or more), but there was no mention of hypertension in their medical chart.

(D) People who were undiagnosed (line C), plus people who were diagnosed but whose blood pressure was still high when measured in this study.

Source: Nieboer et al. (2013), Table 6.1. Percentages have been rounded, so may not add to exactly 100%.

Research in other groups has suggested a link between blood pressure and mercury levels. The researchers used the data from the last seven communities to look for such a link, but did not find one. This is surprising; the explanation may be that the other studies were conducted in populations that have higher mercury levels than the Cree.

Research also suggests that n-3 polyunsaturated fatty acids (Omega-3 fats) and selenium might protect against high blood pressure. However, this relationship was not found in the *Nituuchischaayihtitaau Aschii* study, nor in an earlier study of n-3 polyunsaturates carried out among the Cree (Dewailly et al., 2002).

Blood lipids and fatty acids (cholesterol, triglycerides, fatty acids)

The results in terms of people's blood lipids were mixed. On the one hand, more than a third of adults had imbalances like high levels of triglycerides and low levels of HDL ("good") cholesterol. On the other hand, the picture in terms of people's levels of LDL ("bad") cholesterol, total cholesterol, and ratio of good to bad cholesterol was better than expected.

Table 19 shows the blood lipid results for adults and children across the territory. Analysis did not show a clear pattern by age or gender, but did indicate that undesirable blood lipid levels are strongly related to obesity.

Table 19: Blood lipid profiles of participants across *Eeyou Istchee* (all nine communities), by age group

Children age 8 to 17 (n = 232)*	
Elevated triglyceride levels (>1.2 mmol/L)	~24%
Low HDL ("good") cholesterol	~20%
Adults 18+	
High total cholesterol (≥5.2 mmol/L)	25%
High LDL ("bad") cholesterol (>3.4 mmol/L)	15%
Low HDL ("good") cholesterol (level unspecified in original text)	50%
High ratio of total to HDL cholesterol (≥5.0)	18%
High blood triglycerides (>1.7 mmol/L)	29%

*Modified Cook criteria used to estimate risk for children. Note that 35% of values were missing on the measure of triglycerides.

Source: Nieboer et al. (2013), text Section 6.2.1.

The researchers looked at a series of different fatty acids in the blood, from desirable ones like n-3 PUFAs (Omega 3 fatty acids), to undesirable ones like saturated fats and *trans* fats. Overall, coastal residents tended to have higher levels of some of the n-3 PUFAs, lower levels of *trans* fats, and a better ratio of n-3 to n-6 fats.

The researchers then took a closer look at the fatty-acid profiles of adults 18-74.* This revealed that there was a marked relationship with age: people over 40 had more n-3 PUFAs, and fewer n-6 PUFAs and *trans* fats in their blood, and their overall ratio of n-6 to n-3 fats was better. The opposite was true of younger adults, who tended to have lower levels of n-3 fatty acids and higher levels of *trans* fats. Levels of *trans* fats also varied significantly between the communities.

***PUFA**: Polyunsaturated fatty acids, an umbrella term that includes n-3, n-6, n-9, and several other fatty acids.*

***n-3 fatty acids** (Omega-3 acids): These are believed to protect against heart disease, so they are considered beneficial.*

***DHA**: docosahexaenoic acid, one specific type of n-3 fatty acid.*

***n-6 fatty acids**: fats that, in excess, interfere with the benefits of n-3s; a diet that provides fewer n-6 fats in relation to the n-3s (i.e., a low n-6 to n-3 ratio) is thought to be desirable.*

Encouragingly, the n-3 PUFA values seen in *Eeyou Istchee* are two or three times higher than those of other Quebecers (although they are only half what is observed in Nunavik). The reason for this is that n-3 PUFAs are associated with consumption of fish and game. Levels of one particular n-3 found in game – called DHA – were especially high. The researchers concluded that the traditional diet based on fish and game is providing people with lots of n-3 PUFAs, which should protect them against cardiovascular

* These results are for the last seven communities to be studied, i.e., they exclude Oujé-Bougoumou and Nemaska.

disease. A further advantage is that when people are eating fish and game, they are reducing their intake of alternate foods that may be nutritionally poor. Thus, the traditional diet is to be encouraged.

Atherosclerosis ("hardening of the arteries")

"Atherosclerosis" refers to a process in which cholesterol, blood cells, and waste products gradually clog the arteries. This impairs blood flow, and can lead to heart attacks (myocardial infarction), stroke, and related diseases. The process is natural, and increases with age; it also increases with risk factors such as high blood pressure, diabetes, smoking, obesity, and lipid imbalances.

These are the known risk factors; but studies are now also suggesting a link between atherosclerosis and exposure to mercury and Persistent Organic Pollutants (POPs). As a result, the *Nituuchischaayihtitaau Aschii* study looked to see if people's levels of these contaminants were related to their levels of atherosclerosis. Although the researchers could not measure atherosclerosis directly, they used a proxy measure called CIMT. The results were as follows:

- CIMT increased with age, and was also associated with abnormal blood sugar levels.
- In adults over 40, CIMT levels were higher in men than in women. They did not differ significantly between the communities.
- In younger adults, CIMT was significantly higher:
    - In obese *versus* normal-weight people;
    - In people with an abnormal blood lipid profile;
    - In people with abnormal blood sugar levels (high fasting blood glucose).

*The study used **carotid intima-media thickness** (CIMT) as a surrogate marked for atherosclerosis. CIMT measures plaque build-up in the carotid artery in the neck.*

The results are for the last seven communities to be studied.

Were CIMT levels associated with contaminants? The researchers took a first look for a relationship between CIMT levels and either mercury or one specific PCB (PCB 153). They did not find a clear relationship: the results suggest that something else – possibly age – mediates the relationship between contaminants and CIMT. They concluded that further study is warranted.

Emerging indicators of cardiovascular disease: Heart rate variability, chronic inflammation, and size of plasma LDL

Heart rate variability

Clinicians now believe that greater variability in heart rate is desirable, because low variability increases the risk of sudden cardiac death. Because there is some evidence that mercury reduces variability in heart rate, the researchers checked for this relationship among adults in *Eeyou Istchee*. In this instance they did find some link, meaning that higher mercury levels were associated with less variation in heart rate. The same link has been seen in Nunavik Inuit.

> ***Heart rate variability*** *was measured using a two-hour assessment with a Holter monitor.*
>
> *The researchers controlled for confounding factors when looking for a link between mercury and variations in heart rate.*

Chronic inflammation

Low-grade systemic inflammation is now recognized as a risk factor for cardiovascular disease. The *Nituuchischaayihtitaau Aschii* study looked at various markers of inflammation in the blood of adult participants. The researchers measured C-reactive protein (hs-CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α).

Many adults had evidence of low-grade inflammation. As measured by hs-CRP, 39% had levels of inflammation associated with moderate risk of cardiovascular disease, and a further 45% had levels of inflammation associated with high risk. These proportions were double those seen among other Canadians, but comparable to levels reported for the Six Nations community in Ontario.

Generally speaking, levels of all the inflammatory markers measured in this study appeared to be high. They did not differ by age, but increased steadily with a person's Body Mass Index (i.e., with amount overweight). Levels were also higher:

- In women,
- In people with large waist circumferences,
- In people with diabetes.

The researchers concluded that adult *Eeyouch* have a high prevalence of low-grade systemic inflammation. The strongest predictors of this inflammation are being female, and being obese.

Size of plasma LDL

Size of plasma LDL ("bad" cholesterol) is a new marker for risk of heart disease: small, dense particles of LDL are believed to pose a greater risk of atherosclerosis. The average LDL size among participants in *Eeyou Istchee* was 254.6 Angströms. This compares to 257 Angströms among healthy men in Quebec City, and 255 Angströms in people with heart disease. LDL size was associated with age, higher blood sugars, higher weight (BMI), and diabetic status.

In short, the *Nituuchischaayihtitaau Aschii* study found the same pattern in all communities: a high prevalence of hypertension (~30%), along with unhealthy blood fat levels (like low HDL and high triglycerides) in over a third of all adults. Despite this, the results in terms of total cholesterol, LDL cholesterol, and ratio of total cholesterol to HDL cholesterol, were better than expected. All of the risk factors were linked to obesity (high BMI and waist circumference).

Is there a link between contaminants and risk factors for cardiovascular disease? In this study, the evidence was inconclusive. The researchers found some link between mercury and heart rate variability, but no link with blood pressure. Further study is needed.

Risk factors for osteoporosis

The *Nituuchischaayihtitaau Aschii* study measured bone density in 254 women aged between 35 and 74. Few of the menopausal women were taking hormonal medications; 25% of the pre-menopausal women used oral contraceptives.

Age was the main factor that affected bone density. The proportion of postmenopausal women who were at high risk of fracture (T-score of -2.5 or below) was comparable to the rest of Quebec, at 14%.

***Osteoporosis**: a loss of bone density, resulting at the extreme in fragile bones that fracture easily.*

Risk factors for thyroid disease

The *Nituuchischaayihtitaau Aschii* study asked adults (15+) about their history of thyroid disease, using a clinical questionnaire. The study also measured levels of Thyroid Stimulating Hormone in blood, and iodine levels in urine (because an imbalance in iodine can lead to thyroid disease).

Of the 910 adults across the territory who provided information on their history of thyroid conditions, 41 reported having some form of thyroid disease -- hyperthyroidism, hypothyroidism, or goiter. Blood and urine tests in subgroups of the remaining adults suggested adequate intake of iodine in all age groups, and average levels of "subclinical" hypothyroidism.

Diabetes and its risk factors

Obesity

Obesity is a known risk factor for diabetes, and as discussed in the Nutrition chapter, it is common across *Eeyou Istchee*.

Hyperinsulinemia (high levels of insulin in the blood)

Hyperinsulinemia is a precursor to type 2 diabetes, so the study looked at what proportion of participants had high blood insulin levels. Insulin levels went up as weight

Type 2 diabetes

A form characterized by high blood sugars and insulin resistance (as opposed to Type 1 diabetes, in which the pancreas is unable to make enough insulin). Type 2 is the most common form of diabetes: typically, about 90% of cases are Type 2.

(BMI) did, and were higher in women than men. Predictably, blood sugar levels and insulin levels rose together – yet even participants with normal blood sugar levels had high insulin, and were therefore at increased risk of diabetes. In fact, the high insulin levels were found even in children.

High blood sugars and diabetes

Judging by the blood samples from participants in this study, 10% of the adults across the territory had sugars in a range that put them at risk of diabetes, although they were not yet diabetic. Only 4.0% of participants had undiagnosed diabetes – that is, sugar levels high enough to indicate diabetes, but no mention of diabetes in their medical charts. The proportion of undiagnosed diabetics was similar in all communities except Waswanipi (where it was considerably higher).

Table 20: Prevalence of diagnosed, undiagnosed, and "at risk" state for diabetes: adults in all seven communities studied

Key	Type 2 diabetes	%
	Diagnosed type 2 diabetes (i.e., mentioned in person's medical chart)	19%
A	Undiagnosed diabetes (high blood sugars but no mention in chart)	4%
	Total type 2 diabetes (diagnosed and undiagnosed)	23%
B	At risk of diabetes (blood sugars abnormally high, but not in the diabetes range)	10%

(A) Undiagnosed diabetes: Diabetes not mentioned in chart, but blood sugars ≥7 mmol/L during the study.

(B) At risk of diabetes: Blood sugars between 6.1 and 6.9 mmol/L during the study.

Source: Nieboer et al. (2013), Table 6.6. Percentages have been rounded.

All in all, the situation with respect to risk factors for diabetes is undesirable. Obesity figures in *Eeyou Istchee* are alarming: the rate of obesity is radically higher than for Canadians in general. Insulin levels also appear to be high, especially in girls and women. Diabetes levels are high, and since diabetes is a risk factor for cardiovascular disease, we can predict an increase in heart disease and strokes in the years to come. In short, continued intervention is needed. Particular effort should be made to focus prevention programs on women and girls.

More about diabetes: update from the 2011 Cree Diabetes Information System

According to the latest data from the Cree Diabetes Information System (CDIS), 22.1% of adults in Eeyou Istchee *now have diabetes (CBHSSJB, 2013). The diabetes rate tends to be higher in women, and higher in the Inland communities.*

The age at which people are diagnosed with diabetes has been going down for the past 22 years. In 1989, the average age at diagnosis was 48; now it is just under 40. Blood sugar irregularities are also affecting pregnancies: depending on which criteria you use, these irregularities cause complications in 27-39% of pregnancies.

Recall that the Nituuchischaayihtitaau Aschii *study found that 10% of its participants had pre-diabetes (blood sugar levels that were abnormally high, but not so high as to indicate diabetes). Research shows that if people can change their diet and exercise habits at this stage, they can often delay diabetes or avoid it completely. The CDIS data tell us that over a third (38%) of* Eeyouch *with pre-diabetes go on to develop diabetes. Most of the people who go on to diabetes do so quite rapidly—within five years of being told they are pre-diabetic.*

How well are people controlling their diabetes? According to the Nituuchischaayihtitaau Aschii *study, about one diabetic person in five was managing to keep his/her blood sugars in the recommended range. The CDIS results are somewhat higher than this: they suggest that about one person in three has blood sugars in the desired range.**

*CDIS also tells us about levels of LDL ("bad") cholesterol. As of 2011, 45.5% of adults with diabetes had their LDL cholesterol in the desired range. This is progress, because the comparable figure was just 31.0% in 2006. The improvement is expected to have a large payoff in terms of preventing heart disease. The results in Eeyouch also compare favourably to those of other First Nations in Canada.***

The CDIS report, like the Nituuchischaayihtitaau Aschii *study, concludes that it is urgent to prevent diabetes by reducing risk factors like obesity and inactive lifestyles. This need is especially pressing among women of childbearing age.*

**CDIS uses a different measure of blood sugar levels: Hemoglobin A1C, rather than fasting blood glucose as in the* Nituuchischaayihtitaau Aschii *study.*

***Average LDL of 2.2, as compared to 2.4 in the CIRCLE study of 19 First Nation communities across Canada (Harris et al, 2011).*

Summary: Risk factors for selected chronic diseases

Heart disease and stroke

- *More than a third of adults in* Eeyou Istchee *have high blood pressure, and many do not have it under control.*
- *More than a third of adults have high levels of some kinds of fats, but the results in terms of "bad" LDL cholesterol and ratio of good to bad cholesterol were better than expected. Levels of Omega-3 fats (associated with consumption of fish and game) are two to three times higher than in the south, which should provide some protection against heart disease.*
- *Atherosclerosis (blocked arteries) is more common in people who are obese, or who have abnormal blood-fat or blood-sugar levels.*
- *Many adults—over a third—have markers of chronic inflammation, which is now recognized as a risk factor for heart disease.*
- *All of the risk factors increase with obesity.*

Osteoporosis

- *In this study, rates were comparable to those seen elsewhere in Québec.*

Thyroid disease

- *Results suggest adequate intake of iodine, and average levels of "subclinical" hypothyroidism.*

Diabetes

- *Obesity rates are alarming, and insulin levels are high even in people with normal blood sugars. High insulin levels are a serious sign of risk for diabetes.*
- *CDIS data show that 22% of adults now have diabetes, and people are getting diabetes at younger and younger ages.*
- *Results from blood sugar tests suggest that, across* Eeyou Istchee*, 4.5% of adults have undiagnosed diabetes, and another 9% have prediabetes.*

In sum, there is no special worry about thyroid disease or osteoporosis, but rates of high blood pressure, high blood fats, and chronic inflammation are a serious concern. All of these things are linked to obesity, and all raise the risk of heart disease. On the positive side, high levels of Omega-3 could provide some protective effect.

Diabetes rates are high in Eeyou Istchee*, but few diabetics are undiagnosed. However, the* Nituuchischaayihtitaau Aschii *results suggest that 9% of adults are pre-diabetic. Prevention efforts should continue to address obesity (particularly childhood obesity) and inactive lifestyles.*

DRINKING WATER

Background

Drinking water that is contaminated by microbes can cause severe gastroenteritis (vomiting and diarrhea). Surface water (lakes and rivers) is almost always contaminated by microbes from animal feces. Underground water from wells and springs is usually free of microbes. Some of the community water systems in *Eeyou Istchee* use underground water sources. Others use surface water, and add chlorine to kill microbes. Although tap water can sometimes be contaminated by microbes, the Cree Nation Councils have been testing for the past 10-15 years, and rarely find any. During that time, no outbreaks of disease due to contaminated water have been reported to the Cree Health Board. In short:

- Tap water is almost always safe; if not, the community is informed;
- Bottled water is also safe, but the plastic bottles create a lot of waste;
- Water from underground sources such as natural springs or wells is usually safer than surface water, but it may still be contaminated; it is impossible to judge by looks or taste;
- Water from lakes and rivers is usually contaminated.

However, people often say that they prefer the taste of water from traditional sources, and that tap water turns tea black. Further, many *Eeyouch* spend days, weeks, or months in hunting camps in the bush, where tap water is not available. Because it is responsible for public health, the Cree Health Board wanted to know what proportion of people drink tap water, and what proportion use other sources. Also, there has been some discussion about the possibility of adding fluoride to community water systems, to prevent dental caries. Before this idea can be debated, we need to know how many children actually drink tap water. Consequently, the *Nituuchischaayihtitaau Aschii* study asked people about what water they drink in the community and in the bush. The project also tested the water in local streams, lakes, rivers (and in the storage containers in people's homes) around three communities: Mistissini, Eastmain, and Wemindji.

Where are people getting their drinking water?

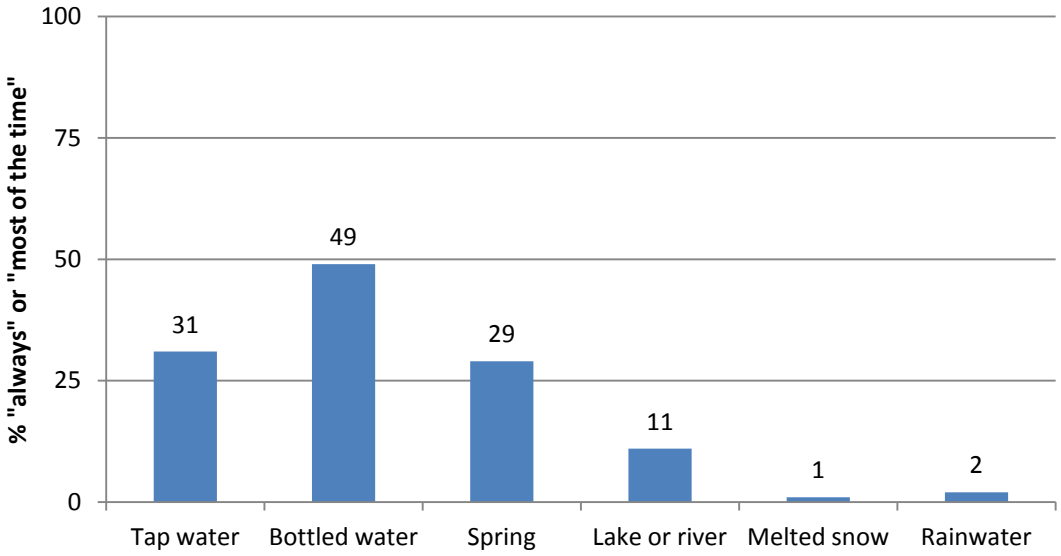
Are people relying mainly on tap water while they are in the communities? The answer, according to participants in the last seven communities to be studied,* is "no." Across all these communities, fewer than half the participants said that they drank tap water all or most of the time (Figure 5); in several communities – Mistissini, Wemindji, Eastmain, and Waswanipi – less than a quarter of the population routinely drank tap water.†

* i.e., excluding Nemaska and Oujé-Bougoumou

† The situation is Mistissini may have changed since the time of the study. Mistissini's community water system now draws water from a spring rather than the lake.

Where then were participants getting their drinking water? In most communities, people were relying on bottled water; in Whapmagoostui, they tended to drink spring water. Generally speaking, few people used lake or river water, but there were two exceptions: Mistissini (where 23% of participants drank lake or river water) and Whapmagoostui (30%). In most communities, younger people seem to be slightly more likely than their elders to routinely drink tap water.

Figure 5: People who "always" or "most of the time" drank water from various sources while in the community – all seven communities, 2005-2009



Source: Nieboer et al. (2013), Table 8.1

Caution: the percentages add to well over 100; there may have been a wording or translation issue in the original questionnaire.

While in the bush, neither tap nor bottled water is a common choice (except in Waswanipi, where 58% say they drank mostly bottled water while in the bush). Instead, people drink from springs, lakes, and rivers. Appreciable proportions use melted snow.

Figure 6: People who "always" or "most of the time" drank water from various sources – all seven communities, 2005-2009

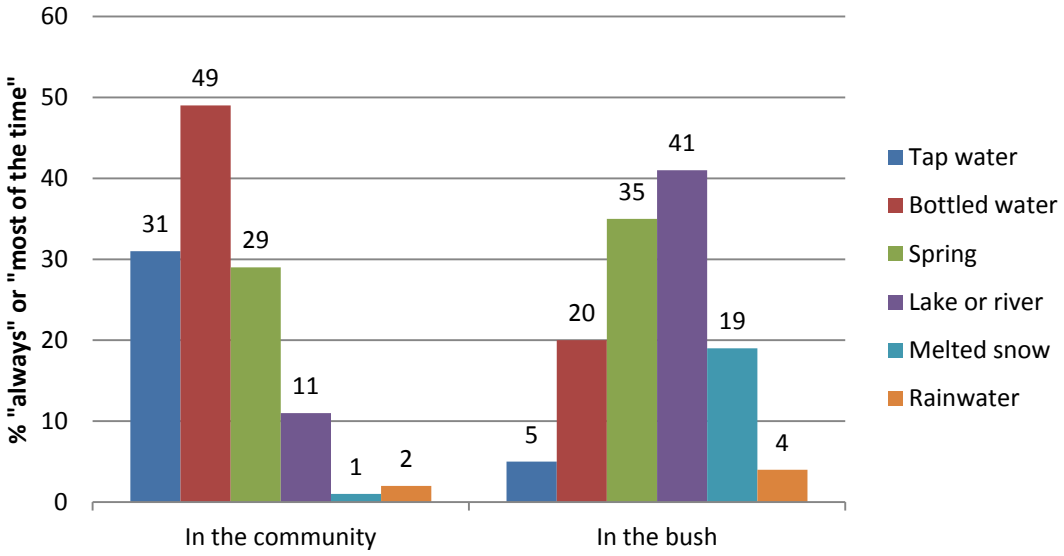


Table 21: Sources of water while in the community and in the bush: *Eeyou Istchee* (age 8 or more), all seven communities

Proportion of respondents who "always" or "most of the time" drink…*	While in the community	While in the bush
Tap water	31%	5%
Bottled water (from the south, or bottled by a community store)	49%	19%
From a spring	29%	35%
From a lake or river	11%	41%
Melted ice or snow	1%	19%
Rainwater	2%	4%
Rarely or never use tap water	44%	87%

* Note that the percentages add to well over 100; there may have been a wording or translation issue in the original questionnaire, such that people reported sources that they routinely use rather than the one source they use most or all of the time.

Source: Nieboer et al. (2013), Table 8.1

Water quality in the natural sources around Mistissini, Wemindji, and Eastmain

With help from community members, the research team identified and tested some of the lakes, rivers, and springs that residents of Mistissini, Wemindji, and Eastmain commonly use. They also tested some of the 5-gallon plastic containers that people were using to store water in their homes. They found some coliform contamination in all the water sources. More of a concern are *E. coli* or Giardia: 16 of 19 sources contained one of these microbes in at least one test. The team tested some sources up to nine times, and got slightly different results each time, so **we cannot be sure that any one source is *always* safe** to drink from. The water in home containers was generally less contaminated than the natural sources, possibly because people were filling their containers from the cleanest of the lakes, rivers, and springs.

Testing for contaminants

The presence of a few coliforms does not make water unfit to drink; but **any** *amount of* E. coli *is unsafe. Giardia (a parasite that causes "beaver fever") is also a concern.*

Since *E. coli* or Giardia occur regularly in natural water sources, it is best to err on the side of safety. **Water from natural sources should be boiled for one minute before use** – even to make tea. Household containers need to be regularly cleaned with dish soap, then rinsed with four cups of clean (tap or boiled) water to which a teaspoon of chlorine bleach has been added.

Summary: Water quality

- *The data should be treated with caution, as people asked which source of water they use "most or all of the time" seem instead to have listed any source that they used frequently.*
- *While in the community, less than half of participants routinely drink tap water, and 44% say they "rarely or never" drink it. Instead, the most common choice was bottled water. In Whapmagoostui and Mistissini, appreciable proportions of people drink water from springs, lakes, or rivers. Tap water is tested regularly by the Cree Nation Councils; on rare occasions, community members are advised not to drink it for short periods.*
- *While in the bush, people rely mainly on water from springs, lakes, and rivers.*
- *Testing around Mistissini, Wemindji, and Eastmain found that most natural water sources contained harmful* E. coli *bacteria in at least one sample. Elders and young children are the most likely to get sick from drinking water that contains these germs. It is best to boil all water from natural sources for one minute before use.*

In short, even while in the community, less than half the population drinks tap water; instead, people rely heavily on bottled water, and some use water from natural sources. No natural source is completely safe all the time; people are advised to boil water from natural sources for at least a minute.

EDUCATIONAL ACTIVITIES

Goals of the educational activities

Besides its scientific objectives, the *Nituuchischaayihtitaau Aschii* study had a substantial educational component. The educational activities had three objectives:

1. To create visibility for the project, and bring the project team and the community together through public-outreach activities;
2. To give something back to the host communities by providing hands-on, culturally relevant education in science, and by employing local youth;
3. To encourage Cree youth to pursue careers in health and science, with the long-term objective of meeting the Cree Health Board's need for local health professionals.

The study team learned as they went along, so the activities varied from one community to the next. After the first study, in Mistissini, the Cree Health Board hired an Educational Activities Coordinator and developed an extensive communication strategy. The educational component was expanded to involve the local schools, and to hire more youth for the project team.

Sharing the project plans and results with the communities

The activities varied somewhat in each community, but always included an opening ceremony and feast. These opening ceremonies showcased local culture, and brought together people from different walks of life. They also allowed the research team to introduce themselves, describe the project, and discuss it with community members. In most communities, over 100 people participated in these ceremonies. In several of the communities, the opening feast included a "Niihmaunnut challenge," designed to reduce the amount of waste and raise awareness of the environment. Participants were asked to bring their own reusable feast kit, including a plate, cup, cutlery, and a cloth napkin. Prizes were awarded to those who brought the most complete, sustainable and traditional kits. People responded enthusiastically to this challenge: some even made their own cutlery, wooden cups, and plates. Since then, at least two of the community feasts in Waskaganish have followed this example, asking participants to supply their own reusable dishes.

The results of the studies were returned to the communities in several ways. Once analysis was complete, a PowerPoint presentation and simple-language brochures were created with each community's results. The Project Coordinator and one of the Principal Investigators presented these results in each community, usually as part of the Annual General Assembly. In addition, three Scientific Gatherings were held, in 2008, 2010, and 2012. These meetings brought all the partners – the CRA, Niskamoon, Hydro-Québec, the Cree Health Board, and the research team – together to review the initial findings and discuss how they should be interpreted.

Teaching youth about science

The bulk of the project's educational activities were targeted at youth in the communities. These activities included:

- Environmental workshops
- Summer camps
- Visits to the project's facilities
- Nutrition-related activities in the daycare centres
- Science workshops in the schools, developed in collaboration with teachers. (These were adapted for each grade, and were built around general science topics such as nutrition, botany, physics, electricity, etc.)

All told, the activities reached over 1,000 youth across the territory. In addition, nine local youth were hired as Science Activities Assistants, and received training in science, communication, and leadership skills.

Table 22: Educational activities carried out in the seven communities

Activities	Number of participants	Communities involved
Science workshops and laboratory visits	874	All
Summer camps	90	Chisasibi, Waskaganish and Whapmagoostui
Activities at day care centres	69	Chisasibi, Waskaganish and Whapmagoostui
Job training opportunities for young adults	9	All except in Waswanipi
Total participants	**1042**	

Source: Nieboer et al. (2013), Section 9.1

Workshops in the schools

Based on experience in the first communities to be studied, the team organized workshops for high school students that would span several periods, and reinforce Quebec's new science curriculum. Because students in *Eeyou Istchee* are taught in their second or even third language, the workshops were structured so as to require minimal verbal and writing skills. Instead, they sought innovative ways for students to convey their learning, such as by stringing beads together to represent the different steps of the water cycle, or by completing hands-on projects such as electronic circuits or wind-powered generators. Consistent with traditional Cree learning methods, story books were sometimes used to supplement science activities. The workshops received positive feedback from teachers and principals.

Collaborative education projects

In some communities, the *Nituuchischaayihtitaau Aschii* project also tried to create links with existing projects and services. For example, school classes toured the clinic and learned about health professions like nursing, nutrition, lab technician, and ultrasound technician. This tour was then linked to classroom sessions on environmental contamination and the findings of the *Nituuchischaayihtitaau Aschii* project.

In a few areas, the study also collaborated with the *Team on Aboriginal Antidiabetic Medicines* (TAAM) to develop a three-period workshop for Secondary 1 students entitled "Plant science, plant stories." Some portions of the workshop were led by local experts in medicinal plants, while other parts were led by the science educators or the TAAM researchers. The activities explicitly emphasized that Cree traditions and western science can complement each other to promote healthy communities.

Summary: Educational activities

- *The purpose of the educational activities was to create visibility for the project, give something back to the host communities, and encourage Cree youth to pursue careers in health and environmental sciences.*
- *Activities for youth included workshops, summer camps, and nutrition-related activities in the daycare centres. Altogether, the educational activities reached over 1,000 youth across* Eeyou Istchee.

CONCLUSIONS

The *Nituuchischaayihtitaau Aschii* study looked at the relationship between the environment, land-based activities, eating habits, and health in *Eeyou Istchee*. Over the years 2005-2009, the study was carried out in seven communities. It used a combination of questionnaires, physical measures, and laboratory analyses to gather information on exposure to contaminants and zoonotic diseases, water source and quality, diet (both traditional and store-bought foods), and risk factors for certain chronic diseases.

Consent for the study was obtained from the 1,730 participants, and from the communities. A research agreement governs ownership and use of the data, and the results were returned to communities in presentations and plain-language brochures. In a further effort to return something to the host communities, the project also organized educational activities for youth, such as summer camps, workshops, and nutrition activities in the daycare centres. The hope was that these activities would encourage the over 1,000 Cree youth who participated to pursue careers in health and environmental sciences.

Although the study was detailed and comprehensive, it was not flawless. As with any such study, there were some methodological issues that may affect the results, notably a low response rate and complications with how some of the questionnaires worked in practice. Consequently, the data should be treated with due caution. Further, readers should bear in mind that because of the small size of the communities and the sample, many of the apparent differences between communities may not be true differences.

The study measured levels of contaminants and elements such as lead, mercury, cadmium, arsenic, selenium, iodine, and organochlorine compounds (PCBs and certain pesticides). With the possible exception of lead in Whapmagoostui, there was minimal concern about in terms of contaminant levels. Some people were over the "action" bar for cadmium, but this seems to be due to smoking rather than to environmental exposure. It is nevertheless a health concern. Although levels of mercury and PCBs were higher than in southern Canadians, they were well below the "action" levels for most people in *Eeyou Istchee*. *Generally speaking, these findings should encourage the eating of fish, which is known to be good for health.*

The results for the nine zoonoses (animal-borne diseases) for which the study tested were similarly reassuring. Although three-quarters of all adults in *Eeyou Istchee* had been exposed to one of these pathogens, the researchers found no evidence that serious illness had resulted. They suggested, however, that physicians in the region should consider these diseases when faced with otherwise-unexplained symptoms.

Like any public health department, the Cree Health Board has an interest in drinking water safety. Consequently, the *Nituuchischaayihtitaau Aschii* study asked people about what water they drink while in the community and in the bush, and it tested some of the local water sources around Mistissini, Eastmain,

and Wemindji. Participants reported that, in the bush, they rely mainly on water from springs, lakes, and rivers. But even while in the community, less than half the population drinks tap water; instead, people rely heavily on bottled water, and some use water from natural sources. The tests of 19 natural water sources around Mistissini, Eastmain, and Wemindji found that 84% contained harmful bacteria in at least one sample. Because it is impossible to tell from looking at the water whether it contains harmful bacteria, water from natural sources should be boiled for at least a minute.

Although the results for contaminants and zoonoses were not alarming, the same cannot be said of the study's findings on nutrition and risk of chronic diseases. The results suggest that *Eeyouch* (especially the younger ones) are eating a mainly "western" diet. This diet tends to include enough meat, but to be low in vegetables/fruits, grains, and milk products, and high in fats and sugar. Consumption of "junk" foods is frequent. This may explain why most people in *Eeyou Istchee* are either overweight or obese, and why intake of specific vitamins and minerals – notably calcium, vitamin D, and magnesium – is low. However, almost everyone in *Eeyou Istchee* eats traditional foods at least occasionally, and those who eat them more often (older adults and people in the coastal communities) appear to have healthier fat levels in their blood than others.

Dietary habits may contribute to the risk of cardiovascular disease and diabetes. The study found high rates of chronic inflammation, high blood pressure, imbalances in blood fats across the territory. All of these things were higher in Cree who were obese, and all increase the risk of heart disease. On the positive side, high levels of healthy Omega-3 fats in blood (associated with consumption of wild meats and fish) may provide some protective effect.

Like previous studies, *Nituuchischaayihtitaau Aschii* found that rates of diabetes are high in *Eeyou Istchee*. Although few Cree with diabetes are undiagnosed, the study identified many adults (9%) at the pre-diabetes stage. The researchers concluded that continued interventions to address obesity and inactive lifestyles are needed.

In contrast to the findings on heart disease and diabetes, those for thyroid disease and osteoporosis were encouraging. The study found that these two diseases were no more common in *Eeyou Istchee* than elsewhere in Canada.

All in all, the study found minimal concern in terms of risks from the natural environment (contaminants, zoonoses, or water quality). It did, however, raise some serious questions about the types of store-bought foods that people are eating, about obesity, and about risks for cardiovascular disease and diabetes.

APPENDIX:

COMPARISON OF VARIOUS THRESHOLD VALUES FOR MERCURY IN BLOOD AND HAIR

Explanation and Source	Blood – Total Mercury		Hair – Total Mercury	
	SI (international) **units: nanomoles per litre**	**Micrograms per litre = ppb** (parts per billion)	**SI units: nanomoles per gram**	**Micrograms per gram = ppm** (parts per million)
Centre de toxicologie, INSPQ, Quebec "Background" level	1-16	0.2-3.2	-	-
Nituuchischaayihtitaau Aschii study (pregnant women children under 15 and women of reproductive age): review fish consumption; contact physician if above these ranges.	60-99	12-20	20-25	4-5
Nituuchischaayihtitaau Aschii study (other adults): review fish consumption; contact physician if above these ranges	100-499	20-100	30-145	6-29
Level at which laboratories must declare to public health authorities in Quebec.	60	12	-	-
Levels corresponding to Health Canada (1998) tolerable daily intake for pregnant women or those under 50 years, infants and young children.	Less than 40	Less than 8	Less than 10	Less than 2
Repeat testing in 6 months is suggested as well as dietary advice, for males under 18 and females under 50 yrs of age. Repeat test immediately and contact physician if above these ranges.[1]	40-200	8- 40	10- 50	2-10
No follow-up is required for females aged 50 and over and males aged 18 and over.[1]	Less than 100	Less than 20	Less than 25	Less than 5
Repeat testing in 6 months is suggested as well as dietary advice for females aged 50 and over and males aged 18 and over. Repeat test immediately and contact physician if above these ranges.[1]	100-500	20-100	25-125	5-25
WHO "critical or earliest effect dose" (sensitive group).[2]	1000	200	250	50

1. Legrand M, Feeley M, Tikhonov C, Schoen D, Li-Muller A (2010). Methylmercury Blood Guidance Values for Canada. *Can J Public Health*. 101:28-31.

2. World Health Organization (WHO). Methylmercury. Environmental Health Criteria 1. Geneva: World Health Organization; 1976. Available from: http://www.inchem.org/documents/ehc/ehc/ehc001.htm

Conversion between SI units and old ones: SI = (old units x 5), and old units = SI divided by 5. This conversion applies to both blood and hair. (See http://www.irsst.qc.ca/ut_conversion_unite.htm)

Blood levels in ppb are usually considered to be equivalent to hair levels in ppm multiplied by 4.

Adapted from a table compiled by Elizabeth Robinson, MD, Public Health Department, Cree Board of Health and Social Services of James Bay, December 2013 (see Robinson, 2013).

REFERENCES

Arctic Monitoring and Assessment Programme (AMAP). *AMAP Assessment 2009: Human Health in the Arctic.* Oslo, Norway: AMAP; 2009. 254 p. Available from: www.amap.no

Arctic Monitoring and Assessment Programme (AMAP). *AMAP Assessment 2011: Mercury in the Arctic.* Oslo, Norway: AMAP; 2011. 193 p. Available from: www.amap.no

Berry M J, Ralston NVC (2008). Mercury toxicity and the mitigating role of selenium. *EcoHealth.* **5**:456-9.

Bonnier-Viger Y, Dewailly E, Egeland GM, Nieboer E, Pereg D (2007). Nituuchischaayihtitauu Aschii. *Multi-community environment-and-health longitudinal study in* Iiyiyiu Aschii: *Mistissini. Technical report: Summary of activities, results and recommendations*. Edited by Pereg D and Nieboer E. Montreal, QC: Cree Board of Health and Social Services of James Bay. Available from: http://www.creehealth.org/library/online/research/environmental-health-study-technical-report-mistissini

CBHSSJB Cree Board of Health and Social Services of James Bay (2012). Nituuchischaayihtitaau Aschii *multi-community environment and health longitudinal study in* Eeyou Istchee*: community reports.* Web content posted Aug 8, 2011. Available from: http://creehealth.org/clinical-protocols/nituuchischaayihtitaau -aschii-community-results.

CBHSSJB Cree Board of Health and Social Services of James Bay, Public Health Department (forthcoming 2013). *Cree Diabetes Information System Annual Update*. Draft of December 2012.

Champagne CM (2008). Magnesium in hypertension, cardiovascular disease, metabolic syndrome, and other conditions: a review. *Nutr Clin Pract.* Apr-May;**23**(2):142-51.

CIHR/NSERC/SSHRC Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada (2010). *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Chapter 9: Research involving the First Nations, Inuit and Métis peoples of Canada.* Ottawa, ON: Her Majesty the Queen in Right of Canada.

Cole TJ, Bellizzi MC, Flegal KM, et al. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* **320**(7244): 1240-3

Dewailly E, Blanchet C, Gingras S, Lemieux S, Holub BJ. (2002) Cardiovascular disease risk factors and n-3 fatty acid status in the adult population of James Bay Cree. *Am J Clin Nutr*. **76**(1):85-92.

Dewailly E, Nieboer E (2005). Exposure and preliminary health assessments of the Oujé-Bougoumou Cree population to mine tailings residues: Report of the survey. Montréal, QC: Institut National de Santé Publique du Québec. Available from: http://www.inspq.qc.ca/pdf/publications/349-OujeBougoumou_Report.pdf

Dumont C, Girard M, Bellavance F, Noël F (1998a). Mercury levels in the Cree population of James Bay, Quebec, from 1988 to 1993/94. *CMAJ*. **158**(11):1439-445.

Dumont C, Noel F, Girard M, Saganash L (1998b). *James Bay Mercury Agreement (1986), Health Component, 1987-1997 Activity Report.* Appendix 8E. Montreal: Public Health Department, Cree Board of Health and Social Services of James Bay.

Gallagher D, Heymsfield SB, Heo M, Jebb S, Murgatroyd P, Sakamoto Y (1999). Body mass index guidelines: corresponding % fat standards based on three-country study. *Inter J Obes*. **23**:S42-3.

Harris, SB, Naqshbandi M, Bhattacharyya O, Hanley AJG, Esler JG, Zinman B; CIRCLE Study Group (2011). Major gaps in diabetes clinical care among Canada's First Nations: Results of the CIRCLE study. *Diabetes Res Clin Pract.* **92**:272-279.

Institute of Medicine (IOM) and Food and Nutrition Board (2000). *Dietary reference intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington DC: National Academy Press.

Institute of Medicine (IOM) and Food and Nutrition Board (2000). *Dietary reference intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids.* Washington DC: National Academy Press.

Institute of Medicine (IOM) and Food and Nutrition Board (2005). *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids (macronutrients)*. Washington DC: National Academy Press.

Nieboer E, Dewailly E, Egeland GM, Château-Degat M-L, Bonnier-Viger Y (2011). Nituuchischaayihtitaau Aschii. *Multi-community environment-and-health longitudinal study in* Eeyou Istchee*: Eastmain and Wemindji. Technical report: Summary of activities, results and recommendations.* Edited by Nieboer E, Robinson E, and Petrov K. Montreal, QC: Cree Board of Health and Social Services of James Bay. Available from: http://www.creehealth.org/library/online/research/nituuchischaayihtitaau-aschii-multi-community-environment-and-health-0

Nieboer E, Dewailly E, Chateau-Degat M-L, Egeland GM, Johnson-Down L, Lévesque B, Robinson E, Torrie J (2013). Nituuchischaayihtitauu Aschii. *Multi-community Environment-and-Health Longitudinal Study in* Iiyiyiu Aschii*: Final Technical Report.* Edited by Nieboer E, Robinson E and Petrov K. Chisasibi, QC: Cree Board of Health and Social Services of James Bay. Available from: http://www.creehealth.org/library/online

Robinson, Elizabeth (2003). "Mercury levels in the recent study in Oujé and Nemaska – 2002." Presented at a workshop on mercury with the Namess Corporation and the Cree Board of Health and Social Services, Public Health Department. Final version for circulation, December 31, 2003.