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ᓄᓇᕕᒃ NUNAVIK 2017

ENVIRONMENTAL CONTAMINANTS: METALS

QANUILIRPITAA? 2017

Nunavik Inuit Health Survey

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RÉGIE RÉGIONALE DE LA SANTÉ ET DES SERVICES SOCIAUX DU NUNAVIK
NUNAVIK REGIONAL BOARD OF HEALTH AND SOCIAL SERVICES

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QANUILIRPITAA? 2017 HEALTH SURVEY

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In memory of Audrey Flemming and Linda Shipaluk

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

CHMS	Canadian Health Measures Survey
CI	confidence interval
DHA	docosahexaenoic acid
DPA	docosapentaenoic acid
EPA	eicosapentaenoic acid
FFQ	food frequency questionnaire
GM	geometric mean
KRG	Kativik Regional Government
MADO-C	notifiable diseases of chemical origin (maladies à declaration obligatoire d'origine chimique)
n-3 PUFA	long chain omega-3 polyunsaturated fatty acids
NQN	*Nutaratsaliit Qanuingisiarningit Niqituinnanut* – Pregnancy Wellness with Country Foods project
PHFSI	physical health and food security interview
PSI	psychosocial interview
RBC	red blood cell
RNUK	Regional Nunavimmi Umajulivijiit Katujaqatigininga (also known as the Nunavik Hunting Fishing Trapping Association (NHFTA))
SDQ	sociodemographic interview

1 BACKGROUND OF THE *QANUILIRPITAA?* 2017 HEALTH SURVEY

The *Qanuilirpitaa?* 2017 Health Survey is a major population health survey conducted in Nunavik that involved the collection, analysis and dissemination of information on the health status of Nunavimmiut. The last health survey conducted prior to it in Nunavik dated from 2004. Since then, no other surveys providing updated information on the health of this population had been carried out. Thus, in February 2014, the Board of Directors of the Nunavik Regional Board of Health and Social Services (NRBHSS) unanimously adopted a resolution to conduct a new health survey in all 14 Nunavik communities, in support of the Strategic Regional Plan.

The general objective of the 2017 health survey was to provide an up-to-date portrait of the health status of Nunavimmiut. It was also aimed at assessing trends and following up on the health and health determinants of adult participants since 2004, as well as evaluating the health status of Nunavik youth. This health survey has strived to move beyond traditional survey approaches so as to nurture the research capabilities and skills of Inuit and support the development and empowerment of communities.

Qanuilirpitaa? 2017 included four different components: 1) an adult component to document the mental and physical health status of adults in 2017 and to follow up on the adult cohort of 2004; 2) a youth component to establish a new cohort of Nunavimmiut aged 16 to 30 years old and to document their mental and physical health status; 3) a community component to establish the health profiles and assets of communities in a participatory research approach; and 4) a community mobilization project aimed at mobilizing communities and fostering their development.

This health survey relied on a high degree of partnership within Nunavik (Nunavik Regional Board of Health and Social Services (NRBHSS), Makivik Corporation, Kativik Regional Government (KRG), Kativik Ilisarniliriniq (KI), Avataq Cultural Institute, Qarjuit Youth Council, Inuulitsivik Health Centre, Ungava Tulattavik Health Centre), as well as between Nunavik, the Institut national de santé publique du Québec and academic researchers from three Canadian universities: Université Laval, McGill University and Trent University. This approach followed the OCAP principles of Ownership, Control, Access and Possession (First Nations Information Governance Centre, 2007).[1] It also emphasized the following values and principles: empowerment and self-determination, respect, value, relevance and usefulness, trust, transparency, engagement, scientific rigour and a realistic approach.

TARGET POPULATION

The survey target population was all permanent Nunavik residents aged 16 years and over. Persons living full time in public institutions were not included in the survey. The most up-to-date beneficiaries register of all Inuit living in Nunavik, provided by the Makivik Corporation in spring 2017, was used to construct the main survey frame. According to this register, the population of Nunavik was 12 488 inhabitants spread out in 14 communities. The register allowed respondents to be selected on the basis of age, sex and coast of residence (Hudson coast and Ungava coast).

SURVEY FRAME

The survey used a stratified proportional model to select respondents. Stratification was conducted based on communities and age groups, given that one of the main objectives of the survey was to provide estimates for two subpopulations aged, respectively, 16 to 30 years and 31 ears and over. In order to obtain precise estimates, the targeted sample size was 1 000 respondents in each age group. Assuming a 50% response rate, nearly 4 000 people were required to obtain the necessary sample size. From this pool, the number of individuals recruited from each

1. OCAP® is a registered trademark of the First Nations Information Governance Centre (FNIGC).

community was proportionate to population size and took into account the number of days that the survey team would remain in each community – a situation that imposed constraints on the number of participants that could be seen. Within each stratum, participants were randomly selected from the beneficiaries register. However, the individuals from the 2004 cohort, all 31 years old and over (representing approximately 700 individuals), were automatically included in the initial sample.

DATA COLLECTION

Data were collected from August 19, 2017 to October 5, 2017 in the 14 villages. The villages were reached by the *Amundsen*, a Canadian Coast Guard Icebreaker, and participants were invited on board the ship for data collection purposes.

Two recruitment teams travelled from one community to another before the ship's arrival. An Inuk assistant in each community helped: identify, contact and transport (if necessary) each participant; inform participants about the sampling and study procedures; obtain informed consent from participants (video) and fill in the identification sheet and sociodemographic questionnaire.

Data collection procedures for the survey included questionnaires, as well as clinical measurements. The survey duration was about four hours for each wave of participants, including their transportation to and from the ship. Unfortunately, this time frame was sometimes insufficient to complete the data collection process. This survey received ethical approval by the Comité d'éthique de la recherche du Centre Hospitalier Universitaire de Québec – Université Laval.

Aboard the ship, the survey questionnaires were administered by interviewers, many of whom were Inuit. Face-to-face interviews were conducted using a computer-assisted interviewing tool. If there were problems with the laptop connections, paper-form questionnaires were filled out. The questionnaires were administered in Inuktitut, English or French, according to the preference of the participants. Interviewers received training in administering the questionnaires prior to the start of the survey. The questionnaires were divided into five blocks: psychosocial interview (blocks 1 and 3), physical health and food security interview (block 2), food frequency questionnaire (block 4), and sociodemographic interview (block 5).

The survey also included a clinical component, with tests to document aspects of physical health, sampling of biological specimens (blood, oropharyngeal swabs, urine, stool, and vaginal swabs), spirometry, and an oral clinical exam. These sessions were supervised by a team comprised of nurses, respiratory therapists, dentists, dental hygienists and assistants, and laboratory technicians.

PARTICIPATION

There were a total of 1 326 participants, including 574 Nunavimmiut aged 16 to 30 years old and 752 Nunavimmiut aged 31 years and over, for total response rates of 30.7% and 41.5%, respectively. The participants' distribution between the two coasts (Ungava and Hudson) was similar. The distribution of men and women was unequal, with twice as many women (873) than men (453) participating in the survey. If the results obtained from this sample are to be inferred to the target population, survey weights must be used.

Overall, as compared to the 2004 survey, the response rate (i.e., the rate of participants over the total number of individuals on the sampling list) was lower than expected, especially among young people. This includes the refusal rate and especially a low contact rate. Several reasons might explain the low response rate, including the short time period available to contact individuals prior to the ship's arrival in the community and non-contact due to people being outside of the community or on the land. Nevertheless, among the individuals that were contacted (n = 1 661), the participation rate was satisfactory with an internal participation rate of 79.7%. More details on the collection, processing and analysis of the data are given in the Methodological Report (Hamel, Hamel & Gagnon, 2020).

2 INTRODUCTION

Inuit residing in Nunavik face elevated exposure to metals, including mercury, lead, and cadmium. **Mercury** released at southern latitudes, mainly through fossil fuel combustion and artisanal gold mining activities, is carried to northern latitudes by oceanic and atmospheric transport. Once converted into methylmercury (an organic form of mercury that is more readily absorbable) by microorganisms, it is biomagnified in Arctic food webs and accumulates in high concentrations in top-predator species (AMAP, 2015). As the Inuit traditional diet comprises large amounts of wild animals, Inuit face elevated exposure to mercury compared to populations living in southern regions (Basu et al., 2018). Conversely, these traditional foods (country foods) are an integral part of Inuit culture, are appreciated for their good taste, and are crucial to sustain food security and nutrition among pregnant women, children, and adults. Country foods are also central to Inuit knowledge transmission and taste preferences in the Arctic (Canadian Council of Academies, 2014).

Pregnant women and children are particularly vulnerable to methylmercury exposure, as this form of mercury can cross both the blood-brain and placental barriers (Pirkle et al., 2016). The Nunavik Child Development Study (NCDS) showed that prenatal chronic low-dose exposure to methylmercury is associated with several subtle adverse neurodevelopmental outcomes (including impaired attention, memory, cognition, vision and motor functions, as well as anxiety) in childhood or adolescence (Boucher et al., 2010, 2012a, 2014, 2016; Ethier et al., 2012; Jacobson et al., 2015; Lamoureux-Tremblay et al., 2020; St-Amour et al., 2006). Prenatal exposure to methylmercury has also been associated with the shortening of gestation by about one week (Dallaire et al., 2013). Similar findings were observed in the Faroe Islands, where marine mammals used to be frequently consumed (AMAP, 2015). Therefore, it is important to minimize exposure of pregnant women and women of childbearing age to methylmercury (Legrand et al., 2010). Although most research has shown effects of prenatal exposure, there is also some evidence that chronic postnatal exposure is associated with altered fine motor functions and reduced heart rate variability (an indication of impaired cardiovascular functions) in school-age children (Boucher et al., 2016; Després et al., 2005; Valera et al., 2012).

Among Nunavimmiut adults, chronic low-dose exposure to methylmercury has also been associated with elevated blood pressure and reduced heart rate variability (Valera et al., 2008; 2009). In other fish-eating adult populations, exposure to methylmercury has been associated with different neurological and immunological impairments, although such associations have never been evaluated in the Nunavimmiut adult population (Ha et al., 2017; Karagas et al., 2012).

In Nunavik, local country foods with the highest concentrations of methylmercury are beluga meat, lake trout and marine mammal organs (Lemire et al., 2015). These foods are eaten frozen, raw, or sometimes cooked. Inuit also often eat dried beluga meat (known as beluga *nikku*), which is particularly high in methylmercury as methylmercury binds to proteins and the drying process concentrates it in this type of country food (Lemire et al., 2015).

Based on the Nunavik Inuit Health Survey conducted in 2004 (*Qanuippitaa?* 2004), beluga meat consumption (raw or *nikku*) was identified as the main contributor to methylmercury exposure among Nunavimmiut adults, especially in Hudson Strait communities where most beluga hunting activities take place in Nunavik and blood mercury levels are the highest (Lemire at al., 2015). In the 1992 and 2004 Inuit health surveys in Nunavik, blood mercury levels were also higher among women compared to men, as well as among older adults (Dewailly et al., 2001; 2007). A more recent study conducted in 2016-2017 among pregnant Inuit women in Nunavik (*Nutaratsaliit Qanuingisiarningit Niqituinnanut* – Pregnancy Wellness with Country Foods project (NQN)) reported lower hair mercury levels in winter, but higher hair mercury levels in summer and fall (Pontual et al., 2021). The consumption of beluga meat, and particularly beluga *nikku*, contributed the most to these seasonal variations in methylmercury exposure. Pregnant women with the greatest variation in hair mercury levels over time were also those with the highest consumption of beluga meat, and other country foods did not have a significant impact on seasonal changes in hair mercury levels (Pontual et al., 2021).

The Minamata Convention, which aims to mitigate global mercury emissions and releases, entered into force on August 16, 2017 (UNEP, 2017). To evaluate its effectiveness, it is important to monitor exposure of populations to methylmercury. Before the Convention, methylmercury exposure among Nunavimmiut adults had already declined between 1992 and 2004. Similarly, an annual decreasing trend in methylmercury exposure among pregnant Inuit women had also been observed in Nunavik between 1992 and 2017, although a quarter of pregnant women still presented blood mercury levels above the Health Canada guideline value in 2017 (Adamou et al., 2020). There is no indication that mercury levels in the Arctic environment have decreased in recent decades. The reduction in methylmercury exposure among Nunavimmiut is likely the consequence of a decline in marine country food consumption (Adamou et al., 2020).

Inuit are also exposed to **lead**, mainly through the consumption of wild animals hunted with lead ammunition, the use of firearms fired with lead ammunition for hunting, and exposure to house dust containing lead, produced perhaps by the cleaning of firearms inside or near the house (Fillion et al., 2014; Lévesque et al., 2003). In 1999, the use of lead pellets for hunting migratory birds was banned in Canada, and the public health authorities of Nunavik actively informed the population about the risks of continued use of lead pellets for hunting (Levesque et al., 2003). This contributed to the voluntarily ban and replacement of lead pellets by steel pellets in Nunavik, and lead exposure greatly declined between 1992 and 2004 in Nunavimmiut adults (Dewailly et al., 2007; Couture et al., 2012). In 1992 and 2004, blood lead levels were higher among men than women, as well as among older Nunavimmiut adults (Dewailly et al., 2001; 2007). In 1992 and 2004, blood lead levels were also positively associated with cigarette consumption (Dewailly et al., 2001; Fontaine et al., 2008), as previously observed in other populations (Grandjean, 2003). Old paint and contaminated drinking water (due to lead pipes or lead-soldered joints) are known sources of lead exposure in other populations (ATSDR, 2020). However, nearly 60% of houses in Nunavik were built after 1991, with the oldest dating back to 1981 (SHQ, 2014), which minimizes the possibility that lead-based paint, lead pipes or lead-soldered joints are a significant source of exposure to lead in the region. Furthermore, lead is found naturally in water, but generally only in trace concentrations (ATSDR, 2020). Indeed, neither water samples obtained at municipal treatment plants nor samples collected from tanker trucks in several communities in 2015 and 2016 contained detectable levels of lead (KRG, personal communication).

Blood lead levels among pregnant Inuit women in Nunavik have also steadily decreased since they were first measured in 1992, but still 5% of pregnant women in 2016-2017 (NQN study) presented blood lead levels above the Health Canada guideline value (Lemire et al., 2018). A few years ago, a study in southern Quebec showed that consumers of wild meat shot with lead-headed bullets may also be exposed to lead, since lead bullet fragments, sometimes microscopic in size, can remain in the meat close to the wound channel of the bullet if not properly removed before consumption (Fachehoun et al., 2015). Moreover, in 2016, an investigation in Nunavik stores revealed that, while steel pellets were widespread, lead pellets remained available for purchase and were used in the region, and that lead-free bullets were not easily accessible in Nunavik, either due to a lack of availability or cost constraints (Pétrin-Dérosiers, 2016).

Exposure to lead is associated with several developmental and neurological adverse effects (ATSDR, 2020). In children, even low exposure to lead can notably induce irreversible adverse effects on brain functions, primarily cognitive function, behaviour and mood as well as motor and sensory functions (ATSDR, 2020). Low-level exposure to lead, prenatal and/or postnatal, has been associated with subtle impairments in growth, intellectual functions, memory, fine motor tasks, and visual brain development as well as with attention deficit and increased impulsivity in Inuit children from Nunavik (Boucher et al., 2009, 2012a, 2012b, 2014; Dallaire et al., 2014; Després et al., 2005; Ethier et al., 2012, 2015; Fraser et al., 2006; Jacobson et al., 2015; Plusquellec et al., 2007; 2010).

In adults, chronic low-level exposure to lead has also been associated with behaviour and cognitive impairments (ATSDR 2020). Low exposure to lead in children and adults can also cause kidney damage and dysfunction, as well as cardiovascular, immunological and reproductive problems (ATSDR, 2020). The effects of lead exposure have yet to be investigated in Nunavimmiut adults. High-dose lead exposure has been associated with anemia, although blood lead levels in Nunavik are below those that have been associated with this adverse effect (ATSDR 2020).

Cadmium from both anthropogenic and natural sources is released into the environment and can accumulate in lichen, vegetation, mollusks and seaweeds (WHO, 2010). High concentrations of cadmium can be found in the kidney and, in lower concentrations, in the liver of cervids (e.g., caribou), since they consume lichen (Robillard et al., 2002). Smokers have a higher exposure to cadmium, as tobacco plants accumulate cadmium from the soil. Non-smokers may also be exposed to cadmium through second-hand smoke (ATSDR, 2012). In *Qanuippitaa?* 2004, blood cadmium levels were within the reference values for the general Quebec population, were not different between sexes, and were higher among younger adults (18 to 24 years old). Overall, blood cadmium levels decreased by 22% between 1992 and 2004 (Dewailly et al., 2007; Fontaine et al., 2008). In 2004, blood cadmium levels were also strongly associated with cigarette consumption, whereas among non-smokers, blood cadmium levels were associated with the consumption of caribou kidneys and livers (Fontaine et al., 2008). The major health effect associated with cadmium exposure is kidney damage, as cadmium accumulates in the kidney and can cause generalized reabsorptive dysfunction (WHO, 2010). Meanwhile, inhalation of cadmium is associated with respiratory diseases and lung cancer (WHO, 2010). Lower chronic exposure to cadmium is also associated with disturbed calcium metabolism and bone damage (ATSDR, 2012; WHO, 2010). These health impacts of cadmium exposure have not been studied in Nunavik.

OBJECTIVES

- To document blood levels of mercury, lead and cadmium among Nunavimmiut aged 16 years and over, by age and sex, and to compare those levels with guideline values;
- To compare the results of the current study with those of the 1992 Santé Québec Survey and the 2004 *Qanuippitaa?* Nunavik Health Survey, other Inuit populations in Canada, and the general Canadian population;
- To examine associations between potential contemporary determinants of exposure and blood concentrations of the aforementioned toxic metals among Nunavimmiut.

3 METHODOLOGICAL ASPECTS

STUDY POPULATION

A total of 1 326 individuals participated in the data collection process onboard the CCGS *Amundsen*, and among them, 93.9% provided a blood sample. The final study sample consisted of 1 245 participants aged 16 and over, including 30 pregnant women.

DATA COLLECTION AND LABORATORY ANALYSES

Blood sample collection and laboratory analyses

Blood samples were collected by venipuncture by research nurses. Whole blood total mercury (a surrogate for methylmercury exposure in fish and marine mammal eating populations), lead and cadmium concentrations were measured using inductively coupled plasma mass spectrometry (ICP-MS) with a NexION® instrument from PerkinElmer (Waltham, MA, USA) and were analyzed at the Centre de toxicologie du Québec (Quebec, QC).

Red blood cell (RBC) fatty acid composition was analyzed at the Laboratory of Nutritional Lipidomics at the University of Waterloo, Ontario, using a Varian 3900 gas chromatograph equipped with a 15 m DB-FFAP capillary column (df = 0.10 μm). The amount of each fatty acid was calculated as a percentage of the total fatty acid content (relative %). The total omega-3 polyunsaturated fatty acid (n-3 PUFA) content in RBCs was calculated by summing the amounts of eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and docosapentaenoic acid (DPA), and was categorized into quartiles.

Dietary assessment and questionnaires

Dietary intake was assessed using a food frequency questionnaire (FFQ). The FFQ measured the frequency of intake for each item in the past three months; serving sizes were not considered. Country food items were then categorized into different groups according to possible sources of mercury, lead or cadmium exposure previously identified in Nunavik. As methylmercury accumulates primarily in predatory species and binds to protein (no methylmercury is present in the fat of marine mammals), the consumption of marine mammals (i.e., beluga *nikku*, beluga meat, beluga *mattaaq*, seal meat, seal liver, walrus meat (*igunak*)) and fish (Arctic char, dried fish (*pitsik*), lake trout, brook or sea trout, salmon, pike or walleye, lake whitefish (coregone) and sculpin (ugly fish)) was taken into account (Lemire et al., 2015). For lead exposure, several country foods were considered based on the lead content of the ammunition used for harvesting those species: wild birds (hunted using pellets), terrestrial animals (i.e., caribou *nikku*, caribou meat, polar bear, muskox; hunted using bullets) and marine mammals (hunted using bullets). In the case of cadmium, consumption of shellfish (mollusks (mussels, scallops, clams) and urchins) and seaweed was considered as these foods may accumulate low levels of cadmium.

In addition to the FFQ, questionnaires to document sociodemographic characteristics, hunting practices, ammunition use, drinking water sources, smoking status, cannabis use and second-hand smoke exposure were administered by trained interviewers. A list of variables used for bivariate analysis as well as the source questionnaire are presented in Table 1.

Table 1 List of variables used for bivariate analysis.

Source	Variables
PHFSI (block 2)	Hunting frequency, ammunition use, gun cleaning inside the house, and meat cleaning
PSI (block 3)	Drinking water source, smoking status, use of cannabis, second-hand smoke exposure
FFQ (block 4)	Consumption of various country foods (marine mammals, fish, shellfish, seaweed, terrestrial animals and wild birds)
SDQ (block 5)	Sex, age, ecological region

PSI = psychosocial interview; PHFSI = physical health and food security interview;
FFQ = food frequency questionnaire; SDQ = sociodemographic questionnaire.

GUIDELINE VALUE EXCEEDANCE

The prevalence of Nunavimmiut overly exposed to toxic metals was assessed using guideline values proposed by Health Canada and Quebec's Ministère de la santé et des services sociaux (notifiable diseases of chemical origin or *maladies à declaration obligatoire d'origine chimique* (MADO-C)) (Caron et al., 2016; Health Canada, 2019; Legrand et al., 2010). Health Canada's blood mercury guideline values were used for women of childbearing age (Legrand et al., 2010), whereas the U.S. lead guideline value for pregnant and breastfeeding women was applied to childbearing age women (Committee on Obstetric Practice, 2012). These guideline values are presented in Table 2.

STATISTICAL ANALYSIS

All statistical analyses were performed with SAS® Studio, Version 3.8. (Cary, North Carolina, USA) and used weights to take into account sampling methodology and item non-response so that the results could be inferred to the target population (Hamel, Hamel & Gagnon, 2020). For all statistical analyses, a significance level of $\alpha < 0.05$ was used and variance was estimated with the Balanced Repeated Replication (BRR) method.

Descriptive statistics were presented as geometric means (95% confidence intervals) of metal concentrations in whole blood and as prevalence of individuals exhibiting concentrations of metal above guideline values.

Bivariate analysis was performed to assess metal concentrations according to sex, age, ecological region, n-3 PUFA, drinking water source, smoking status, cannabis, hunting frequency, ammunition use, meat cleaning, gun cleaning, and consumption of marine mammals, terrestrial animals, wild birds, fish, shellfish and seaweed. For dichotomous independent variables, t-tests were used. For categorical independent variables with multiple categories, ANOVA were used, followed by post-hoc t-tests with Tukey-Kramer correction to consider unbalanced data. Comparisons of metal concentrations (unadjusted for age) were made with results from the 1992 Santé Québec Survey and the 2004 *Qanuippitaa?* Nunavik Health Survey. Comparisons were also made with concentrations documented in the Inuit Health Survey 2007-2008 conducted in the other regions of the Inuit Nunangat and with concentrations measured in the general Canadian population, as part of the Canadian Health Measures Survey (CHMS): Cycle 4, conducted in 2014-2015 (Health Canada, 2017). When the 95% confidence intervals of geometric means did not overlap, the difference between geometric mean values was considered significantly different.

4 RESULTS

4.1 PREVALENCE OF METALS CONCENTRATIONS ABOVE GUIDELINE VALUES

The prevalence rates for Nunavimmiut aged 16 years and over with concentrations exceeding the MADO-C guideline values for blood mercury, lead and cadmium were 40%, 4% and 7%, respectively (Table 2). Almost half (45%) of women were above the MADO-C guideline value for blood mercury, compared to 36% of men. Nearly six out of ten women of childbearing age (57%) exceeded Health Canada's mercury blood guideline value (Legrand et al., 2010), whereas 9% exceeded the United States blood lead guideline value for pregnancy or lactation (Committee on Obstetric Practice, 2012). Moreover, up to 7% of older women exceeded the Health Canada guideline for blood lead levels.

Table 2 Guideline exceedances (prevalence and 95% CI) for blood mercury, lead, and cadmium levels in Nunavimmiut aged 16 years and over, Nunavik, 2017.

	Mercury (%)			Lead (%)		Cadmium (%)
	Health Canada (women of childbearing age and men 18 years and under)[1]	Health Canada (women past reproductive age and men over 18 years)[1]	MADO-C[2]	U.S. Committee on obstetric practice (pregnant and breastfeeding women)[3]	Health Canada[4] and MADO-C[2]	MADO-C[2]
	≥ 40 nmol/L	≥ 100 nmol/L	≥ 60 nmol/L	≥ 0.25 µmol/L	≥ 0.5 µmol/L	≥ 45 nmol/L
Women (16 years and over)	–	–	44.6 (41.3 – 48.0)	–	3.9* (2.4 – 5.4)	6.3* (4.4 – 8.2)
Women of childbearing age (16 – 49 years)	57.4 (53.4 – 61.4)	–	40.5 (36.6 – 44.4)	9.1 (6.7 – 11.5)	2.9** (1.5 – 4.4)	6.8* (4.4 – 9.2)
Women (50 years and over)	–	35.8 (28.9 – 42.6)	57.3 (50.1 – 64.5)	–	6.9** (3.0 – 10.8)	4.7** (1.9 – 7.5)
Men (16 years and over)	–	–	35.8 (31.0 – 40.5)		3.0** (1.4 – 4.6)	7.7* (4.7 – 10.7)
Men (16 – 18 years)	31.7* (20.1 – 43.3)		21.0** (10.6 – 31.4)	–	1.2** (0.0 – 3.6)	7.4** (0.0 – 15.7)
Men (19 years and over)		19.6 (15.6 – 23.6)	38.2 (33.0 – 4 3.4)	–	3.3** (1.4 – 5.2)	7.7* (4.4 – 11.0)
Total	–	–	40.2 (37.3 – 43.0)	–	3.5* (2.4 – 4.5)	7.0 (5.2 – 8.7)

1. Health Canada provisional interim blood guideline value for mercury in women of childbearing age and adults (Legrand et al., 2010).
2. Quebec notifiable diseases of chemical origin (MADO-C) guideline values for blood mercury, lead and cadmium in adults (Caron et al., 2016).
3. U.S. guideline value for blood lead in pregnant and breastfeeding women (Committee on Obstetric Practice, 2012).
4. Health Canada guideline value for blood lead in adults (Health Canada, 2019).

* The coefficient of variation is greater than 15% and lower than or equal to 25%. The proportion should be interpreted carefully.

** The coefficient of variation is greater than 25%. The proportion is shown for information only.

Unit conversion: mercury: µg/L × 4.99 = nmol/L; lead: µg/L × 0.0048 = µmol/L; cadmium: µg/L × 8.90 = nmol/L.

4.2 MEAN CONCENTRATIONS OF TOXIC METALS ACCORDING TO SEX AND AGE GROUP

Blood mercury levels were higher in women than men, as well as among older Nunavimmiut (Table 3). Blood lead levels were higher in men than women, as well as among older Nunavimmiut. Blood cadmium levels were not different between sexes, but concentrations were higher among younger Nunavimmiut.

Table 3 Blood mercury, lead and cadmium levels (GM and 95% CI) according to sex and age group, Nunavik, 2017.

Contaminant and age group	Total		Men		Women	
	GM	(95% CI)	GM	(95% CI)	GM	(95% CI)
Mercury (nmol/L)						
16 – 29 years	33[a]	(29 – 36)	27[a]	(22 – 32)	41[a]	(37 – 45)
30 – 49 years	41[b]	(36 – 47)	35[a]	(28 – 44)	48[a]	(43 – 54)
50 years and over	66[c]	(59 – 73)	59[b]	(50 – 69)	73[b]	(65 – 82)
Total	42	(39 – 45)	***35***	(31 – 39)	***50***	(47 – 53)
Lead (μmol/L)						
16 – 29	0.09[a]	(0.08 – 0.09)	0.10[a]	(0.09 – 0.11)	0.08[a]	(0.07 – 0.09)
30 – 49	0.13[b]	(0.12 – 0.14)	0.15[b]	(0.13 – 0.17)	0.12[b]	(0.10 – 0.13)
50 years and over	0.18[c]	(0.17 – 0.20)	0.18[b]	(0.16 – 0.20)	0.18[c]	(0.17 – 0.20)
Total	0.12	(0.12 – 0.13)	***0.13***	(0.12 – 0.14)	***0.11***	(0.10 – 0.12)
Cadmium (nmol/L)						
16 – 29	17[a]	(15 – 19)	16[a]	(13 – 20)	17[a]	(15 – 19)
30 – 49	15[a]	(14 – 17)	17[a]	(14 – 20)	14[b]	(13 – 16)
50 years and over	11[b]	(9– 12)	8[b]	(7 – 10)	13[b]	(12 – 15)
Total	14	(14 – 15)	14	(12 – 16)	15	(14 – 16)

a, b, c Estimates in **bold** and with different exponents are significantly different between age groups ($p < 0.05$).
Estimates in ***bold and italics*** are significantly different between sexes (all age groups together) ($p < 0.05$).
GM: geometric mean; CI: confidence interval.
Unit conversion: mercury: μg/L × 4.99 = nmol/L; lead: μg/L × 0.0048 = μmol/L; cadmium: μg/L × 8.90 = nmol/L.

4.3 COMPARISONS WITH OTHER SURVEYS IN NUNAVIK AND ELSEWHERE IN CANADA

Santé Québec survey, 1992 and *Qanuippitaa?* 2004 (Nunavik)

Blood levels for mercury, lead, and cadmium in 2017 were compared to those reported in the Santé Québec Survey in 1992 and the *Qanuippitaa?* Nunavik Inuit Health Survey in 2004 (Dewailly et al., 2001; 2007) among people aged 18 years and over. Concentrations of all three toxic metals have progressively decreased since 1992. Over the 25-year period between 1992 and 2017, mercury levels fell by 44%, lead levels by 71% and cadmium levels by 58%. Between 2004 and 2017, mercury levels declined only moderately (by 18%), whereas lead levels decreased by 37% and cadmium levels by half (48%).

Table 4 Blood mercury, lead and cadmium levels (GM and 95% CI) among Nunavimmiut aged 18 years and over in Nunavik (1992, 2004 and 2017).

Contaminant	1992[1]		2004[1]		2017	
	GM	(95% CI)	GM	(95% CI)	GM	(95% CI)
Mercury (nmol/L)	**75[a]**	(69 – 81)	**51[b]**	(48 – 55)	**42[c]**	(39 – 45)
Lead (µmol/L)	**0.42[a]**	(0.40 – 0.44)	**0.19[b]**	(0.18 – 0.20)	**0.12[c]**	(0.12 – 0.13)
Cadmium (nmol/L)	**33[a]**	(31 – 36)	**27[b]**	(25 – 28)	**14[c]**	(14 – 15)

1. Data sources: Santé Québec Survey, 1992, and *Qanuippitaa*? 2004 (Dewailly et al., 2007; Fontaine et al., 2008).
Estimates in **bold** and with different exponents are significantly different between health surveys based on comparison of 95% CIs.
GM: geometric mean; CI: confidence interval.
Unit conversion: mercury: µg/L × 4.99 = nmol/L; lead: µg/L × 0.0048 = µmol/L; cadmium: µg/L × 8.90 = nmol/L.

Inuit in other regions of the Canadian Arctic and non-Inuit Canadian population

As shown in Table 5, blood mercury levels in Nunavik in 2017 were higher than among Inuit from the other regions of the Inuit Nunangat in 2007-2008. In contrast, blood lead levels in Nunavik in 2017 were lower than levels in the Inuit Health Survey 2007-2008, whereas blood cadmium levels were not different between Arctic regions.

Blood mercury, lead and cadmium levels in Nunavik in 2017 were all markedly higher than in the general Canadian population in 2014-2015 (Health Canada, 2017). Indeed, in 2017, blood mercury levels among Nunavimmiut were 12-fold higher, blood lead levels two-fold higher, and blood cadmium levels nearly 5-fold higher than levels in the general Canadian population in 2014-2015.

Table 5 Blood mercury, lead, and cadmium levels (GM and 95% CI) among Nunavimmiut aged 18 years and over in Nunavik (2017), among Inuit from other regions of the Inuit Nunangat (2007-2008) and among the general Canadian population (2014-2015).

	Qanuilirpitaa? 2017		Inuit Health Survey 2007-2008[1]		CHMS 2014-2015[2]	
	GM	(95% CI)	GM	(95% CI)	GM	(95% CI)
Mercury (nmol/L)	42	(39 – 45)	**35**	(33 – 36)	**3.4**	(3.2 – 3.6)
Lead (µmol/L)	0.12	(0.12 – 0.13)	**0.17**	(0.16 – 0.17)	**0.05**	(0.05 – 0.05)
Cadmium (nmol/L)	14	(14 – 15)	14	(13 – 15)	**3.2**	(3.0 – 3.4)

1. Data source: Inuit Health Survey 2007-2008 (Laird et al., 2015).
2. Data source: Canadian Health Measures Survey: Cycle 4 (2014-2015) (Health Canada, 2017).
Estimates in **bold** are different from the *Qanuilirpitaa?* 2017 corresponding estimate based on non-overlapping 95% CIs.
GM: geometric mean; CI: confidence interval.
Unit conversion: mercury: µg/L × 4.99 = nmol/L; lead: µg/L × 0.0048 = µmol/L; cadmium: µg/L × 8.90 = nmol/.

4.4 POTENTIAL DETERMINANTS OF BLOOD MERCURY, LEAD AND CADMIUM LEVELS

Associations between blood metal concentrations and sociodemographic characteristics, drinking water sources and lifestyle characteristics are reported in Tables 6 to 13.

Sociodemographic Characteristics

blood mercury levels were two-fold higher in Nunavimmiut from Hudson Strait villages compared to those living in Hudson Bay villages. They were also slightly higher in Hudson Bay than in Ungava Bay. Conversely, blood lead levels were significantly higher in Nunavimmiut living in Hudson Bay villages, whereas blood cadmium levels were significantly higher among residents from Hudson Bay and Hudson Strait.

Table 6 Blood mercury, lead, and cadmium levels (GM and 95% CI) according to ecological region, Nunavik, 2017.

	Mercury (nmol/L)		Lead (μmol/L)		Cadmium (nmol/L)	
	GM	(95% CI)	GM	(95% CI)	GM	(95% CI)
Ecological region[1]						
Hudson Bay	**37**[b]	(32 – 42)	**0.14**[a]	(0.13 – 0.15)	**18**[a]	(16 – 20)
Hudson Strait	**75**[a]	(67 – 83)	**0.11**[b]	(0.10 – 0.11)	**15**[a]	(13 – 17)
Ungava Bay	**31**[c]	(28 – 34)	**0.11**[b]	(0.11 – 0.12)	**11**[b]	(10 – 12)

a, b, c Estimates in **bold** and with different exponents are significantly different between ecological regions ($p < 0.05$).
1. Hudson Strait villages: Ivujivik, Salluit, Kangiqsujuaq and Quaqtaq; Hudson Bay villages: Kuujjuarapik, Umiujaq, Inukjuak, Puvirnituq and Akulivik; Ungava Bay villages: Kangirsuk, Aupaluk, Tasiujaq, Kuujjuaq and Kangiqsualujjuaq.
GM: geometric mean; CI: confidence interval.
Unit conversion: mercury: μg/L × 4.99 = nmol/L; lead: μg/L × 0.0048 = μmol/L; cadmium: μg/L × 8.90 = nmol/L.

Blood lead levels were not associated with drinking water sources in the summer and winter (Table 7).

Table 7 Blood levels for lead (GM and 95% CI) according to drinking water source among Nunavimmiut aged 16 years and over, Nunavik, 2017.

	Lead (μmol/L)	
	GM	(95% CI)
Drinking water source (summer)		
Municipal system[1]	0. 12	(0.12 – 0.13)
Other[2]	0.11	(0.10 – 0.12)
Drinking water source (winter)		
Municipal system[1]	0. 12	(0.12 – 0.13)
Other[2]	0.11	(0.10 – 0.12)

Estimates in **bold** are significantly different between variable categories ($p < 0.05$).
1. Municipal system includes tap at home and directly at the water plant.
2. Other sources: bottled water, nearby lake, river, or stream, melted snow, ice or iceberg.
GM: geometric mean; CI: confidence interval.
Unit conversion: lead: μg/L × 0.0048 = μmol/L; cadmium: μg/L × 8.90 = nmol/L.

Lifestyle Characteristics

tobacco and cannabis use. At the time of the survey, blood cadmium levels in current smokers were seven-fold higher than those of ex-smokers, who also had slightly higher cadmium levels than non-smokers (Table 8). Blood cadmium levels were higher as well among people who reported exposure to second-hand smoke in their home and had used cannabis in the 12 months prior to the survey. Smokers and cannabis users as well as those who reported being exposed to second-hand smoke in their house also exhibited higher blood lead levels.

Table 8 Blood lead and cadmium levels (GM and 95% CI) according to smoking status and cannabis consumption, Nunavik, 2017.

	Lead (µmol/L)		Cadmium (nmol/L)	
	GM	(95% CI)	GM	(95% CI)
Tobacco smoking status (at the time of the survey)[1]				
Current smoker	**0.13**[a]	(0.13 – 0.14)	**22.7**[a]	(21.8 – 23.6)
Former smoker	**0.09**[b]	(0.08 – 0.10)	**3.0**[b]	(2.7 – 3.3)
Never smoked	**0.10**[b]	(0.08 – 0.12)	**2.2**[c]	(1.9 – 2.6)
Exposure to second-hand smoke in the house				
Every day and nearly every day	**0.14**[a]	(0.13 – 0.16)	**18.3**[a]	(16.3 – 20.6)
Once a week or less	**0.11**[b]	(0.11 – 0.12)	**13.2**[b]	(12.2 – 14.3)
Cannabis use (last 12 months)[2]				
More than once a month	**0.13**[a]	(0.12 – 0.14)	**18.8**[a]	(17.3 – 20.4)
Once a month or less	**0.11**[b]	(0.10 – 0.12)	**11.6**[b]	(10.4 – 13.0)

a, b, c Estimates in **bold** and with different exponents are significantly different between variable categories ($p < 0.05$).
1. Based on reported smoking status at the time of the survey. Similar associations were observed using urinary cotinine.
2. Cannabis use included "weed, pot, marijuana, grass or hashish".
GM: geometric mean; CI: confidence interval.
Unit conversion: lead: µg/L × 0.0048 = µmol/L; cadmium: µg/L × 8.90 = nmol/L.

Hunting practices. Blood lead levels were significantly higher in people who reported hunting once per week or more during the summer season, as well as individuals using lead shot or pellets for hunting and those cleaning guns inside the house (or living in houses where someone cleaned guns inside) (Table 9). Conversely, people who reported using firearms, lead bullets or slugs for hunting did not display higher blood lead levels, and individuals who reported cleaning a large part of the meat contaminated with lead fragments around the wound channel of the bullet or the slug (10 cm and above) had higher blood lead levels, contrary to what was expected.

Table 9 Blood lead levels (GM and 95% CI) according to hunting practices and ammunition use, Nunavik, 2017.

	%[1]	Lead (µmol/L)	
		GM	(95% CI)
Hunting frequency (summer)[2]			
Once a week or more	37	**0.13[a]**	(0.13 – 0.14)
1 to 3 days a month	22	**0.11[b]**	(0.10 – 0.12)
Less than once a month/Never	39	**0.12[b]**	(0.11 – 0.13)
Among those who reported going hunting at least during one season (81% of respondents):			
Gun cleaning inside the house [3]			
Yes	38	**0.13[a]**	(0.12 – 0.14)
No	62	**0.12[b]**	(0.11 – 0.12)
Use of firearms[3]			
Yes	52	0.13	(0.12 – 0.13)
No	48	0.12	(0.11 – 0.13)
Among those who reported using firearms (42% of respondents):			
Lead ammunition use – bullets[4]			
Yes	88	0.12	(0.12 – 0.13)
No	12	0.14	(0.11 – 0.18)
Lead ammunition use – shots or pellets[4]			
Yes	61	**0.13[a]**	(0.12 – 0.15)
No	39	**0.11[b]**	(0.10 – 0.12)
Lead ammunition use – slugs[4]			
Yes	14	0.14	(0.11 – 0.17)
No	86	0.12	(0.12 – 0.13)
Meat cleaning (Meat removal)[4]			
None, only extract the bullet/slug	21	**0.10[a]**	(0.09 – 0.12)
Cut away less than 5 cm	29	0.13	(0.12 – 0.15)
Cut away between 5 and 10 cm	32	0.12	(0.11 – 0.14)
Cut away more than 10 cm	18	**0.14[b]**	(0.12 – 0.17)

a, b, c Estimates in **bold** and with different exponents are significantly different between variable categories ($p < 0.05$).
1. Participants who answered "Do not know" to a question were computed as not having answered the question.
2. Same trend for other seasons; associations (ANOVA) were significant for the fall (0.001), but not significant for spring ($p = 0.06$) and winter ($p = 0.09$).
3. This question was answered only by participants who reported going hunting at least during one season.
4. This question was answered only by participants who reported going hunting at least during one season and being the person who used the guns for hunting.

GM: geometric mean; CI: confidence interval.
Unit conversion: lead: µg/L × 0.0048 = µmol/L.

Dietary intake. Blood mercury levels were significantly higher in Nunavimmiut who reported consuming marine mammals and fish more frequently in the three months prior to the survey (Table 10). Blood lead levels were slightly higher in individuals who declared consuming wild birds and marine mammals more frequently during the same period (Table 11). Blood cadmium levels were not associated with shellfish (mollusks and urchins) and seaweed consumption frequency (Table 12).

Table 10 **Blood mercury levels (GM and 95% CI) according to the consumption of marine mammals and fish during the three months prior to the survey, Nunavik, 2017.**

	Mercury (nmol/L)		
	Median (times/day)	GM	(95% CI)
Marine mammals (meat and organs and beluga *mattaaq*)[1]			
Above or equal to median	0.20	**53**	(48 – 59)
Below median		**33**	(30 – 37)
Fish[2]			
Above or equal to median	0.27	**47**	(43 – 51)
Below median		**37**	(34 – 41)

Estimates in **bold** are significantly different between variable categories ($p < 0.05$).
1. Marine mammals: beluga *nikku*, beluga meat, beluga *mattaaq*, seal meat, seal liver and walrus meat (*igunak*).
2. Fish: Arctic char, dried fish (*pitsik*), lake trout, brook or sea trout, salmon, pike or walleye, lake whitefish (coregone) and sculpin (ugly fish).

GM: geometric mean; CI: confidence interval.
Unit conversion: mercury: µg/L × 4.99 = nmol/L.

Table 11 **Blood lead levels (GM and 95% CI) according to the consumption of terrestrial animals, wild birds, marine mammals and fish during the three months prior to the survey, Nunavik, 2017.**

	Lead (µmol/L)		
	Median (times/day)	GM	(95% CI)
Terrestrial animals[1]			
Above or equal to median	0.21	0.13	(0.12 – 0.13)
Below median		0.12	(0.11 – 0.13)
Wild birds[2]			
Above or equal to median	0.06	**0.13**	(0.12 – 0.14)
Below median		**0.11**	(0.10 – 0.11)
Marine mammals (meat, organs, *mattaaq*, fat)[3]			
Above or equal to median	0.32	**0.13**	(0.12 – 0.13)
Below median		**0.11**	(0.10 – 0.12)

Estimates in **bold** are significantly different between variable categories ($p < 0.05$).
1. Terrestrial animals: caribou *nikku*, caribou meat, polar bear and muskox.
2. Wild birds: ptarmigan, partridge and goose (Canada or white goose).
3. Marine mammals: beluga *nikku*, beluga meat, beluga *mattaaq*, beluga *misirak/ursuk*, seal meat, seal liver, seal *misirak/ursuk* and walrus meat (*igunak*).

GM: geometric mean; CI: confidence interval.
Unit conversion: lead: µg/L × 0.0048 = µmol/L.

Table 12 Blood cadmium levels (GM and 95% CI) according to consumption of shellfish and seaweed during the three months prior to the survey, Nunavik, 2017.

	Cadmium (nmol/L)			
	Median (times/day)	% of consumers	GM	(95% CI)
Shellfish[1]				
Above or equal to median	0.01		15	(14 – 16)
Below median			15	(13 – 16)
Seaweed[2]				
Consumer		27.2	14	(13 – 16)
Non-consumer			15	(14 – 16)

Estimates in **bold** are significantly different between variable categories ($p < 0.05$) (no statistical differences in this table).
1. Shellfish: mollusks (mussels, scallops, clams) and urchins.
2. Less than 50% of Nunavimmiut consumed seaweed, therefore the variable is presented as consumer vs. non-consumer.
GM: geometric mean; CI: confidence interval.
Unit conversion: cadmium: µg/L × 8.90 = nmol/L.

Blood mercury levels were strongly and positively associated with long-chain omega-3 polyunsaturated fatty acid (n-3 PUFA) quartiles in red blood cells (Table 13).

Table 13 Blood mercury levels (GM and 95% CI) according to quartiles of n-3 PUFA content in RBC membranes, Nunavik, 2017.

	Mercury (nmol/L)	
	GM	(95% CI)
RBC n-3 PUFA (quartiles, %)[1]		
Q1 (2.8 – 5.8)	**19**[a]	(16 – 21)
Q2 (5.6 – 7.4)	**40**[b]	(35 – 44)
Q3 (7.4 – 9.4)	**59**[c]	(54 – 65)
Q4 (9.4 – 16.8)	**90**[d]	(82 – 100)

a, b, c, d Estimates in **bold** and with different exponents are significantly different between variable categories ($p < 0.05$).
1. Sum of EPA, DHA and DPA expressed as the % of total fatty acids in RBC.
GM: geometric mean; CI: confidence interval.
Unit conversion: mercury: µg/L × 4.99 = nmol/L.

5 DISCUSSION

MERCURY

Although blood mercury levels in Nunavimmiut have declined by 44% since the 1992 Santé Québec Survey in Nunavik, methylmercury exposure remains an important public health issue in Nunavik, especially among women. Most notably, more than half (57%) of women of childbearing age presented blood mercury levels above the Health Canada guideline value at the time of the survey in summer and fall 2017. Low chronic exposure to methylmercury during pregnancy have been associated with several adverse neurodevelopmental outcomes later in childhood, both in Nunavik and among other populations consuming marine mammals and fish (Pirkle et al., 2016). Overall, blood mercury levels in Nunavik were several times higher than in the general Canadian population (Health Canada, 2017) and this highlights the importance of international conventions (e.g., the Minamata Convention) for decreasing methylmercury bioaccumulation in Arctic wildlife and protecting the exceptional quality of country foods to foster healthy pregnancies, children and adults in Nunavik.

As observed in previous surveys, blood mercury levels in 2017 were higher among older Nunavimmiut. Further, as previously observed in 2004, blood mercury levels remained higher among residents of Hudson Strait villages, followed by those of Hudson Bay villages (Lemire et al., 2015). The Hudson Strait region is where most beluga harvesting takes place in Nunavik. Beluga blubber and *misirak* (rendered blubber), beluga *mattaaq* (made of beluga skin and blubber) and beluga meat and *nikku* (dried meat) are highly praised country foods in Nunavik. In the present survey, as in *Qanuippitaa?* 2004, these country foods were more frequently consumed in Hudson Strait villages, most likely because they are more accessible in this region (see the thematic report "Country and Market Food Consumption and Nutritional Status"). Moreover, in *Qanuilirpitaa?* 2017, lake trout (which also accumulates high levels of mercury) was the second most frequently consumed fish after Arctic Char in Hudson Bay villages (see the thematic report "Country and Market Food Consumption and Nutritional Status"). In the present report, marine mammal and fish consumption was associated with higher blood mercury levels. Moreover, blood mercury levels were also strongly and positively associated with omega-3 polyunsaturated fatty acids in red blood cells. This finding supports previous observations that the consumption of country foods, and particularly marine foods, which are exceptionally rich in these high-quality fats, is a major determinant of mercury exposure in Nunavik (Fontaine et al., 2008; Lemire et al., 2015). More in-depth analyses are under way to identify which specific country foods contributed the most to mercury intake in Nunavimmiut in summer and fall 2017.

In the present survey, women exhibited 30% higher blood mercury concentrations than men. Conversely, in other regions of Inuit Nunangat, Inuit men systematically presented higher blood mercury levels (Curren et al., 2017), similar to those observed among other fish-eating populations in, for example, Eeyou Istchee, Japan and the Brazilian Amazon (Drescher et al., 2014; Passos et al., 2008; Tsuji et al., 2012). Interestingly, in 2004 and 2017, Inuit women also systematically presented higher blood selenium and n-3 PUFA levels (see thematic report "Country and Market Food Consumption and Nutritional Status"). Higher blood mercury, selenium and n-3 PUFA levels in Nunavimmiut women could be due to preferential consumption of specific country foods containing higher concentrations of these elements by Nunavimmiut women, as suggested by Little and al. (2019) for selenium. Additional studies would make it possible to better understand the health effects of gender-based country food preferences among Nunavimmiut.

The exceptional blood selenium status of Nunavimmiut is due to their elevated intake of selenoneine, an organoselenide compound that is found in high concentrations in beluga *mattaaq* (Achouba et al., 2019; Little et al., 2019). Selenium and selenoneine are known to interact with methylmercury in red blood cells, and selenoneine has been shown to enhance the demethylation of methylmercury (Khan and Wang, 2010; Yamashita et al., 2013). Further studies are needed to explore the hypothesis that the demethylation of mercury would in turn decrease the distribution of methylmercury to target organs (such as the brain) or to the foetus.

LEAD

Blood lead levels markedly declined in Nunavik between 1992 and 2017 (by 71%), mostly thanks to the voluntarily ban on lead pellets by Nunavik hunters in the late 1990s (Lévesque et al., 2003). However, in 2017, 9% of women of childbearing age (16 to 49 years old), 7% of older women (50 years and over) and 3% of men (16 years and over) in Nunavik still presented blood lead levels above U.S. or Health Canada guidelines. Moreover, lead exposure remained twice as high compared to the prevalence observed in the general Canadian population in 2014-2015 (Health Canada, 2017).

Blood lead levels were greater among Nunavimmiut aged 50 and over than in the younger age groups. Lead is known to accumulate in the body with age and is stored mainly in bones, accounting for >90% of the total body burden of lead in adults (ATSDR, 2020). Lead stored in bone can be remobilized and released back into the circulation. A number of conditions, including menopause, andropause and osteoporosis, can increase remobilization of lead from bone and thereby raise blood lead levels (Health Canada, 2013a). Therefore, lifelong accumulation of lead and bone resorption occurring in elders may explain the higher blood lead levels noted in this age group.

In the present survey, blood lead levels were slightly higher among men, perhaps reflecting that more men than women practice hunting, use firearms, and clean them (Furgal and Rochette, 2007). In the present survey, people who went hunting frequently, who used lead pellets and who reported cleaning guns inside the house (or living in houses where someone cleaned guns inside) exhibited slightly higher blood lead levels. Furthermore, consumption of wild birds, which are hunted using pellets, was also associated with higher blood lead levels. Interestingly, geese consumption was more frequent in Hudson Bay villages (thematic report "Country and Market Food Consumption and Nutritional Status"), where blood lead levels were found to be the highest. Taken together, these results suggest that lead ammunition, and particularly lead pellets, continue to play a role in lead exposure in Nunavik. As of 2016, lead pellets were still available for purchase and used in the region (Pétrin-Dérosiers, 2016).

Some of the results for lead exposure were not in line with current hypotheses. Nunavimmiut who use lead bullets or slugs for hunting did not present higher blood lead levels, while individuals who cleaned the largest share of the meat contaminated with lead micro-fragments around the wound channel of the bullet or the slug exhibited higher blood lead levels, contrary to what was expected. Surprisingly, blood lead levels were also associated with the consumption of marine mammals. These mammals are hunted with bullets, but shot essentially in the head, which is not often consumed by Inuit (NHFTA, personal communication). Consequently, care should be exercised in interpreting these results, especially because not all participants answered the questions with respect to gun cleaning, firearm use, bullet use and meat cleaning due to the structure of the questionnaire.

Finally, blood lead levels were also elevated among individuals who reported smoking cigarettes, being exposed to second-hand smoke in their house and using cannabis, which is often smoked simultaneously with tobacco. Cigarette smoking was frequent and remained similar between 2004 and 2017 (69% and 72% of daily smokers, respectively) and cannabis use was also frequent among Nunavimmiut in 2017 (63% had used cannabis during the previous year). Exposure to second-hand smoke was also prevalent in 2017, with 27% of Nunavimmiut reporting being exposed to second-hand smoke in their home more than once a week (Bélanger et al., 2020). Interestingly, the association between lead exposure and tobacco smoking status was also reported in previous surveys in Nunavik (Dewailly et al., 2001; Fontaine et al., 2008) and elsewhere (Grandjean 1993; Ritcher 2013). More in-depth multivariate analyses are needed to confirm these findings and better identify key practices, dietary sources and substance use leading to elevated lead exposure in Nunavik.

CADMIUM

Blood cadmium levels among Nunavimmiut in 2017 were five times higher than in the general Canadian population, although concentrations had declined by nearly 50% since the last health survey in 2004. In the present survey, 7% of Nunavimmiut presented blood cadmium levels above the MADO guideline values applicable in the province of Quebec. Blood cadmium levels were higher among younger Nunavimmiut, not different between sexes, and more elevated in Hudson Bay and Hudson Strait villages. They were strongly associated with current cigarette smoking, exposure to second-hand smoke and cannabis consumption, and were moderately associated with past cigarette smoking. As mentioned above, smoking prevalence did not decline between 2004 and 2017, and further investigation is needed to explain the important decrease in blood cadmium levels within this period. A reduction in the number of cigarettes smoked daily by smokers could explain the decrease in blood cadmium levels noted in this population. However, the average number of cigarettes consumed daily did not change substantially between 2004 and 2017 (Bélanger et al., 2020; Plaziac, Hamel and Rochette, 2007). Alternatively, a decrease in the cadmium content of tobacco could also explain the reduction in blood cadmium levels among smokers. The cadmium content of tobacco leaves reflects that of agricultural soils, which can be increased by the use of phosphate fertilizers (Lugon-Moulin et al., 2006). Amending soil with low-cadmium fertilizers has been suggested as a means to lower the cadmium content of tobacco (Manohar et al., 2012). No recent data on the cadmium content of Canadian tobacco were located.

Blood cadmium levels were not associated with shellfish (mollusks and urchins) or seaweed consumption, but these country foods were not consumed very often by Nunavimmiut at the time of the survey. No information regarding caribou kidney and liver consumption was obtained in the present survey, even though caribou organs were previously linked to blood cadmium levels among non-smoking Nunavimmiut (Fontaine et al., 2008).

Further analyses are needed to disentangle the effects of cigarette smoking and cannabis use on cadmium exposure among Nunavimmiut and better define the possible dietary sources.

LIMITATIONS

In the present report, we used concentrations of metals in blood as biomarkers to assess exposure to these toxicants. Although concentrations of metal in biological fluids are frequently used as biomarkers of exposure, values may be influenced by genetic variability, lifestyle factors, health status, the type of biological sample used for making measurements, and the analytical methodology. For example, blood mercury levels have been associated with hemoglobin levels in maternal and cord blood from a Faroes cohort (Kim et al., 2014). Moreover, in the Inuit Health Survey 2007-2008, biomarker levels for mercury, cadmium and lead were found to vary significantly according to several gene variants (Parajuli et al., 2018). The lower the exposure, the greater the impact of these factors on blood metal levels. More in-depth analyses of factors associated with blood metal levels will require the use of multivariate models.

6 CONCLUSION

These findings indicate that mercury exposure is still a key public health issue in Nunavik, especially among women. International regulations aimed at reducing mercury at the source are of the utmost importance to protecting the exceptional quality of country foods in Nunavik and elsewhere in the circumpolar region. Nevertheless, there is a need to address and closely monitor the effects of climate change on the exposure of Arctic wildlife and Inuit to mercury, which can increase due to the release of mercury from thawing permafrost and melting glaciers and change according to the redistribution of species in food webs (AMAP, 2021). In the meantime, regional and local interventions aimed at mitigating mercury exposure, especially for unborn babies and children, while considering the central role of country food in health and wellness, as well as its benefits in terms of nutrition and food security, are important for healthy pregnancies and children in Nunavik.

These findings also highlight the fact that lead and cadmium exposure remains a concern for some Nunavimmiut and that ongoing activities are important to promote the use of lead-free ammunition, reduce tobacco and cannabis consumption and encourage smoke-free homes, all with a view to continuing to decrease lead and cadmium exposure in Nunavik.

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APPENDIX A

QUESTIONNAIRES

[8] ᐆᒪᔪᕐᓂᐊᓂᖅ ᐃᖃᓪᓚᐊᓂᕐᓗ

ᐊᐱᕐᓃᑎᐅᓚᖓᓕᕐᒥᔪᑦ ᐆᒪᔪᕐᓂᐊᕆᓂᓃᑎᓐᓂᑦ ᐃᖃᓪᓚᐊᓂᕆᓃᑎᓐᓄᓕᖓᔪᑦ

[8] HUNTING AND FISHING

The following questions refer to your hunting and fishing habits

1. <u>ᐊᓂᒍᕐᑐᓂᑦ ᑕᕐᕿᓂᑦ 12ᓂᑦ,</u> ᖃᑦᓯᕕᒐᓚᑦᓱᑎᑦ ᐆᒪᔪᕐᓂᐊᕆᐊᕐᓂᕐᑭ? ᓚᐅᕐᓯᒪᖖᒋᐸᑦ ᖃᖓᑐᐃᓐᓇᖓᓂ ᐊᕐᕌᒍᒥ ᐁᒋᑦ ᑎᒥᐅᑉ ᖃᓄᐃᓕᖓᓂᖓᓄᑦ-ᐊᕕᑦᑐᓯᒪᔪᖅ 7 ᐊᐱᕐᓱᑎᒃ 7ᒧᑦ.

1. <u>In the past 12 months</u>, on average, how often did you go hunting? If NEVER in all seasons go to PHFS – Section 7 –Q7

		1- Never ᓚᐅᕐᓯᒪᖖᒋᑐᖅ	2- Less than once a month ᐊᑕᐅᓯᕐᒥᒃ ᐃᑭᓐᓂᓴᖅ ᑕᕐᕿᓚᒦᒥ	3- 1 to 3 days per month 1ᒥᑦ 3ᒧᑦ ᐅᓐᓄᓂᑦ ᑕᕐᕿᓚᒦᒥ	4- Once a week or more ᐊᑕᐅᓯᐊᕐᓱᓂ ᐱᓇᓱᐊᕈᓯᓚᒦᒥ ᐅᖓᑖᓄᓐᓃᑦ	DK/ NR/R
ᐊ) ᐅᐱᕐᖓᓴᒥ	a) Spring	1	2	3	4	99
ᐸ) ᐅᐱᕐᖔᒥ(ᐊᐅᔭᒥ)	b) Summer	1	2	3	4	99
ᑕ) ᐅᑭᐊᒥ	c) Fall	1	2	3	4	99
ᑲ) ᐅᑭᐅᒥ	d) Winter	1	2	3	4	99

2. [4] ᐃᕝᕕᑦ ᐃᓪᓗᒥᐅᖃᑏᓪᓗᓃᑦ ᕿᑭᐅᑎᓂᑦ ᓴᓗᒻᒪᕌᓱᖑᕕᓯ ᐃᓪᓘᑉ ᐃᓗᐊᓂ?
   - ◯ 1- ᐋ
   - ◯ 2- ᐊᐅᑲ
   - ◯ 99- ᖃᐅᔨᒪᖖᖏᑐᖅ-ᑭᐅᖖᖏᑐᖅ-ᑭᐅᒍᒪᖖᖏᑐᖅ

2. [4] Do you or someone in your home clean guns inside the house?
   - ◯ 1- Yes
   - ◯ 2- No
   - ◯ 99- DK/NR/R

3. [3N] ᕿᑭᐅᑎᒦᒃ ᐊᑐᕐᑎᒋᔭᐅᓃᖑᕕᑦ?
   - ◯ 1- ᐋ
   - ◯ 2- ᐊᐅᑲ ᐁᒋᑦ ᑎᒥᐅᑉ ᖃᓄᐃᓕᖓᓂᖓᓄᑦ-ᐊᕕᑦᑐᓯᒪᔪᖅ 7 -ᐊᐱᕐᓱᑎᒃ 7ᒧᑦ
   - ◯ 99- ᖃᐅᔨᒪᖖᖏᑐᖅ-ᑭᐅᖖᖏᑐᖅ-ᑭᐅᒍᒪᖖᖏᑐᖅ ᐁᒋᑦ ᑎᒥᐅᑉ ᖃᓄᐃᓕᖓᓂᖓᓄᑦ-ᐊᕕᑦᑐᓯᒪᔪᖅ 7 -ᐊᐱᕐᓱᑎᒃ 7ᒧᑦ

3. [3N] Are you the one who use the firearm?
   - ◯ 1- Yes
   - ◯ 2- No Go to PHFS – Section 7 –Q7
   - ◯ 99- DK/NR/R Go to PHFS – Section 7 –Q7

4. [2] ᐊᑐᓰᖑᕖᑦ ᓇᓪᓗᐃᓐᓇᖏᓐᓂᑦ ᐅᑯᓂᖓ ᓴᒃᑯᓂᑦ ᐆᒪᔪᕐᓂᐊᓇᐊᓗᕋᕖᑦ?

(ᖃᓄᐃᓗᖁᔨᒍᑏᑦ: ᐊᐱᕐᓯᑎᒃ ᑕᑯᔭᐅᑎᑦᓯᓗᓂ ᐊᑦᔨᖑᐊᖏᓐᓂᑦ ᓴᒃᑯᐃᑦ ᐊᐱᕐᓯᑕᒥᓄᑦ)

4. [2] Do you use any of the following types of ammunition for hunting?

(INSTRUCTIONS : the interviewer shows the pictures of ammunition to the participant)

		Yes ᐋ	No ᐊᐅᑲ	DK/NR/R
ᐊ) ᓴᒃᑯᐃᑦ (ᐅᖁᒣᓗᑕᓖᑦ)	a) Bullets (with lead)	◯ 1	◯ 2	◯ 99
ᐸ) ᓴᒃᑯᐃᑦ (ᐅᑯᒣᓗᑕᖃᖏᒃᑐᑦ, ᐅᒃᑰᑎᒥᓗᒍ ᑲᔪᖅ ᑭᑭᐊᑦᓴᔭᒃ)	b) Bullets (without lead, ex. Copper)	◯ 1	◯ 2	◯ 99
ᑕ) ᐅᖁᒣᑦᑐᔭᖅ ᓴᒃᑯᒃ ᖁᑭᐅᑎᓪᒪᓇᒧᑦ	c) Lead shot for shotguns	◯ 1	◯ 2	◯ 99
ᑲ) ᐅᖁᒣᑦᑐᔭᖃᖏᒃᑐᖅ ᓴᒃᑯᒃ (ᑭᑭᐊᑦᓴᔭᒃ, ᐊᓯᖏᓪᓗ) ᖁᑭᐅᑎᓪᒪᓇᒧᑦ	d) Unleaded shot (steel, etc.) for shotguns	◯ 1	◯ 2	◯ 99
ᒐ) ᐅᖁᒣᓗᑕᓕᒃ ᓴᒃᑯᒃ (ᐅᖁᒣᓗᑕᓕᒃ ᐊᑕᐅᓯᕐᒥᒃ ᓴᒃᑯᒃ) ᖁᑭᐅᑎᓪᒪᓐᓇᓄᑦ	e) Lead slug (with one lead bullet) for shotguns	◯ 1	◯ 2	◯ 99
ᒪ) ᐅᖁᒣᓗᑕᖃᖏᒃᑐᖅ ᓴᒃᑯᒃ (ᐊᑕᐅᓯᕐᒥᒃ ᓯᑎᔪᔭᒥᒃ ᓴᒃᑯ, ᐊᓯᖏᓪᓗ) ᖁᑭᐅᑎᓪᒪᓇᓄᑦ	f) Unleaded slug (with one steel bullet, etc.) for shotguns	◯ 1	◯ 2	◯ 99

5. [5N] ᖃᓄᖅ ᐋᑦᑐᓰᖑᕕᑦ ᓂᕿᖕᒪᓂᒃ, ᖁᒃᑭᖕᒪᓂᑦ ᓴᒃᑯᒧᑦ ᐅᕝᕙᓗᓐᓃᑦ ᓴᒃᑯᐊᕈᕐᒧᑦ?

ᖃᓄᐃᓘᖁᔨᒍᑎᒃ: ᖁᒃᑭᐅᑉ ᐃᓂᖓ ᑐᑭᓕᒃ ᓴᒃᑰᑉ ᐃᑎᕐᕕᕕᓂᖓ: ᑕᒪᒥᓐᓂ ᓯᓚᑖᓂ ᐃᓗᐊᓂᓗ ᓂᕿᖓᑕ. ᐊᐱᕐᓯᑎᒃ ᑕᑯᔭᐅᑎᑦᓯᓗᓂ ᐊᑦᔨᖑᐊᖓᓂᒃ ᓂᕿᒥᒃ ᖁᒃᑭᓕᓪᒥᑦ ᐃᓚᐅᔪᒧᑦ.

- ◯ 1- ᓱᖕᖏᑕᕋ, ᓴᒃᑯᖓ ᐲᑐᐃᓐᓇᓱᒍ ᓂᕿᒥ
  ᐲᕐᓯᕗᖓ ᓴᒃᑯᒥᒃ ᐊᒻᒪᓗ...
- ◯ 2- ᐲᕐᓯᕗᖓ ᓂᕿᒥᒃ ᒥᑭᓂᕐᓴᒥᒃ 5 cmᒥᒃ ᐊᕙᑎᖓᓂᑦᑐᒥᒃ ᓴᒃᑰᑉ/ᓴᒃᑯᒧᑦ ᓱᕐᕋᑕᐅᕗᒥᑦ
- ◯ 3- ᐲᕐᓯᕗᖓ ᓂᕿᒥᒃ 5-10 cmᖓᓚᖕᓂᑦ ᐊᕙᑎᖓᓂᑦᑐᒥᒃ ᓴᒃᑰᑉ/ᓴᒃᑯᒧᑦ ᓱᕐᕋᑕᐅᕖᑉ
- ◯ 4- ᐲᕐᓯᕗᖓ 10 cmᒥᒃ ᐊᖏᓂᕐᓴᒥᒃ ᓂᕿᒥᒃ ᖁᒃᑭᐅᑉ ᐊᕙᑎᖓᓂ/ᓴᒃᑯᒧᑦ ᓱᕐᕋᑕᐅᕖᑉ
- ◯ 99- ᖃᐅᔨᒪᖖᖏᑐᖅ-ᑭᐅᖕᖏᑐᖅ-ᑭᐅᒍᒪᖕᖏᑐᖅ

5. [5N] How do you clean meat that is damaged after shooting with a bullet or a slug?

Instructions: the impact area refers to the bullet channel: both at the surface of the animal and inside the meat. The interviewer shows the picture of the meat with bullet impact to the participant.

- ◯ 1- Nothing is done, I only extract the slug/bullet from the meat
  I extract the slug/bullet and...
- ◯ 2- I cut away less than 5 cm of the meat around the slug/bullet impact
- ◯ 3- I cut away between 5 and 10 cm of the meat around the slug/bullet impact
- ◯ 4- I cut away more than 10 cm of the meat around the slug/bullet impact
- ◯ 99- DK/NR/R

6. [6N] ᑕᒃᑲᓂᑦᓴᓇᖅ ᐊᕐᕌᒍᑉ ᐃᓗᐊᓂ, 2011ᒥᓂᑦ (ᐊᕐᕌᒍᐃᑦ ᑕᓪᓚᒪᐅᓚᕐᑐᑦ) ᐅᑯᐊ ᐆᒪᔪᕐᓂᐊᑕᕕᓂᑎᑦ ᓂᕆᔭᑦᓴᐅᓯᑎᑦ ᐆᒪᔪᓇᐊᑐᓂᕐᓴᐅᕚᑦ, ᐱᔭᓇᐊᑭᓐᓂᓴᐅᕚᑦ ᐅᑉᕙᓗᓐᓃᑦ ᐅᒫᑦᓴᓈᕐᕐᑲᑦ ᑕᑯᒥᐊᖏᑦ/ᐆᒪᔪᕐᓂᐊᓇᐊᖏᑦ/ᐆᒪᔪᓇᐊᖏᑦ?

6. [6N] <u>Compared to the same season, since 2011</u> (in the last five years) have the following species you hunt for food been harder, easier or the same to find/hunt/catch?

		1- Harder ᐱᔭᓇᐊᑐᓂᕐᓴᖅ	2- No change ᐊᓯᑦᔩᖏᑦᑐᖅ	3- Easier ᐱᔭᓇᐊᑭᓐᓂᓴᖅ	4- I do not hunt this species ᑖᒃᑯᓂᖓ ᐆᒪᔪᕐᓂᐊᓲᖏᖖᖏᑐᖓ	DK/NR/R
ᐊ) ᑐᑦᑐᒃ	a) Caribou	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᐸ) ᐳᐃᔦᒃ	b) Seal	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᑕ) ᕿᓚᓗᒐᖅ	c) Beluga	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᑲ) ᐁᕕᖅ	d) Walrus	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᒐ) ᓂᕐᓚᒃ	e) Goose	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99

7. <u>ᐊᓂᒍᕐᑐᓂᑦ ᑕᕐᕿᓂᑦ 12ᓂᑦ</u>, ᖃᑦᓯᑦ ᑖᒃᑯᐊ ᐊᓪᓚᓯᒪᔪᐃᑦ ᐆᒪᔪᐃᑦ ᐋᑦᑐᓂᕐᖃᑎᑦ, ᓴᓗᒻᒪᓴᓂᖅ, ᓇᑲᑎᓐᓂᑦ, ᐊᓯᖏᓪᓗ.?

7. <u>In the past 12 months</u>, how many of the following animals did you prepare such as skinning, washing, cutting, etc.?

		None ᐱᑕᖃᖏᑐᖅ	1 - 2	3 - 9	10 - 29	More than 30 30 ᐅᖓᑖᓂ	DK/NR/R
ᐊ) ᕐᑯᐸᓄᐊᑦ	a) Wild Birds	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 99
ᐸ) ᑐᑦᑐᒃ ᐅᒥᒻᒪᓐᓃᑦ	b) Caribou or muskox	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 99
ᑕ) ᑎᕆᒐᓂᐊᖅ, ᐊᒪᕈᐃᑦ ᕿᒻᒦᓐᓃᑦ	c) Fox, wolves or dogs	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 99
ᑲ) ᐊᑦᓴᒃ ᓇᓄᖅ	d) Bear	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 99
ᒐ) ᐃᒪᕐᒥᐅᑌᑦ ᐆᒪᔪᐃᑦ (ᐳᐃᔩᑦ, ᕿᓚᓗᑦ, ᐁᕕᖅ)	e) Sea mammals (seals, whales, walrus)	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	◯ 99

8. [8N] ᑐᓴᓚᐅᕐᓯᒪᕚᑦ ᐃᓯᒫᓗᑎᐅᔪᓂᑦ ᓴᒃᑯᒥ ᐅᕐᑯᒣᑦᑐᔭᓪᓕᒃ ᐆᒪᔪᕐᓂᐊᑐᓄᑦ ᓄᓇᕕᒻᒥ ᐊᑐᕐᑕᐅᓲᓂᑦ?

◯ 1- ᐋ

◯ 2- ᐊᐅᑲ

◯ 99- ᖃᐅᔨᒪᖖᖏᑐᖅ-ᑭᐅᖖᖏᑐᖅ-ᑭᐅᒍᒪᖖᖏᑐᖅ

8. [8N] Have you heard about the concern related to the use of lead shot for hunting game in Nunavik?

◯ 1- Yes

◯ 2- No

◯ 99- DK/NR/R

9. [8] ᐊᓂᒍᕐᑐᓂᑦ ᑕᕐᕿᓂᑦ 12ᓂᑦ, ᖃᑦᓯᕕᑦᓱᑎᑦ, ᐃᖃᓪᓚᐊᓂᕐᕿᑦ?

9. [8] In the past 12 months, on average, how often did you go fishing?

		1- Never ᓚᐅᕐᓯᒪᖕᖏᑐᖅ	2- Less than once a month ᐊᑕᐅᓯᕐᒥᒃ ᐃᑭᓐᓂᓴᖅ ᑕᕐᕿᓚᒫᒥ	3- 1 to 3 days per month 1ᒥᑦ 3ᒧᑦ ᐅᓪᓗᓂᑦ ᑕᕐᕿᓚᒫᒥ	4- Once a week or more ᐊᑕᐅᓯᐊᕐᓱᓂ ᐱᓇᓱᐊᕈᓯᓚᒫᒥ ᐅᖕᒐᑖᓄᓗᓐᓃᑦ	DK/ NR/R
ᐊ) ᐅᐱᕐᖕᒐᓴᒥ	a) Spring	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᐸ) ᐅᐱᕐᖕᒑᒥ(ᐊᐅᔭᒥ)	b) Summer	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᑕ) ᐅᑭᐊᒥ	c) Fall	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᑲ) ᐅᑭᐅᒥ	d) Winter	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99

10. [9] ᐊᓂᒍᕐᑐᓂᑦ ᑕᕐᕿᓂᑦ 12ᓂᑦ, ᓄᓂᕙᓐᓇᐅᑎᓪᓗᒍ, ᖃᑦᓯᕕᑦᓱᑎᑦ ᓄᓂᕙᕆᐊᖃᑦᑕᓂᕐᕿᑦ?

10. [9] In the past 12 months, during berry picking season, how often did you go picking berries?

1- Never ᓚᐅᕐᓯᒪᖕᖏᑐᖅ	2- Less than once a month ᐊᑕᐅᓯᕐᒥᒃ ᐃᑭᓐᓂᓴᖅ ᑕᕐᕿᓚᒫᒥ	3- 1 to 3 days per month 1ᒥᑦ 3ᒧᑦ ᐅᓪᓗᓂᑦ ᑕᕐᕿᓚᒫᒥ	4- Once a week or more ᐊᑕᐅᓯᐊᕐᓱᓂ ᐱᓇᓱᐊᕈᓯᓚᒫᒥ ᐅᖕᒐᑖᓄᓗᓐᓃᑦ	DK/ NR/R
◯ 1	◯ 2	◯ 3	◯ 4	◯ 99

11. ᑕᕐᕿᓂᑦ 12 ᐊᓂᒍᕐᑐᓂᑦ, ᖃᓄᓪᓗᐊᑎᒋᑕᒫᑦ ᑯᐊᓐᓂᑕᓇᐊᓲᖕᒍᕕᑦ, ᐅᕕᓗᕐᑕᓇᐊᓲᖕᒍᕕᑦ (ᐅᕕᓗᐃᑦ, ᑕᓪᓗᕈᓐᓄᑦ, ᐊᒻᒨᒪᔪᐃᑦ, ᐊᓯᖕᒥᓪᓗ) ᐊᒻᒪᓗ ᒥᕐᖁᓕᒃ?

11. In the past 12 months, on average, how often did you go harvesting seaweeds, mollusks (mussels, scallops, clams, etc.) and urchins?

		1- Never ᓚᐅᕐᓯᒪᖕᖏᑐᖅ	2- Less than once a month ᐊᑕᐅᓯᕐᒥᒃ ᐃᑭᓐᓂᓴᖅ ᑕᕐᕿᓚᒫᒥ	3- 1 to 3 days per month 1ᒥᑦ 3ᒧᑦ ᐅᓪᓗᓂᑦ ᑕᕐᕿᓚᒫᒥ	4- Once a week or more ᐊᑕᐅᓯᐊᕐᓱᓂ ᐱᓇᓱᐊᕈᓯᓚᒫᒥ ᐅᖕᒐᑖᓄᓗᓐᓃᑦ	DK/ NR/R
ᐊ) ᐅᐱᕐᖕᒐᓴᒥ	a) Spring	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᐸ) ᐅᐱᕐᖕᒑᒥ(ᐊᐅᔭᒥ)	b) Summer	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᑕ) ᐅᑭᐊᒥ	c) Fall	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99
ᑲ) ᐅᑭᐅᒥ	d) Winter	◯ 1	◯ 2	◯ 3	◯ 4	◯ 99

1. **ᒫᓐᓇᐅᑎᓪᓗᒍ, ᓱᐴᕈᓯᔪᓲᖑᕚᑦ ᒥᑐᐹᑭᓲᖑᕚᑦ ᖃᐅᑕᒫᑦ, ᐃᓚᖓᓂ, ᐅᑉᐱᓗᓐᓃᑦ ᓚᐅᕐᓯᒪᙱᓚᑎ?**

- ◯ 1- ᖃᐅᑕᒫᑦ ᐁᒥᑦ ᐃᓯᒪᒧᑦ ᐃᓅᖃᑎᒌᓄᓗ ᕿᑦᑐᓯᒪᔪᖅ 3,1, ᐊᐱᕐᓲᑎᒧᑦ 3ᒧᑦ ᑕᒐ 5ᒨᕐᓗᑎᑦ
- ◯ 2- ᐃᓚᖓᓂ ᐁᒥᑦ ᐃᓯᒪᒧᑦ ᐃᓅᖃᑎᒌᓄᓗ ᕿᑦᑐᓯᒪᔪᖅ 3,1, ᐊᐱᕐᓲᑎᒧᑦ 4ᒧᑦ ᑕᒐ 5ᒨᕐᓗᑎᑦ
- ◯ 3- ᓚᐅᕐᓯᒪᙱᑐᖓ ᐊᕿᑦᑐᓯᒪᔪᖅ 3.1, ᐊᐱᕐᓲᑎᒧᑦ 2ᒨᓇᑦ
- ◯ 99- ᖃᐅᔨᒪᙱᑐᖅ/ᑭᐅᙱᑐᖅ/ᑭᐅᒍᒪᙱᑐᖅ ᐊᕿᑦᑐᓯᒪᔪᖅ 3.1, ᐊᐱᕐᓲᑎᒧᑦ 2ᒨᓇᑦ

1. **<u>At the present time</u>, do you smoke cigarettes daily, occasionally, or not at all?**

- ◯ 1- Daily Go to PS – Section 3.1 - Q3 and then Q5
- ◯ 2- Occasionally Go to PS – Section 3.1 - Q4 and then Q5
- ◯ 3- Not at all Go to PS – Section 3.1 - Q2
- ◯ 99- DK/NR/R Go to PS – Section 3.1 - Q2

2. **<u>ᓲᐴᕈᓯᔪᓲᖑᙱᑐᓄᑦ ᒥᑐᐹᑭᓲᖑᙱᑐᓄᑦ</u> ᒫᓐᓇᐅᑎᓪᓗᒍ**

ᐊ) ᓲᐴᕈᓯᔭᓚᐅᕐᓯᒪᕚᑦ ᒥᑐᐹᑭᓚᐅᕐᓯᒪᕚᑦ?

- ◯ 1- ᓲᐴᓇᓯᔭᓚᐅᕐᓯᒪᙱᑐᖓ/ ᑐᐹᑭᓚᐅᕐᓯᒪᙱᑐᖓ ᐊᕿᑦᑐᓯᒪᔪᖅ 3.1, ᐊᐱᕐᓲᑎᒧᑦ 7ᒧᑦ.
- ◯ 2- ᐋ, ᑭᓯᐊᓂ ᐃᓗᐃᑦᑑᖏᑦᑐᒥᒃ ᓲᐴᕈᑎᒥᒃ/ᑐᐹᑭᒥᒃ ᐁᒥᑦ ᐃᓯᒪᒧᑦ ᐃᓅᖃᑎᒌᓄᓗ ᐊᕿᑦᑐᓯᒪᔪᖅ 3.1, ᐊᐱᕐᓲᑎᒧᑦ 7ᒨᓇᑦ
- ◯ 3- ᐋ, ᐊᑕᐅᓯᕐᔪᐊᒥᒃ ᓲᐴᕈᑎᒥᒃ/ᑐᐹᑭᒥᒃ ᑭᓯᐊᓂ ᐃᑭᓐᓂᓴᓂᑦ 100ᓂᑦ ᓲᐴᕈᑎᓂᑦ/ᑐᐹᑭᓂᑦ (ᐃᑦᓯᕙᐊᐱᓐᓂᑦ ᐃᓗᐃᑦᑐᓂᑦ 4ᒐᓚᓐᓂᑦ) ᐃᓅᓯᓕᒫᕐᓂ ᐊᐱᕐᓲᑎᒧᑦ 4ᒧᑦ ᑕᒐ 5ᒨᕐᓗᑎᑦ
- ◯ 4- ᐋ, 100ᒐᓚᓐᓂᑦ ᓲᐴᕈᑎᓂᑦ/ᑐᐹᑭᓂᑦ ᐅᓄᕐᓂᓴᓂᓗᓐᓃᑦ (ᐃᑦᓯᕙᐊᐱᓐᓂᑦ ᐃᓗᐃᑦᑐᓂᑦ 4ᒐᓚᓐᓂᑦ)ᐃᓅᓯᓕᒫᕐᓂ ᐁᒥᑦ ᐃᓯᒪᒧᑦ ᐃᓅᖃᑎᒌᓄᓗ ᐊᕿᑦᑐᓯᒪᔪᖅ 3.1ᒧᑦ- ᐊᐱᕐᓲᑎᒃ 4 ᐊᒻᒪᓗ 5ᓄᑦ
- ◯ 99- ᖃᐅᔨᒪᙱᑐᖅ/ᑭᐅᙱᑐᖅ/ᑭᐅᒍᒪᙱᑐᖅ ᐁᒥᑦ ᐃᓯᒪᒧᑦ ᐃᓅᖃᑎᒌᓄᓗ ᐊᕿᑦᑐᓯᒪᔪᖅ 3.1, ᐊᐱᕐᓲᑎᒧᑦ 7ᒨᓇᑦ

2. **For those who <u>do not smoke at all</u> at this time**

a) Have you <u>ever</u> smoked cigarettes?

- ◯ 1- Never smoked Go to PS – Section 3.1 - Q7
- ◯ 2- Yes, but not a whole cigarette Go to PS – Section 3.1- Q7
- ◯ 3- Yes, at least one cigarette but less than 100 cigarettes (about 4 packs) in your lifetime Go to PS – Section 3.1- Q7
- ◯ 4- Yes, at least 100 cigarettes or more (about 4 packs) in your lifetime Go to PS – Section 3.1 - Q4 and then Q5
- ◯ 99- DK/NR/R Go to PS – Section 3.1- Q7

8. **[9] <u>ᒫᓐᓇᐅᑎᓪᓗᒍ</u>, ᖃᓄᓪᓗᐊᑎᒥᒃ ᐳᔪᕐᑕᐅᔪᒥᒃ ᓲᐴᕈᑎᒧᑦ/ᑐᐹᑭᒧᑦ ᐊᓂᕐᑎᓇᖅᑕᕐᑭᑦ ᐊᓂᕐᕋᓂ?**

- ◯ 1- ᖃᐅᑕᒫᑦ
- ◯ 2- ᖃᐅᑕᒫᑲᓵᖅ
- ◯ 3- ᐊᑕᐅᓯᕕᖅᑰᓯᖓ ᐱᓇᓯᐊᕈᓯᓚᒫᒥ
- ◯ 4- ᐊᑕᐅᓯᕕᖅᑰᓯᖓ ᑕᖅᑭᑕᒫᑦ
- ◯ 5- ᑕᖅᑭᑕᒫᒍᙱᑐᖅ
- ◯ 6- ᓚᐅᕐᓯᒪᙱᑐᖓ
- ◯ 99- ᖃᐅᔨᒪᙱᑐᖅ/ᑭᐅᙱᑐᖅ/ᑭᐅᒍᒪᙱᑐᖅ

8. **[9] <u>Currently</u>, how often are you exposed to second-hand smoke in your home?**

- ◯ 1- Every day
- ◯ 2- Nearly every day
- ◯ 3- Approximately once a week
- ◯ 4- Approximately once a month
- ◯ 5- Less than once a month
- ◯ 6- Never
- ◯ 99- DK/NR/R

23. <u>ᑕᕐᕿᓂᑦ 12ᓂᑦ ᐊᓂᒍᕐᑐᓂᑦ</u>, ᐱᓯᒪᕖᑦ ᐅᑦᑐᕋᕐᓯᒪᕕᓪᓗᓃᑦ ᒥᑦ (weed), ᐹᑦ (pot), ᒪᕆᒍᐊᓇ (marijuana) ᑯᕋᔅ (grass) ᐅᕝᕙᓗᓐᓃᑦ ᖃᔅᓯᔅ (hashish)?

- 1- ᓚᐅᕐᓯᒪᖕᖏᑐᖅ
- 2- ᐊᑕᐅᓯᐊᕐᓱᓂ ᒪᕐᕈᕕᑦᓱᓂᓗᓐᓃᑦ
- 3- 3-11 ᐊᑯᓐᓂᖕᒋᓐᓂ ᐊᕐᕋᒍᓕᒫᒥ
- 4- ᐊᑕᐅᓯᐊᕐᓱᓂ ᑕᕐᕿᓕᒫᒥ
- 5- 2-3-ᕕᑦᓱᓂ ᑕᕐᕿᓕᒫᒥ
- 6- ᐊᑕᐅᓯᐊᕐᓱᓂ ᒪᕐᕈᕕᑦᓱᓂᓗᓐᓃᑦ ᐱᓇᓱᐊᕈᓯᓕᒫᒥ
- 7- 3-4 ᒐᓚᕕᑦᓱᓂ ᐱᓇᓱᐊᕈᓯᓕᒫᒥ
- 8- ᖃᐅᑕᒫᑦ ᖃᐅᑕᒫᑲᓴᓪᓗᓃᑦ
- 99- ᖃᐅᔨᒪᖕᖏᑐᖅ/ᑭᐅᖕᖏᑐᖅ/ᑭᐅᒍᒪᖕᖏᑐᖅ

23. <u>In the past 12 months</u>, have you used or tried weed, pot, marijuana, grass or hashish?

- 1- Never
- 2- Once or twice
- 3- 3 to 11 times a year
- 4- About once a month
- 5- 2 or 3 times a month
- 6- About once or twice a week
- 7- 3 to 4 times a week
- 8- Daily or almost daily
- 99- DK/NR/R

4. [7] <u>ᐅᐱᕐᖔᖑᓚᐅᔪᒥ (ᐊᐅᔭᐅᓚᐅᔪᒥ)</u>, ᓇᑭᑦ ᐱᓯᒪᔪᒥᒃ ᐃᒥᕐᑲᑦᑕᓚᐅᔪᕕᓯᐯ

- 1- ᓄᓇᓕᐅᑉ ᐃᒪᕐᑲᕐᑎᓯᒍᑎᖓ (ᑯᕕᔪᒥ ᐃᒪᖅ/ ᐃᒪᕐᑲᐅᑎᒥ ᐊᓂᕐᕋᓂ)
- 2- ᐃᒥᕐᑕᕕᒻᒥ ᐃᒥᕐᑕᓱᒍ
- 3- ᐳᓪᓚᐅᔭᓂᑦ ᐃᒪᖅ
- 4- ᑕᓯᕐᒥ ᖃᓂᑦᑐᒥ, ᑰᒻᒥ ᑰᓕᕐᒥᓗᓐᓃᑦ
- 5- ᐊᓂᐅᒥᒃ ᐊᐅᑦᑐᕕᓂᕐᒥᒃ; ᓯᑯᒥᒃ ᐱᖃᓗᔭᒥᓗᓐᓃᑦ
- 99- ᖃᐅᔨᒪᖕᖏᑐᖅ/ᑭᐅᖕᖏᑐᖅ/ᑭᐅᒍᒪᖕᖏᑐᖅ

4. [7] <u>In the last summer</u>, what was the main source of drinking water in your home?

- 1- Municipal system (tap water/water tank at home)
- 2- Tap directly at the water plant
- 3- Bottled water
- 4- From nearby lake, river or stream
- 5- Melted snow, ice or iceberg
- 99- DK/NR/R

5. [8] <u>ᐅᑭᐅᖑᓚᐅᔪᒥ</u>, ᓇᑭᑦ ᐱᓯᒪᔪᒥᒃ ᐃᒥᕐᑲᑦᑕᓚᐅᔪᕕᓯᐯ

- 1- ᓄᓇᓕᐅᑉ ᐃᒪᕐᑲᕐᑎᓯᒍᑎᖓ (ᑯᕕᔪᒥ ᐃᒪᖅ/ ᐃᒪᕐᑲᐅᑎᒥ ᐊᓂᕐᕋᓂ)
- 2- ᐃᒥᕐᑕᕕᒻᒥ ᐃᒥᕐᑕᓱᒍ
- 3- ᐳᓪᓚᐅᔭᓂᑦ ᐃᒪᖅ
- 4- ᑕᓯᕐᒥ ᖃᓂᑦᑐᒥ, ᑰᒻᒥ ᑰᓕᕐᒥᓗᓐᓃᑦ
- 5- ᐊᓂᐅᒥᒃ ᐊᐅᑦᑐᕕᓂᕐᒥᒃ; ᓯᑯᒥᒃ ᐱᖃᓗᔭᒥᓗᓐᓃᑦ
- 99- ᖃᐅᔨᒪᖕᖏᑐᖅ/ᑭᐅᖕᖏᑐᖅ/ᑭᐅᒍᒪᖕᖏᑐᖅ

5. [8] <u>In the last winter</u>, what was the main source of drinking water in your home?

- 1- Municipal system (tap water/water tank at home)
- 2- Tap directly at the water plant
- 3- Bottled water
- 4- From nearby lake, river or stream
- 5- Melted snow, ice or iceberg
- 99- DK/NR/R

In the last 3 months, how often on average do you eat this food?

Country foods		Never or less than once a month	1-3 times a month	Once a week	2-6 times a week	Once a day	2-3 times a day	4 times and more a day
Marine mammals								
Beluga	1. Dried meat (nikku)							
	2. Meat 2.1 Do you often eat this raw? ◯ Yes ◯ No							
	3. Misirak/Ursuk (blubber only)							
	4. Mattaaq (skin and blubber)							
Seal	5. Meat (fresh, cooked, frozen) 5.1 Do you often eat this raw? ◯ Yes ◯ No							
	6. Misirak/Ursuk (blubber only)							
	7. [8] Liver 7.1 Do you often eat this raw? ◯ Yes ◯ No							
8. [9] Walrus meat, igunak 8.1 Do you often eat this raw? ◯ Yes ◯ No								
Game Animals and Birds								
Caribou	9. [10] Dried meat (nikku)							
	10. [11] Meat 10.1 Do you often eat this raw? ◯ Yes ◯ No							
11. [12] Polar bear								
12. [13] Muskox								
13. [14] Ptarmigan, partridge 13.1 Do you often eat this raw? ◯ Yes ◯ No								

Country foods	Never or less than once a month	1-3 times a month	Once a week	2-6 times a week	Once a day	2-3 times a day	4 times and more a day
14. [15] Goose (Canada or white goose) 14.1 Do you often eat this raw? ◯ Yes ◯ No							
15. [16] Eggs of game bird 15.1 Which ones do you usually eat? (check all that apply) ◯ Duck ◯ Geese ◯ Murre/Seagulls							
Fish and seafood							
16. [17] Dried fish (nikku, pitsik) 16.1 Which ones do you usually eat? (check all that apply) ◯ Char ◯ Brook trout ◯ Lake trout ◯ Other							
17. [18] Lake trout (fresh, cooked or frozen, NOT dried)							
18. [19] Brook or sea trout, or salmon (fresh, cooked, canned or frozen, NOT dried)							
19. [20] Arctic char (fresh, cooked or frozen, NOT dried)							
20. [21] Pike or walleye							
21. [22] Other fish, e.g. Lake whitefish (Coregone), Sculpin (Ugly fish)							
22. [23] Mollusks (Mussels, scallops, clams, etc.) and urchins 22.1 Do you often eat this raw? ◯ Yes ◯ No							
23. [24] Seaweed (kuanniq, qirquak, etc.)							

ᓄᓇᕕᒻᒥ ᐃᓗᓯᓕᕆᓂᕐᒧᑦ ᑲᑎᒪᔩᑦ

RÉGIE RÉGIONALE DE LA SANTÉ ET DES SERVICES SOCIAUX DU NUNAVIK

NUNAVIK REGIONAL BOARD OF HEALTH AND SOCIAL SERVICES