Factors associated with the intake of traditional foods in the Eeyou Istchee (Cree) of northern Quebec include age, speaking the Cree language and food sovereignty indicators

Willows Noreen, Louise Johnson-Down, Moubarac Jean-Claude, Michel Lucas, Elizabeth Robinson and Malek Batal

*Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada; Département de nutrition, Faculté de Médecine, Université de Montréal, Montréal, QC, Canada; *Axe Santé publique et pratiques optimales en santé, Centre de recherche du Centre Hospitalier Universitaire (CHU) de Québec, Québec, QC, Canada; *Department of Social and Preventive Medicine, Université Laval, Québec, QC, Canada; *Cree Board of health and Social Services of James Bay, Montreal, QC, Canada

ABSTRACT
The Eeyouch are a First Nations (Cree) population that live above 49.6°N latitude in Eeyou Istchee in northern Quebec. Eeyouch rely on traditional foods (TF) hunted, fished or gathered from the land. The overarching aim of this study was to achieve an understanding of the factors associated with TF intake among Eeyouch. Data were from 465 women and 330 men who participated in the Nituuchischaayihntitaau Aschii Multi-Community Environment-and-Health (E&H) study. The relationship between TF consumption and dietary, health, sociodemographic and food sovereignty (i.e. being a hunter or receiving Income Security to hunt, trap or fish) variables was examined using linear and logistic regression. Analyses were stratified by sex because of the male/female discrepancy in being a hunter. Among respondents, almost all (99.7%) consumed TF, 51% were hunters and 10% received Income Security. Higher intake of TF was associated with lower consumption of less nutritious ultra-processed products (UPP). In women, TF intake increased with age, hunting and receiving Income Security, but decreased with high school education. In men, TF intake increased with age and speaking only Cree at home. The findings suggest that increased food sovereignty would result in improved diet quality among Eeyouch through increased TF intake and decreased UPP intake.

INTRODUCTION
There are 3 groups of Indigenous peoples recognised in the Canadian constitution: First Nations, Inuit and Metis [1]. The Eeyouch are a First Nations population that live in 9 rural or remote communities located above 49.6°N latitude in Eeyou Istchee, the boreal and taiga forest region of their traditional hunting lands in northern Quebec. Traditional foods (TF) hunted, fished, trapped or gathered from the land have always been an important part of the diet and culture of the Eeyouch [2]. More common examples of their TF include moose, goose, ptarmigan, caribou and whitefish [3]. Not only do TF contribute nutritious, minimally processed food to the diet, but the harvesting and gathering activities involved in their procurement are also important to the health and well-being of Eeyouch, as they require physical activity and connect people to their traditional lands [4,5].

Similar to other Indigenous peoples of Canada, the Eeyouch have had to contend with colonial policies that have led to a loss of control of their lands and resources, and a decline in their traditional way of life as hunters and gatherers [3,6]. As a result, the intake of TF along with the activities associated with their procurement has decreased over time in the Eeyouch population, similar to other Indigenous populations in Canada [7,8]. Diminished TF consumption has been accompanied by an increased consumption of store-bought market foods (MF) and increased sedentariness [3]. Although nutritious MF could be an important complement to TF in the diet, a large portion of First Nations’ diets consists of MF that are ultra-processed food and drinks (that is, ultra-processed products (UPP)) of poor nutritional quality [9]. The prevalence of these highly processed foods and drinks in the diet is likely the result of their ubiquity in rural and remote stores, which is attributable to their long shelf life and light weight making them ideal products for shipping over long distances. Another attribute of these foods which
makes them ubiquitous is the use of flavour enhancers, oils, sugar and sodium, creating cheap and highly palatable products [10].

The dietary shift from TF to MF has resulted in a contemporary Eeyouch diet that is high in saturated fat, free sugar, refined foods and low in fibre; this combination is often termed the "Western diet" [3,11,12]. Evidence that a compromised diet and increased sedentariness have accompanied this nutrition transition is the rise in nutrition-related chronic disease (NRCD) among Eeyouch such as insulin resistance, type 2 diabetes and cardiovascular disease [13,14]. For example, the prevalence of diabetes for Eeyouch aged 20 years and older is almost 3 times higher than the average in Canada and diabetes affects 1 quarter of adults [15,16]. Previous research in the Eeyouch showed a positive association between the percentage of total energy intake from ultra-processed MF and cardiometabolic risk [14].

Given the high prevalence of NRCD, an increased dietary share of TF could improve the health of Eeyouch people. There are many factors at multiple ecological levels that both promote and impede the consumption of TF. Factors that are associated with TF intake among other Indigenous groups are community remoteness, having a hunter in the family, being physically active, participating in traditional activities, food sharing practices and the high cost of MF [17–22]. Previous studies in Eeyouch found higher intakes of TF to be associated with older age, walking more than 30 min a day, and having fewer years of schooling [19]. Likely obstacles to Eeyouch procuring TF based on data from other Indigenous groups include lack of transmission of traditional knowledge of hunting and preserving TF; the time, cost and energy required for harvesting activities; the yearly and seasonal availability of game and fish; climate change; and wage labour opportunities [21,23–25].

The concept of food sovereignty has been used to represent the difficulties encountered by Indigenous peoples in Canada in harvesting TF [26,27]. Food sovereignty is

the right of peoples to define their own policies and strategies for sustainable production, distribution, and consumption of food, with respect to their own cultures and their own systems of managing natural resources and rural areas, and is considered to be a precondition for Food Security. [28]

Advocates in this area identify the ability of First Nations to fish, hunt and gather as key elements in achieving food sovereignty [26,27,29] and the Eeyouch are partnering in projects to articulate their vision of this [30]. As Indigenous peoples strive to become sovereign over their own environments including their TF systems, they face many challenges that are outside of their control but have a great impact on their TF systems and way of life [4,26,27]. For example, some TF have been identified as containing environmental contaminants (e.g. mercury, lead and organochlorines), and thus individuals and communities need to balance the health risks and benefits of consuming these foods [13,19,20,31].

It is important to advance our understanding of the many factors that influence TF intake among Eeyouch and the impact of TF on their health. Using data from the Nituuchischaayihtitaau Aschii Multi-Community (E&H) study, we explored the relationship between food sovereignty proxy variables and socio-economic, dietary, lifestyle and health factors that are associated with TF consumption in the Eeyouch. Diet was assessed using the NOVA method to classify foods as UPP considering the success that we had with this method in examining the diet of the Eeyouch and other First Nations in 4 Canadian regions [9,14]. In this study, having a hunter in the home and receiving Income Security for hunters and trappers (a programme whereby Eeyouch are paid an annual income to spend time on the land hunting, trapping and fishing) were considered proxy indicators of food sovereignty as they signify individuals were engaged in cultural food procurement activities from the local food system.

Methods

Study population

The Nituuchischaayihtitaau Aschii Multi-Community (E&H) study was cross-sectional, funded and coordinated by the Cree Board of Health and Social Services of James Bay (CBHSSJB) of Quebec. It was a joint project of the CBHSSJB and McMaster, Laval and McGill universities. Seven Eeyouch communities were approached to participate in the study. All Eeyouch adults except pregnant women were eligible to participate. A random age-stratified sample was targeted, as described elsewhere [32]. Bilingual interviewers (Cree, English) were recruited and trained in each community in interviewing and diet-assessment methods. In total, data were pooled from 1,101 adults 18 years and over interviewed during the spring and (or) summer of 2005, 2007, 2008 and 2009. Written consent was obtained in either English or Cree First Nation language from all participants [32–34]. Ethical approval was obtained from the
research committee of the CBHSSJB, and from McGill, Laval and McMaster universities.

**Dietary assessment**

We derived frequency of TF intake from a qualitative food frequency questionnaire (FFQ). The FFQ that included all TF species consumed by the Eeyouch (that is, wild game, fish, fowl and berries) was administered to originally estimate the frequency of yearly consumption of TF by season. Participants were asked the following questions: “In the past 12 months, did you eat any of the following animals, fish, birds and ducks, wild berries? If yes, how often did you eat these for each of the following seasons?” and participants estimated their intake by season. A total of 35 possible TF items were investigated. The average daily frequency of each TF consumed per season was estimated from the FFQ. Thereafter, the daily frequency estimates per season for each item were summed, and this figure was then multiplied by 7 to obtain the weekly frequency of all TF consumed. Quintiles of weekly frequency of TF were also established.

Information about UPP intake was derived from 24-h dietary recalls. Although a second 24-h recall was collected in 26% of adults, only the first recall was used for these analyses. The 24-h dietary recalls used a 5-step multiple pass approach [35,36] and were collected from May to September. Food models helped to estimate portion size. To ensure quality control, a research assistant reviewed the recalls daily and provided feedback as necessary. Foods from the 24-h dietary recalls that were soft drinks and juices, commercial breads, sweet and salty snacks and ready-to-eat meals were categorised as UPP using the NOVA classification [10] similar to other studies examining the diet of First Nations in 4 Canadian regions and elsewhere in the same Eeyouch population [9,14]. Per cent of energy intake from UPP was determined from the ratio of UPP energy divided by total dietary energy from all foods.

**Sociodemographic characteristics**

Sociodemographic data were obtained from interviewer-administered questionnaires. Hunting and receiving Income Security to hunt, fish or trap were considered proxy variables for food sovereignty. Age was divided by 10 to provide the impact of a 10-year change in age on the outcome variable. Other variables were Cree (First Nation) language only spoken at home; at least some high school education; large household size (>4 persons); children under 18 years of age in the home; wage employment (full-time or part-time employment) vs. employment insurance or not working (due to health reasons, parental leave, hunter and trapper Income Security Program, social welfare, student, homemaker, pension and other); perceived good health (excellent, very good and good); and smoking >5 cigarettes/day.

**Cardiometabolic risk**

Trained research nurses measured height and waist circumference (WC) upon exhalation with the measuring tape between the last floating rib and the iliac crest. Weight and body mass index (BMI) (kg m$^{-2}$) were assessed using a bioelectrical impedance scale (Tanita Corp., Arlington Heights, IL, USA). Lifestyle characteristics such as average daily walking over the past 7 days were obtained from the International Physical Activity Questionnaire [37]. Blood pressure (BP) was taken at 3 intervals as recommended by the Canadian Hypertension Education Program using a manual mercury sphygmomanometer, 15-in stethoscopes, and cuffs sized to the subjects’ arms [38]; the last 2 measures were then averaged. Blood samples were taken to measure several metabolites from participants who had fasted overnight with methods described elsewhere [13]. For the current study, data on triglycerides [39], high-density lipoprotein cholesterol (HDL-C) and fasting plasma glucose (FPG) were used as measures of cardiovascular health. Cardiometabolic risk was determined using metabolic syndrome (MetS) as assessed using recommendations of the International Diabetes Federation (IDF) [40]. IDF thresholds for TG (>1.7 mmol/L), HDL-C (<1.03 mmol/L for men and <1.29 mmol/L in women) and FPG (>5.6 mmol/L) were applied. Central adiposity was considered WC ≥90 cm for men and ≥80 cm for women. High blood pressure (HBP) was deemed a systolic BP ≥130 mmHg or a diastolic BP ≥85 mmHg [41]. Participants were categorised as having MetS if they presented with central obesity and 2 of the following: HBP, elevated TG, elevated FPG or low HDL-C [40,41].

**Statistical analysis**

Descriptive statistics with non-normal distributions were log-normally transformed and reported as geometric means with a 95% confidence interval (CI). Means of continuous variables were compared using unpaired t-tests. Chi-square was used to compare categorical variables. TF intake was modelled as quintiles of frequency (per week) of TF intake and descriptive statistics were compared across quintiles with p trend assessed using univariate logistic regression. Following this, separate unadjusted logistic regression and
adjusted backward multiple logistic regression models were conducted for each independent variable, to report the unadjusted and adjusted odds ratio (OR) of being in the 5th quintile of TF intake compared to being in the other 4 quintiles (combined) of intake. Multiple linear regression analyses were performed with continuous weekly frequency of TF intake, taking care to eliminate issues of collinearity and backward selection of variables was done with p<0.1. Having a hunter in the home and receiving Income Security for hunters and trappers were forced in all analyses as proxy variables of food sovereignty. The presence of interactions was investigated in all multivariate analyses. Data were stratified by gender in all analyses because of the difference in hunting practice between females and males. MetS was removed from all analysis considering the strong association with BMI. Statistical analyses were conducted with SAS software (version 9.4, SAS Institute, Cary, NC, USA). Two-sided p<0.05 values were statistically significant.

Results

The sample consisted of 465 (58.5%) women and 330 (41.5%) men. Table 1 provides data on socio-demographic, lifestyle and health characteristic stratified by gender. Two-thirds of the participants lived in communities on the coast of James Bay or Hudson Bay and the remainder in inland communities located in the boreal forest of Eeyou Istchee. The mean age of participants was 38.8±14.9 years. Most of the participants (82%) had attended some high school, 58% received income from working outside the home. Median household size was 5 persons; women were more likely to report having children in their households (p<0.01). A high connection with Cree culture was evident among participants. A majority (65%) spoke only Cree in their homes. With 1 exception, all respondents (99.7%) reported TF consumption. Despite pervasive TF consumption, 39% of energy in the diet came from UPP. Altogether, 51% of the participants self-identified as hunters and 10% received Income Security for being a hunter, fisher or trapper. Compared to women, men had more frequent TF intake and were more likely to be hunters and receive Income Security (p<0.001) (Table 1).

The mean BMI of participants was 33.8±6.92 kg·m⁻², with women having a significantly higher BMI than men. A large proportion (70.6%) of the sample was obese with the clear majority (98%) of all participants demonstrating central adiposity. MetS was present in 49% of participants.

In unadjusted analyses in both sexes, higher quintiles of frequency of consumption of TF were associated with participation in the Income Security Program and increasing age, whereas lower quintiles of frequency of consumption of TF were associated with a greater likelihood of having attended high school and increasing intake of UPP. In women, BMI and the likelihood of being a hunter increased as the frequency of consumption of TF did, whereas frequency of consumption of TF was lower if children under 18 years of age were present in the home. In men, higher quintiles of TF intake were associated with speaking only Cree in the home and having MetS, whereas lower TF intake was associated with smoking, income from employment and having attended high school (Table 2).

The odds of being in the highest quintile of TF intake compared to other quintiles combined were determined using logistic multivariate regression analysis. Women had greater odds for high TF intake if they were a hunter (OR 2.77, 95% CI: 1.59, 4.85), received Income Security (OR 2.72, 95% CI: 1.14, 6.46), were older (OR 1.34, 95% CI: 1.09, 1.64) or had a higher BMI (OR 1.04, 95% CI: 1.00, 1.08). Lower odds of high TF consumption occurred for having some high school education (OR 0.38, 95% CI: 0.19, 0.75) (Table 3). Men had greater odds of high TF intake if they were older (OR 1.41, 95% CI: 1.16, 1.70) or only spoke Cree at home (OR 2.79, 95% CI: 1.31, 3.84) (Table 3).

Adjusted multivariate regression in women (R² = 0.256) found increasing age, receiving Income Security and being a hunter as positively associated with frequency of TF intake, whereas having some high school was negatively associated with frequency of TF intake (Table 4). In men, R² was only 0.088 and the frequency of TF intake increased with age (Table 4).

Discussion

The Eeyouch First Nations living in the northern part of the province of Quebec are still reliant on foods hunted, fished, trapped and gathered from the land, for sustenance and to provide a sense of cultural connectedness, spirituality, social cohesion, cultural identity and physical activity through procurement activities [4,19]. The traditional diet of the Eeyouch offers them some protection from insulin resistance, a precursor to diabetes [13]. Given its many positive benefits, our study examined factors measured in the Nituchishoayiyhittau Aschii Multi-Community (E&H) study which were associated with TF consumption.
We found that almost every participant of the Nituuchishaayihtitaau Aschii Multi-Community (E&H) study included TF in their diet, typically 4.8 times per week. Despite the pervasiveness of TF in the diet of Eeyouch participants, 39% of energy in the diet was derived from the consumption of ultra-processed foods and beverages (UPP). The percentage of energy in the diet derived from UPP was lower than the share (48%) in the general Canadian populace [42,43]. TF intake is an indicator of positive diet quality, while UPP intake is an indicator of poor diet quality [42,44–46]. A previous study found that in Eeyouch, increasing intake of UPP was associated with presence of the MetS [14]. Obesity (BMI >30 kg·m⁻²) was highly prevalent in our participants (70.6%). Almost every participant in our study had central adiposity and half of respondents had MetS using culturally appropriate criteria for this population [40,41]. In our analyses, BMI only appears as a factor in the adjusted logistic regression in women comparing the highest quintile of TF intake to all others. Since all quintiles of TF intake had BMI with geometric means greater than 30, the results may not be clinically relevant. In the present study, UPP intake decreased with increasing TF consumption, like another study in Canadian First Nations [9]. These findings suggest that those who eat TF most often have a healthier diet not only because TF has inherent health attributes but because it also replaces UPP in the diet.

Age was positively associated with TF intake among Eeyouch participants in all analyses, as seen in other Indigenous and First Nations studies [3,47,48]. Laberge et al. state that determinants of TF consumption are intrinsically related to cultural factors in Eeyouch and other First Nations populations [19,20]. Our findings confirmed this supposition. We chose speaking Cree in the home as a proxy for a more traditional First Nations lifestyle. The numbers of Cree speakers in the present study showed a
Table 2. Characteristics of 795 adults 18 years and older according quintiles of weekly frequency of traditional food intake for 7 Eeyou Istchee communities in northern Quebec (Canada), by gender, 2005–2009.

| Characteristics                  | Q1          | Q2          | Q3          | Q4          | Q5          | P for trend |
|----------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
|                                  | Women       | Men         | Women       | Men         | Women       | Men         |
| n                                |             |             |             |             |             |             |
| Per cent energy as UPP<sup>c</sup> | 44.2 [29.6, 66.0] | 54.8 [50.5, 59.76] | 31.3 [18.3, 53.3] | 36.2 [24.5, 53.4] | 32.2 [21.9, 47.6] | <0.001      |
| Hunter (n (%))                   | 9 (8.99)    | 7 (7.45)    | 22 (23.4)   | 23 (24.7)   | 38 (40.9)   | <0.001      |
| Hunter Income Security<sup>y</sup> (n (%)) | 3 (3.30) | 4 (4.25)    | 4 (4.25)    | 3 (3.23)    | 21 (22.6)   | <0.001      |
| Age (years)                      |             |             |             |             |             |             |
| Q1                               | 28.8 [27.1, 30.7] | 31.7 [29.7, 33.9] | 36.3 [33.7, 39.0] | 39.0 [36.4, 41.7] | 45.0 [41.5, 48.7] | <0.001      |
| Q2                               | 56 (61.5)   | 70 (74.5)   | 72 (76.6)   | 66 (71.0)   | 54 (58.1)   | 0.450       |
| Q3                               | 52 (57.1)   | 59 (62.8)   | 66 (70.2)   | 56 (60.2)   | 55 (59.1)   | 0.938       |
| Q4                               | 76 (83.5)   | 76 (80.9)   | 71 (75.5)   | 63 (67.7)   | 54 (58.1)   | <0.001      |
| Q5                               | 81 (89.0)   | 86 (91.5)   | 84 (89.3)   | 77 (82.8)   | 50 (53.8)   | <0.001      |
| Income from employment<sup>x</sup> (n (%)) | 54 (59.3) | 51 (54.3)   | 61 (64.9)   | 66 (71.0)   | 42 (45.2)   | 0.465       |
| Speak only Cree at home<sup>k</sup> (n (%)) | 49 (53.8) | 65 (69.1)   | 54 (57.4)   | 63 (67.7)   | 64 (68.8)   | 0.074       |
| Walk ≥60 min/day<sup>j</sup> (n (%)) | 46 (50.5) | 50 (53.2)   | 43 (45.7)   | 47 (50.5)   | 43 (46.2)   | 0.490       |
| Smoking<sup>l</sup> (n (%))      | 34 (37.4)   | 27 (28.7)   | 22 (23.4)   | 36 (38.7)   | 17 (18.3)   | 0.063       |
| Perceived good health<sup>h</sup> (n (%)) | 68 (74.7) | 65 (69.1)   | 70 (74.5)   | 69 (74.2)   | 70 (75.3)   | 0.667       |
| Body mass index (kg·m⁻²)         | 32.9 [31.5, 34.4] | 34.6 [32.2, 36.2] | 34.8 [33.3, 36.3] | 34.4 [33.0, 35.9] | 35.6 [34.4, 37.2] | 0.030 |
| Metabolic syndrome<sup>i</sup> (n (%)) | 37 (40.7) | 53 (56.4)   | 44 (46.8)   | 43 (46.2)   | 58 (62.4)   | 0.046       |

UPP: ultra-processed products.

<sup>a</sup>Q5 represents the highest quintile of intake. <sup>b</sup>Logistic regression used to test for trend. <sup>c</sup>All such variables, geometric mean [95% confidence interval]. <sup>d</sup>Per cent energy as UPP was obtained from 24-h recalls. A programme whereby members of the community are paid an annual income to spend time on the land hunting, trapping and fishing. <sup>e</sup>Two of the communities were inland and the remainder on the coast of James Bay. <sup>f</sup>Attended some high school, not necessarily complete. <sup>g</sup>Anyone reporting working full- or part-time plus those who reported obtaining income from hunting. Individuals that usually speak only Cree at home. <sup>h</sup>Self-report of average time walked per day for the past 7 days. <sup>i</sup>Any programme whereby members of the community are paid an annual income to spend time on the land hunting, trapping and fishing. <sup>j</sup>Logistic regression used to test for trend. <sup>k</sup>Two of the communities were inland and the remainder on the coast of James Bay. <sup>l</sup>Attended some high school, not necessarily complete. <sup>m</sup>Anyone reporting working full- or part-time plus those who reported obtaining income from hunting. Individuals that usually speak only Cree at home. <sup>n</sup>Self-report of average time walked per day for the past 7 days. <sup:o</sup>Any programme whereby members of the community are paid an annual income to spend time on the land hunting, trapping and fishing. <sup>p</sup>Logistic regression used to test for trend. <sup>q</sup>Two of the communities were inland and the remainder on the coast of James Bay. <sup>r</sup>Attended some high school, not necessarily complete. <sup>s</sup>Anyone reporting working full- or part-time plus those who reported obtaining income from hunting. Individuals that usually speak only Cree at home. <sup>t</sup>Self-report of average time walked per day for the past 7 days. <sup>u</sup>Any programme whereby members of the community are paid an annual income to spend time on the land hunting, trapping and fishing. <sup>v</sup>Logistic regression used to test for trend. <sup>w</sup>Two of the communities were inland and the remainder on the coast of James Bay. <sup>x</sup>Attended some high school, not necessarily complete. <sup>y</sup>Anyone reporting working full- or part-time plus those who reported obtaining income from hunting. Individuals that usually speak only Cree at home. <sup>z</sup>Self-report of average time walked per day for the past 7 days. 

remarkable connection of participants to the Eeyou culture.

In men, speaking only Cree in the home was a positive predictor in our analyses of TF intake. To support TF procurement, the Cree Hunters and Trappers Income Security Program provides an annual income, benefits and other incentives to Eeyou who choose hunting, trapping and fishing activities as a way of life [49]. We found that as the frequency of TF intake increased, so did reliance on the Hunting Income Security Program, a proxy indicator of food sovereignty. In women, both hunting and Income Security were common factors for TF intake in both the linear and logistic regressions indicating the importance of food sovereignty in helping women secure food from the land. Future studies could examine the cost of hunting and food sharing practices to better characterise the relationship between hunting and TF intake.

Understanding the facilitators and barriers to TF intake can help to better promote food sovereignty and this very important practice in Indigenous peoples like the Eeyou. We found that age and factors indicating a strong connection to Cree culture (speaking only Cree at home) and food sovereignty (being a hunter and receiving income support to hunt, fish and trap) were associated with TF intake, similar to preliminary analysis of data from the Multi-Community E&H study by Laberge et al. [20]. Our findings indicate the importance of the Income Security Program in promoting the intake of TF. The promotion of hunting, especially in women, may help to encourage TF intake as well as encouraging individuals to apply for the Income Security Program. In our analysis, more highly educated women had lower TF intake. This association is perhaps due to women with higher
Table 3. Odds ratio of being in the highest quintiles (Q5) of the weekly traditional food intake according to food sovereignty proxy and sociodemographic, lifestyle and health characteristics for adults 18 years and older from 7 Eeyou Istchee communities in northern Quebec (Canada), by gender, 2005–2009.

| Characteristics                              | Women (n=465) | Men (n=330) |
|----------------------------------------------|---------------|-------------|
|                                              | Unadjusted    | Adjusted*   | Unadjusted    | Adjusted*   |
|                                              | Odds ratio    | Odds ratio  | Odds ratio    | Odds ratio  |
|                                              | [95% confidence limits] | [95% confidence limits] | [95% confidence limits] | [95% confidence limits] |
| Diet quality                                 |               |             |               |             |
| Per cent energy as UPPb                      | 0.979 [0.969, 0.990] | <0.001     | 0.982 [0.970, 0.994] | 0.003     |
| Food sovereignty                              |               |             |               |             |
| Hunter                                       | 3.523 [2.145, 5.786] | <0.001     | 2.773 [1.586, 4.851] | <0.001     |
| Hunter Income Security                        | 7.458 [3.623, 15.355] | <0.001     | 2.719 [1.144, 6.461] | 0.023     |
| Sociodemographic, lifestyle and health       |               |             |               |             |
| Age                                          | 1.757 [1.492, 2.069] | <0.001     | 1.499 [1.258, 1.784] | <0.001     |
| Coastal community                             | 0.566 [0.354, 0.905] | 0.018      | 0.775 [0.440, 1.364] | 0.376     |
| Household size >4                            | 0.863 [0.543, 1.373] | 0.535      | 0.604 [0.350, 1.042] | 0.070     |
| Children <18 years in household               | 0.416 [0.258, 0.671] | <0.001     | 0.589 [0.314, 1.105] | 0.099     |
| Some high school education                   | 0.156 [0.093, 0.261] | <0.001     | 0.378 [0.191, 0.746] | 0.005     |
| Income from employment                        | 0.497 [0.314, 0.787] | 0.003      | 0.479 [0.277, 0.828] | 0.008     |
| Speak Cree at home                           | 1.347 [0.828, 2.190] | 0.230      | 2.857 [1.427, 5.720] | 0.003     |
| Walk 60 min/day                              | 0.860 [0.545, 1.356] | 0.516      | 1.031 [0.600, 1.772] | 0.912     |
| Smoking                                      | 0.476 [0.269, 0.840] | 0.010      | 0.471 [0.248, 0.895] | 0.021     |
| Perceived good health                        | 1.119 [0.663, 1.889] | 0.674      | 1.084 [0.579, 2.029] | 0.800     |
| Body mass index                              | 1.028 [0.997, 1.060] | 0.075      | 1.038 [1.003, 1.075] | 0.032     |
| UPP: ultra-processed products.               |               |             |               |             |

*Backward multiple logistic regression with odds ratio for model containing only variables with p<0.1. bPer cent energy as UPP was obtained from 24-h recalls. cAge was divided in 10-year increments. dTwo of the communities were inland and the remainder on the coast of James Bay. eAttended some high school, not necessarily complete. fAnyone reporting working full- or part-time plus those who reported obtaining income from hunting. gIndividuals that usually speak only Cree at home. hSelf-report of average time walked per day for the past 7 days. iSmoked ≥5 cigarettes per day. jReported good, very good or excellent health.

Table 4. Linear regression of the average weekly traditional food intake over 1 year according to sociodemographic, lifestyle and health characteristics for 795 adults 18 years and older from 7 Eeyou Istchee communities in northern Quebec (Canada), by gender, 2005–2009.

| Characteristics                              | Women | Men |
|----------------------------------------------|-------|-----|
|                                              | Unadjusted | Adjusted* | Unadjusted | Adjusted* |
|                                              | Beta coefficient | SE | p     | Beta coefficient | SE | p     |
| Diet quality                                 |       |       |       |               |       |       |
| Per cent energy as UPPb                      | −0.060 | 0.013 | <0.001 | −0.054 | 0.026 | 0.043 |
| Food sovereignty                              |       |       |       |               |       |       |
| Hunter                                       | 4.574 | 0.711 | <0.001 | 3.149 | 0.657 | <0.001 | 2.395 | 2.416 | 0.322 | 1.904 | 2.341 | 0.417 |
| Hunter Income Security                        | 8.149 | 1.087 | <0.001 | 4.448 | 1.076 | <0.001 | 5.942 | 1.717 | <0.001 | 3.193 | 1.838 | 0.083 |
| Sociodemographic, lifestyle and health       |       |       |       |               |       |       |
| Age                                          | 0.174 | 0.019 | <0.001 | 0.951 | 0.220 | <0.001 | 0.171 | 0.039 | <0.001 | 1.445 | 0.042 | <0.001 |
| Coastal community                             | −1.71 | 0.648 | 0.009 | 0.495 | 1.323 | 0.709 | 0.115 | 1.274 | 0.928 | 0.090 | 1.283 | 0.944 |
| Household size >4                            | −1.125 | 0.623 | 0.072 | −0.090 | 1.283 | 0.944 | −0.065 | 1.607 | <0.001 | −2.314 | 1.240 | 0.062 |
| Children <18 years in household               | −0.648 | 0.145 | <0.001 | −2.727 | 0.830 | 0.001 | −6.057 | 1.607 | <0.001 | −3.642 | 1.240 | 0.062 |
| Some high schoolf                            | −6.170 | 0.724 | <0.001 | −2.727 | 0.830 | 0.001 | 2.335 | 2.218 | 0.074 | 2.597 | 2.218 | 0.074 |
| Income from employmentg                       | −2.051 | 0.610 | <0.001 | −2.314 | 1.240 | 0.062 | 1.442 | 0.627 | 0.022 | 3.470 | 1.302 | 0.008 |
| Walk ≥60 min/dayh                            | −0.638 | 0.607 | 0.293 | 1.263 | 1.234 | 0.307 | 2.103 | 1.199 | 0.080 | 0.162 | 0.688 | 0.813 |
| Smokingh                                     | −1.729 | 0.663 | 0.009 | −2.638 | 1.299 | 0.043 | −1.119 | 1.302 | 0.283 | −1.133 | 0.302 | 0.001 |
| Perceived good health                        | −0.162 | 0.088 | 0.033 | 0.646 | 1.414 | 0.648 | −0.389 | 1.302 | 0.283 | −0.389 | 1.302 | 0.283 |
| Body mass index                              | 0.040 | 0.042 | 0.333 | 0.113 | 0.106 | 0.283 | 0.113 | 0.106 | 0.283 |

*Backward multiple regression beta coefficients for model containing only variables with p<0.1. bPer cent energy as UPP was obtained from 24-h recalls. A programme whereby members of the community are paid an annual income to spend time on the land hunting, trapping and fishing. Age was divided in 10-year increments. Two of the communities were inland and the remainder on the coast of James Bay. Attended some high school, not necessarily complete. Anyone reporting working full- or part-time plus those who reported obtaining income from hunting. Individuals that usually speak only Cree at home. Self-report of average time walked per day for the past 7 days. Smoked ≥5 cigarettes per day. Reported good, very good or excellent health.
education having wage employment, and therefore less time to dedicate to traditional activities. Understanding the relationship between health and TF can help us to better target interventions to improve the quality of life of First Nations individuals. However, promotion of TF in Indigenous peoples also needs to take into account the link between TF and environmental contaminants, a concern that has arisen from many years of environmental degradation as a result of human activity [50–53]. Changing climate conditions are also affecting the harvesting of TF [54]. Future research needs to elucidate the complex systems that influence TF intake, food sovereignty and its relationship to the culture of First Nations peoples.

There are limitations to our study. Self-reporting of diet may have resulted in the underestimation of unhealthy foods and the overestimation of healthy foods such as TF that are promoted in these communities [55]. One 24-h recall is a good measure of group intake but cannot be used to characterise usual intake in individuals [55]. The FFQ measured yearly TF consumption from which weekly TF consumption was derived. Better precision in weekly estimates might have been obtained if the FFQ had used a shorter duration of time. Our analysis was cross-sectional thereby not allowing us to infer any causal relationships between TF and factors that may influence it. Having a hunter in the home and receiving income security for hunting and trapping were used as proxies for food sovereignty in this study population; however, these variables may be poor proxies for self-determination over food practices in many Indigenous communities in Canada because they are influenced by economic, food and harvest policies. The analyses were also unweighted, so they may not be completely representative of this population. Our results may also not be representative of other Canadian First Nations with rates of obesity that are considerably lower than among the participants in the present study [9,56].

Acknowledgements

We would like to thank all the participants who made this study possible. This scientific communication is a report from the Nituchishiyhitaau Aschii: Multi-Community Environment and Health Longitudinal Study in Iiyiyiu Aschii supported by the Cree people of northern Quebec, the Cree First Nations and the Cree Board of Health and Social Services of James Bay through financial contribution from Niskamoon Corporation.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

Funding for this analysis was provided by an operating grant from the Canadian Institutes for Health Research (CIHR) for the research project “Pulling Together for Health Research: Food Security in First Nations Communities”, grant numbers [348833] and [334049]. The data used in this article originate from the Nituchishiyhitaau Aschii: Multi-Community Environment and Health Longitudinal Study in Iiyiyiu Aschii with financial contribution from Niskamoon Corporation. At the time of this research, Noreen Willows was the recipient of a Health Scholar award from Alberta Innovates Health Solutions.

ORCID

Willows Noreen https://orcid.org/0000-0002-8550-5213
Louise Johnson-Down https://orcid.org/0000-0002-4426-7108
Moubarac Jean-Claude https://orcid.org/0000-0001-8409-7855
Michel Lucas https://orcid.org/0000-0001-6629-5612
Malek Batal https://orcid.org/0000-0001-5672-0371

References

[1] Government of Canada. Constitution Acts, 1867 to 1982. Ottawa, Ontario, Canada: Department of Justice, Government of Canada; 2018 [cited 2018 16 Oct]. Available from: http://laws-lois.justice.gc.ca/eng/Const/FullText.html

[2] Berkes F, Farkas C. Eastern James Bay Cree Indians: changing patterns of wild food use and nutrition. Ecol Food Nutr. 1978;7:155–172.

[3] Johnson-Down L, Egeland GM. How is the nutrition transition affecting the dietary adequacy in eeyouch (Cree) adults of northern Quebec Canada? Appl Physiol Nutr Metab. 2013;38(3):300–305.

[4] Willows ND. Determinants of healthy eating in Aboriginal peoples in Canada: the current state of knowledge and research gaps. Can J Public Health. 2005;96(Suppl 3):S32-6, S36-41. PubMed PMID: 16042162; englfr.

[5] Richmond CA, Ross NA. The determinants of First Nation and Inuit health: a critical population health approach. Health Place. 2009 Jun;15(2):403–411. PubMed PMID: 18760954.

[6] Adelson N. The embodiment of inequity: health disparities in aboriginal Canada. Can J Public Health. 2005;96(Suppl 2): S45–61. PubMed PMID: 16078555.

[7] Torrie JB, Kishchuk N, Webster A. The evolution of health status and health determinants in the Cree region (Eeyou Istchee): eastmain-1-A powerhouse and rupert diversion sectoral report. Montreal, Quebec, Canada: Cree Board of Health and Social Services of James Bay; 2005. p. 1–373.

[8] Kuhnlein HV, Receveur O, Soueida R, et al. Arctic Indigenous peoples experience the nutrition transition with changing dietary patterns and obesity. J Nutr. 2004 Jun;134(6):1447–1453. PubMed PMID: 15173410; eng.

[9] Batal M, Johnson-Down L, Moubarac JC, et al. Quantifying associations of the dietary share of ultra-
processed foods with overall diet quality in First Nations peoples in the Canadian provinces of British Columbia, Alberta, Manitoba and Ontario. Public Health Nutr. 2017 Jul 25;1–11. PubMed PMID: 28738909. DOI: 10.1017/S1368980017001677

[10] Monteiro CA, Cannon G, Moubarac JC, et al. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr. 2017 Mar;21:1–13. PubMed PMID: 28322183.

[11] Popkin BM. Nutrition transition, diet change and its implications. In: Caballero B, Allen L, Prentice AM, editors. Encyclopedia of human nutrition. Third Edition ed. Netherlands and UK: Academic Press; 2013. p. 320–328.

[12] Kuhnlein HV, Receveur O. Dietary change and traditional food systems of indigenous peoples. Annu Rev Nutr. 1996;16:417–442. PubMed PMID: 8839933; eng.

[13] Johnson-Down L, Labonté ME, Martin ID, et al. Quality of diet is associated with insulin resistance in the Cree (Eeyouch) indigenous population of northern Quebec. Nutr Metab Cardiovasc Dis. 2015 Jan;25(1):85–92. PubMed PMID: 25240691.

[14] Lavigne-Robichaud M, Moubarac JC, Lantagne-Lopez S, et al. Diet quality indices in relation to metabolic syndrome in an Indigenous Cree (Eeyouch) population in northern Quebec, Canada. Public Health Nutr. 2017 Jul 07;1–9. PubMed PMID: 28683844. DOI: 10.1017/S136898001700115X

[15] Morrow K, editor. Cree board of health and social services of james bay cree board of health and social services of james bay annual report. In: Cree Board of Health and Social Services of James Bay. Chisasibi, Quebec, Canada; 2016.

[16] Canadian Diabetes Association. Diabetes in Canada 2015 [cited 2016 29 September]. Available from: https://www.diabetes.ca/getmedia/513a0f6c-b1c9-4e56-a77c-6a492bf7350f/diabetes-charter-backgrounder-national-english.pdf.aspx

[17] Redwood DG, Ferucci ED, Schumacher MC, et al. Traditional foods and physical activity patterns and associations with cultural factors in a diverse Alaska Native population. Int J Circumpolar Health. 2008 Sep;67(4):335–348.

[18] Skinner K, Hanning RM, Desjardins E, et al. Giving voice to food insecurity in a remote indigenous community in subarctic Ontario, Canada: traditional ways, ways to cope, ways forward. BMC Public Health. 2013 May 02;13:427. PubMed PMID: 23639143; PubMed Central PMCID: PMC3561721.

[19] Laberge Gaudin V, Receveur O, Girard F, et al. Facilitators and barriers to traditional food consumption in the Cree community of mistissini, Northern Quebec. Ecol Food Nutr. 2015;54(6):663–692. PubMed PMID: 26517308.

[20] Veronique LG, Olivier R, Leah W, et al. A mixed methods inquiry into the determinants of traditional food consumption among three Cree communities of Eeyou Istchee from an ecological perspective. Int J Circumpolar Health. 2014;73:24918.

[21] Chan HM, Fediu K, Hamilton S, et al. Food security in Nunavut, Canada: barriers and recommendations. Int J Circumpolar Health. 2006;65(5):416–431.

[22] Pars T, Osler M, Bjervegaard P. Contemporary use of traditional and imported food among greenlandic inuit [inuit]; subsistence; food; social surveys; gender differences; acculturation; culture (anthropology); greenland. Arctic. 2001;54(1):10.

[23] Skinner K, Hanning R, Tsjui L. Barriers and supports for healthy eating and physical activity for first nation youths in northern Canada. Int J Circumpolar Health. 2006;65(2):148–161.

[24] Lambden J, Receveur O, Marshall J, et al. Traditional and market food access in Arctic Canada is affected by economic factors. Int J Circumpolar Health. 2006 Sep;65(4):331–340. PubMed PMID: 17131971.

[25] Guyot M, Dickson C, Paci C, et al. Local observations of climate change and impacts on traditional food security in two northern Aboriginal communities. Int J Circumpolar Health. 2006 Dec;65(5):403–415. PubMed PMID: 17319085.

[26] Morrison D. First annual interior of bc indigenous food sovereignty conference report. B.C. Food Systems Network; 2006.

[27] Morrison D. Indigenous food sovereignty – A model for social learning. In: Wittman H, Wiebe N, editors. Food sovereignty in Canada: creating just and sustainable food systems. Halifax, Nova Scotia, Canada: Fernwood Publishing; 2011. p. 97–113.

[28] Indigenous peoples in route to the Rio +20 Conference, editor global preparatory meeting of indigenous peoples on Rio +20 and Kari-Oca 2, conclusions and recommendations. Indigenous Peoples in Route to the Rio +20 Conference; 2011; Manaus, Amazonia, Brazil.

[29] Centre for Indigenous Conservation and Development Alternatives. Livelihoods, food sovereignty and coping with neoliberal growth, 2017 [cited 2018 Feb 2]. Available from: http://cicada.world/research/themes/live-lihoods-food-sovereignty-and-coping-with-neoliberal-growth/

[30] Centre for Indigenous Conservation and Development Alternatives. Protected areas development and environmental stewardship, eeyou istchee (Crees of northern Quebec), 2017 [cited 2018 Feb 2]. Available from: http://cicada.world/research/programs/instead/pro-ected-areas-development-and-environmental-steward-ship-eeyou-istchee-crees-of-northern-quebec/

[31] Libeira EN, Tsjui LS, Martin ID, et al. Source identification of human exposure to lead in nine Cree Nations from Quebec, Canada (Eeyou Istchee territory). Environ Res. 2018 Feb;161:409–417. PubMed PMID: 29197759.

[32] Nieboer E, Dewaille E, Johnson-Down L, et al. Nituuchischaayihtitaau aschii multi-community environment-and-health study in eeyou istchee 2005–2009: final technical report. In: Nieboer E, Robinson E, Petrov K, editors. Public Health Report Series 4 on the Health of the Population. Chisasibi, Quebec, Canada: Cree Board of Health and Social Services of James Bay; 2013.

[33] Bonnier-Viger Y, M-L C-D, Dewaille E, et al. Nituuchischaayihtitaau Aschii multi-community environment and health longitudinal study in eeyou istchee: eastmain and wemindji technical report. In: Nieboer E, Robinson E, Petrov K, editors. Public health report series 4 on the health of the population. Chisasibi, Quebec, Canada: Cree Board of Health and Social Services of James Bay; 2011.

[34] Bonnier-Viger Y, Dewaille E, Egeland GM, et al. Nituuchischaayihtitaau Aschii Multi-community
Environment-and-health Longitudinal Study in Ii’yiiyu Aschii: Mistissini Technical Report. Cree Board of Health and Social Services of James Bay (CBHSSJB); 2007 [cited 2018 16 Oct]. Available from: http://www.creehealth.org/library/online/research/environmental-health-study-technical-report-mistissini

[35] Conway JM, Ingwersen LA, Moshfegh AJ. Accuracy of dietary recall using the USDA five-step multiple-pass method in men: an observational validation study. J Am Diet Assoc. 2004 Apr;104(4):595–603. S0002822304000082. S0002822304000082.

[36] Conway JM, Ingwersen LA, Vinyard BT, et al. Effectiveness of the US Department of Agriculture 5-step multiple-pass method in assessing food intake in obese and nonobese women. Am J Clin Nutr. 2003 May;77(5):1171–1178. PubMed PMID: 12716668; eng.

[37] IPAQ INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE 2002 [cited 2012]. Available from: https://f0362602-a-737. PubMed PMID: 12716668; eng.

[38] Touyz RM, Canadian Hypertension Education P. Highlights and summary of the 2006 Canadian hypertension education program recommendations. Can J Cardiol. 2006 May 15 22(7):565–571. PubMed PMID: 16755311; PubMed Central PMCID: PMCPMC2560863.

[39] Gesink D, Rink E, Montgomery-Andersen R, et al. Developing a culturally competent and socially relevant sexual health survey with an urban Arctic community. Int J Circumpolar Health. 2010 Feb;69(1):25–37. PubMed PMID: 20167154; eng.

[40] Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation. 2009 Oct 20;120(16):1640–1645. PubMed PMID: 19805654.

[41] Alberti KG, Zimmet P, Shaw J. Metabolic syndrome–a new world-wide definition. A consensus statement from the international diabetes federation. Diabet Med. 2006 May;23(5):469–480. PubMed PMID: 16681555.

[42] Moubarac JC, Batal M, Louzada ML, et al. Consumption of ultra-processed foods predicts diet quality in Canada. Appetite. 2017 Jan 01;108:512–520. PubMed PMID: 27825941.

[43] Moubarac JC, Martins AP, Claro RM, et al. Consumption of ultra-processed foods and likely impact on human health. Evidence from Canada. Public Health Nutr. 2013 Dec;16(12):2240–2248. PubMed PMID: 23171687; eng.

[44] Monteiro CA, Levy RB, Claro RM, et al. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. Public Health Nutr. 2011 Jan;14(1):5–13. PubMed PMID: 21211100.

[45] Louzada ML, Martins AP, Canella DS, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. Rev Saude Publica. 2015;49:38. PubMed PMID: 26176747; PubMed Central PMCID: PMCPMC4544452. eng.

[46] Martinez Steele E, Baraldi LG, Louzada ML, et al. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ Open. 2016;6(3):e009892. PubMed PMID: 26962035; PubMed Central PMCID: PMCPMC4785287. eng.

[47] Batal M, Gray-Donald K, Kuhnlein HV, et al. Estimation of traditional food intake in indigenous communities in Denendeh and the Yukon. Int J Circumpolar Health. 2005 Feb;64(1):46–54. PubMed PMID: 15776992; eng.

[48] Kuhnlein HV, Receveur O. Local cultural animal food contributes high levels of nutrients for Arctic Canadian indigenous adults and children. J Nutr. 2007 Apr;137(4):1110–1114. PubMed PMID: 17374689; eng.

[49] Cree hunters and trappers income security board. The Program Quebec, Quebec, Canada; 2017 [cited 2017 Oct 27]. Available from: http://www.chtisb.ca/program/

[50] Juric AK, Batal M, David W, et al. A total diet study and probabilistic assessment risk assessment of dietary mercury exposure among First Nations living on-reserve in Ontario, Canada. Environ Res. 2017 Oct;158:409–420. PubMed PMID: 28689032.

[51] Marushka L, Batal M, David W, et al. Association between fish consumption, dietary omega-3 fatty acids and persistent organic pollutants intake, and type 2 diabetes in 18 First Nations in Ontario, Canada. Environ Res. 2017 Jul;156:725–737. PubMed PMID: 28482294.

[52] Libedea EN, Tsuji LJ, Martin ID, et al. Plasma concentrations of persistent organic pollutants in the Cree of northern Quebec, Canada: results from the multi-community environment-and-health study. Sci Total Environ. 2014;470–471:818–828. PubMed PMID: 24189104.

[53] Libedea EN, Wainman BC, Leblanc A, et al. Dietary exposure of PBDEs resulting from a subsistence diet in three First Nation communities in the James Bay Region of Canada. Environ Int. 2011 Apr;37(3):631–636. PubMed PMID: 21255843; eng.

[54] Ford JD, Berrang-Ford L, King M, et al. Vulnerability of indigenous health systems in the Cree of northern Quebec, Canada to climate change. Global Environmental Change. 2010;20(4):668–680.

[55] Institute of Medicine. Dietary Reference intakes: applications in Dietary Assessment. Washington, DC, USA: The National Academies Press; 2000.

[56] Public Health Agency of Canada. Diabetes in Canada: facts and figures from a public health perspective. Ottawa, Ontario, Canada: Public Health Agency of Canada; 2011.