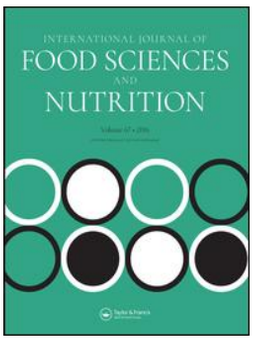

International Journal of Food Sciences and Nutrition

ISSN: 0963-7486 (Print) 1465-3478 (Online) Journal homepage: http://www.tandfonline.com/loi/iijf20

Sociodemographic associations of the dietary proportion of ultra-processed foods in First Nations peoples in the Canadian provinces of British Columbia, Manitoba, Alberta and Ontario

Malek Batal, Louise Johnson-Down, Jean-Claude Moubarac, Amy Ing, Karen Fediuk, Tonio Sadik, Hing Man Chan & Noreen Willows

To cite this article: Malek Batal, Louise Johnson-Down, Jean-Claude Moubarac, Amy Ing, Karen Fediuk, Tonio Sadik, Hing Man Chan & Noreen Willows (2017): Sociodemographic associations of the dietary proportion of ultra-processed foods in First Nations peoples in the Canadian provinces of British Columbia, Manitoba, Alberta and Ontario, International Journal of Food Sciences and Nutrition, DOI: 10.1080/09637486.2017.1412405

To link to this article: https://doi.org/10.1080/09637486.2017.1412405

Published online: 18 Dec 2017.

INTERNATIONAL JOURNAL OF FOOD SCIENCES AND NUTRITION, 2017
https://doi.org/10.1080/09637486.2017.1412405

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

Sociodemographic associations of the dietary proportion of ultra-processed foods in First Nations peoples in the Canadian provinces of British Columbia, Manitoba, Alberta and Ontario

Malek Batal[a], Louise Johnson-Down[b], Jean-Claude Moubarac[a], Amy Ing[a], Karen Fediuk[c], Tonio Sadik[d], Hing Man Chan[e] and Noreen Willows[f]

[a]Département de nutrition, Faculté de Médecine, Université de Montréal, Pavillon Liliane de Stewart, Montréal, QC, Canada; [b]School of Dietetics and Human Nutrition, McGill University, Ste Anne de Bellevue, QC, Canada; [c]First Nations Food, Nutrition and Environment Study, University of Ottawa, Ottawa, ON, Canada; [d]Assembly of First Nations, Ottawa, ON, Canada; [e]Department of Biology, University of Ottawa, Ottawa, ON, Canada; [f]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada

ABSTRACT

We investigated the food types consumed by 3276 First Nations citizens from the First Nations Food Nutrition and Environment Study (FNFNES) living on-reserve in Canada. Data from 24-h dietary recalls were classified into NOVA categories: fresh or minimally processed foods (MPF), processed culinary ingredients, processed foods, and ultra-processed foods (UPF). Individuals were classified as traditional food (TF) eaters if they ate MPF of their First Nations culture. UPF accounted for 54.0% of energy intake; 23% of participants ate TF. Increasing age and household size, living in British Columbia and TF eating were associated with a lower intake of energy from UPF. Eating TF appeared to be protective against intake of UPF.

ARTICLE HISTORY
Received 20 July 2017
Revised 27 November 2017
Accepted 29 November 2017

KEYWORDS
Diet; First Nation; Indian; North American; NOVA classification; ultra-processed food; food: food processing: food choice

Introduction

First Nations peoples represent approximately 62% of Indigenous peoples in Canada (Statistics Canada 2015a) and 3% of the general Canadian population (Statistics Canada 2015b). Half of First Nations peoples live on federal government reserves (tracts of land which are often remote, set aside for the use of a First Nation) while half live off-reserve, most often in urban centres (Statistics Canada 2015a). In comparison with the non-Indigenous Canadian population, First Nations peoples are younger, with fewer years of formal education, live in overcrowded homes that are likely to require major repairs, and are more likely to experience poverty (Statistics Canada 2015a). First Nations peoples have undergone a nutrition transition as a result of European colonisation and the introduction of high-calorie and nutrient-poor store-bought foods, with resultant adverse health consequences (Willows 2005). For example, obesity-related chronic diseases are highly prevalent as a result of poor diet and inactivity associated with the nutrition transition (Young et al. 2000; Liu et al. 2006; Public Health Agency of Canada 2011). Colonialism with the accompanying marginalisation and political and economic disadvantages have thus led to health disparities (Adelson 2005).

A strong sense of cultural identity is important for the well-being of First Nations peoples considering the many challenges that they face. This is because health and well-being are perceived as being holistic and based on a balance among physical, mental, emotional, spiritual and social factors (National Aboriginal Health Organization (NAHO) 2007). First Nations diets in the pre-colonial and early-colonial periods consisted solely of fresh and minimally processed traditional foods (TF) such as game, fish, fowl, eggs, plants and berries. Across ecosystems, First Nations peoples used diverse resource management and food production technologies including hunting, foraging, trapping and intensive food production strategies such as clam gardens, estuarine root beds, berry patches, crab-apple orchards and plant species domestication including sunflower, corn, beans and squash (Deur and Turner 2005). TF continue to be important to the health of

CONTACT Noreen Willows noreen.willows@ualberta.ca Department of Agricultural, Food and Nutritional Science, University of Alberta, Mailbox #54 11405 87 Avenue, Edmonton, AB, Canada T6G 2P5

First Nations peoples because they are nutrient-dense, contribute to a sense of cultural identity and physical activity is required for their procurement (Batal et al. 2005; Willows 2005; Chan et al. 2011; Chan et al. 2012; Johnson-Down and Egeland 2013; Chan et al. 2014; Chan et al. 2016). Processed foods, rather than TF or fresh foods, often constitute a substantial portion of the diet of contemporary First Nations peoples (Willows 2005; Ho et al. 2008). The significance of industrial processing on the nature of food and on the state of human health has been insufficiently addressed. NOVA (a name, not an acronym) is a tool that classifies foods according to the nature, extent and purpose of food processing, rather than in terms of nutrients. The NOVA classification permits an examination of the importance of processed foods in the diet (Moubarac et al. 2014; Adams and White 2015; Food and Agriculture Organization 2015). Previous research has revealed that while food processing can be beneficial to the diet (e.g. through increased bioavailability of some nutrients), ultra-processed food (UPF) *per se* are nutritionally imbalanced and their consumption negatively impacts the nutritional quality of diets (Monteiro et al. 2011; Moubarac et al. 2013; Louzada et al. 2015b; Martinez Steele et al. 2016; Moubarac et al. 2017). Canadian studies in the general population and First Nations reported that diets with a high proportion of UPF were nutritionally inferior (Batal et al. 2017; Moubarac et al. 2017). Using the NOVA classification, the relationship between UPF intake and sociodemographic factors in a population can be studied to help to determine who may be at greatest risk of dietary inadequacy and nutritional deficiencies.

Investigating the importance of processed food in the diet is relatively new and relating this to sociodemographic variables has been investigated in only a few populations (Adams and White 2015; Louzada et al. 2015a) but never explored in an Indigenous population such as the economically disadvantaged on-reserve First Nations population in Canada. Using a cross-sectional analysis, we aimed to use the NOVA categorisation to investigate the possible associations between selected sociodemographic variables and the intake of UPF among First Nations people living on-reserve in four Canadian provinces.

Materials and methods

Study

After passage of a resolution by the Assembly of First Nations (AFN) in 2007 for the generation of additional knowledge on the diet and environment of First Nations living on reserve south of the 60th parallel, the First Nations Food, Nutrition and Environment Study (FNFNES) was designed to contribute to filling gaps in these areas with respect to First Nations peoples (Chan et al. 2011, 2012, 2014, 2016). FNFNES is a joint project between the AFN, University of Northern British Columbia, University of Ottawa and Université de Montréal, with funding and technical support from Health Canada, to investigate diet and food-related exposures to environmental contaminants. First Nations Principles of Ownership, Control, Access and Possession (OCAP®) as well as "the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans" guided the study. Study activities were planned with the involvement of individual communities, and data, results and reports were communicated to the communities in face-to face meetings with community members and workers before reports were issued.

The Research Ethics Boards of Health Canada, the University of Northern British Columbia, the University of Alberta, the University of Ottawa and the Université de Montréal granted ethical approval.

Sampling and data collection

To date, FNFNES data are available from participants who were randomly selected using a multi-stage sampling strategy in four Canadian provinces (British Columbia, Alberta, Manitoba and Ontario) (Chan et al. 2011, 2012, 2014, 2016). First, ecological zones or naturally occurring divisions of the earth's surface by the distribution of plants and animals were the basis for community sampling (Wiken 1986). Second, households were randomly selected within each community. The person with the next birthday was selected to participate when more than one adult was present in a household. Criteria for inclusion were: 19 years of age and older, living on-reserve and self-identified as First Nations.

Data collection took place from 2008 to 2013. Trained community members administered questionnaires to one participant from each household to collect information on dietary patterns, lifestyle, general health status, environmental concerns and food security. Dietary intake data were collected using a 24-h recall, employing a 3-stage multiple pass method: quick list, detailed description and review (Raper et al. 2004) with estimation of portion sizes with the aid of 3-dimensional food models (Santé Québec, Montréal, Québec, Canada).

Of the 5355 households in 58 communities that were sampled, 50 households were ineligible (not First

Table 1. Description of NOVA classification[a].

Fresh or minimally processed foods (MPF)	These include fresh, squeezed, chilled, frozen, or dried fruits and leafy and root vegetables; grains such as rice, corn and wheat; legumes of all types; roots and tubers such as potatoes; meat, poultry, fish and seafood, whole or in the form of steaks, fillets and other cuts, or chilled or frozen; eggs; milk, pasteurised or powdered; fresh or pasteurised fruit or vegetable juices without added sugar, sweeteners or flavours; grits, flakes or flour made from corn, wheat, oats, or cassava; pasta, couscous made with flours, flakes or grits and water; tree and ground nuts and other oil seeds without added salt or sugar; spices and herbs; plain yogurt with no added sugar or artificial sweeteners added; tea, coffee, and drinking water. This also includes foods with two or more items, such as dried mixed fruits or granola made from cereals, nuts and dried fruits with no added sugar, honey or oil, and foods with vitamins and minerals added generally to replace nutrients lost during processing, such as wheat or corn flour fortified with iron or folic acid
Processed culinary ingredients (PCI)	These foods are not normally consumed alone but mainly used as ingredients to prepare, season and fresh or minimally processed foods. Examples are salt, sugar, molasses, honey, maple syrup, vinegar, vegetable oils, seeds, butter, lard and starches extracted from corn and other plants. These foods may have two ingredients such as salted butter or may have added vitamins or minerals, such as iodised salt, and vinegar made by acetic fermentation of wine or other alcoholic drinks. These items may contain additives that preserve the product's original properties. Examples are vegetable oils with added anti-oxidants, salt with added anti-humectants, and vinegar with added preservatives that prevent microorganism proliferation
Processed foods (PF)	Most processed foods have two or more ingredients. These processes may include preservation or cooking methods, and, in the case of breads and cheese, non-alcoholic fermentation. The main purpose of processing is to increase the shelf life, or to modify or enhance the taste. Examples are canned vegetables, fruits and legumes; salted or sugared nuts and seeds; salted, cured, or smoked meats; canned fish; as well as breads and cheeses
Ultra-processed foods (UPF)	These are industrial formulations that typically have five or more ingredients. Constituents of ultra-processed foods include substances not commonly used in culinary preparations, such as hydrolysed protein, modified starches and hydrogenated oils, and other additives such as colourants, flavourings, non-sugar sweeteners, etc. The main purpose of industrial ultra-processing is to create products that are ready-to-eat, to drink or to heat. Examples of these are carbonated drinks; sweet or savoury packaged snacks; ice cream, chocolate, candies; packaged breads and buns; margarines and spreads; cookies, pastries, cakes, and cake mixes; breakfast 'cereals', 'cereal' and 'energy' bars and drinks; 'fruit' yogurts and drinks; cocoa drinks; meat and chicken extracts and 'instant' sauces; powdered or 'fortified' meal and substitutes; and many ready-to-heat products including pre-prepared pies and pasta and pizza dishes; fried poultry and fish, sausages, burgers, hot dogs, and other reconstituted meat products, and packaged 'instant' soups, noodles and desserts

[a]Moubarac et al. (2017).

Nations, 19 years or older, or living on-reserve; or for health reasons such as deafness and cognitive impairment) and 138 homes were vacant. Of these 58 communities, 11 (19%) were remote (fly-in or winter road only) and 25 (43%) were rural and at least 60 km away from the nearest urban centre. Of the 5167 eligible households, a total of 3847 households completed interviews, for a participation rate of 74.5%. For the present study, responses were excluded from pregnant and breastfeeding women ($n = 143$) as well as from individuals with no food intake on the day prior to being interviewed ($n = 4$). For the remaining 3700 participants, data on variables used for analysis were missing for 424 individuals and the final sample size for these analyses was 3276.

Data processing and analysis

The 24-h dietary recalls were entered by research nutritionists at the Université de Montréal and analysed using CANDAT (Godin, London, Ontario, Canada) which is a nutrient analysis software that uses the 2010 Canadian Nutrient File (CNF) (Health Canada 2010). In addition to the CNF, a food file was created that contained nutritional information on foods missing from the CNF. The accuracy of 24-h recalls was ensured using several steps: (1) a sub-sample of 10% of the records were cross-checked and any discrepancies were reconciled, (2) if many errors were found in step 1, a further 10% check were reviewed and (3) a review of outliers such as unusual foods and intakes that were ±2 SD of the mean for energy and selected nutrients. The remainder of the questionnaire data were entered into a database using Epi-Info version 3.5.4 (CDC, Atlanta, GA).

The NOVA classification was used to categorise foods and food products into four categories: (1) fresh or minimally processed foods (MPF) such as fresh, dried or frozen fruits and vegetables, meats, grains and pasteurised milk; (2) processed culinary ingredient (PCI) such as sugar, oils, fats and salt used in cooking; (3) processed foods (PF) such as canned foods, artisanal breads, cheese and smoked foods; and (4) ultra-processed foods (UPF) which are industrial formulations based on refined substances and additives such as sweetened breakfast cereals, sweetened drinks and juices, snack foods and "instant" soups and noodles (Moubarac et al. 2014; Adams and White 2015; Food and Agriculture Organization 2015; Batal et al. 2017; Moubarac et al. 2017) (Table 1). Mean estimates of the proportion of food energy (% total energy) were calculated for each NOVA food group. Quintiles of the energy contribution of UPF were used as proxy for diet quality; where highest diet quality would be represented by the first quintile and poorer diet quality by the fifth quintile. In parallel, participants were classified as being consumers of TF when TF was reported consumed at least once on the 24-h dietary recall.

Table 2. Top five traditional foods reported on the 24 h recalls collected in the fall season in adults 19 years and older from 58 on reserve First Nations communities in British Columbia, Manitoba, Alberta and Ontario (Canada), 2008–2013.

Province	British Columbia	Alberta	Manitoba	Ontario
Foods	Moose	Moose	Moose	Moose
	Salmon	Wild mint (tea)	Caribou	Walleye
	Raspberries	Deer	Deer	Whitefish
	Deer	Elk	Duck	Deer
	Blueberries	Northern pike & grouse[a]	Blueberries	Maple syrup

Source: FNFNES study.
[a]Tied.

TF eating was used as a proxy variable to indicate the individual had a more culturally attuned First Nations way of life.

Considering reports that TF is consumed more often by older individuals (Kuhnlein and Receveur 1996; Kuhnlein and Delormier 1999; Johnson-Down and Egeland 2013), means of sociodemographic variables were calculated by adult age categories established using Institute of Medicine categories for nutrient requirements: 19–30 years; 31–50 years; 51–70 years; 71 years and older (Institute of Medicine, Food and Nutrition Board 2005). Proportions of categorical variables were established for these age categories, for sex, main source of income (wages; worker's compensation or employment insurance; social assistance; pension/senior's benefits), employment (where anyone in the household performed any part- or full-time work) and province of residence.

Unadjusted linear regression models were run for each of the sociodemographic variables to investigate possible associations with the quintiles of percent of food energy from UPF. Quintiles of percent energy as UPF were chosen as the dependent variable rather than percent energy as UPF because a single 24-h dietary recall is a good measure of group intake but not individual intake (Willett 2012). To aid in the interpretation of data, categorical variables with more than two groupings were coded as numbers. Provinces were coded as 1 for British Columbia, 2 for Alberta, 3 for Manitoba, and 4 for Ontario in order to determine if there was a west to east geographical trend in the data. Income source was coded 1 for wages, 2 for worker's compensation/employment insurance, 3 for pension/senior's benefits and 4 for social assistance (also known as welfare).

After exploring possible collinearity between variables, a stepwise multiple regression was run with quintiles of percent of energy as UPF as the dependent variable and all sociodemographic variables as independent variables, eliminating variables with a p value greater than 0.10. All analyses were unweighted and used SAS/STAT software version 9.4 (SAS, Cary, NC, 2013). p Values less than 0.05 were considered significant.

Results

Ontario had the majority of participants at 34.7% followed by British Columbia (30.0%), Manitoba (19.3%) and Alberta (16.1%). Mean age of participants was 45.2 ± 14.9 years and 62.6% were women. Mean years of schooling was 10.6 ± 3.18 (implying that many individuals had not completed high school) and mean household size was 3.74 ± 2.31. About half (50.8%) of participants reported wages or self-employment as their main source of income and 64% of participants reported at least one member of their household working part-time or full-time in the wage economy. Twenty-three percent of participants reported having eaten at least one TF on the day of the 24-h recall, with British Columbia having the highest percentage of TF eaters (35.7%). Table 2 presents the five most reported TF from each of the four participating provinces, in order of frequency of consumption. Moose was the most commonly eaten TF, deer was frequently eaten irrespective of province of residence, while other frequent TF varied by province. Sociodemographic and dietary characteristics by age groupings are reported in Table 3. There was a young to old age gradient for increased TF consumption.

Mean energy intake of First Nations individuals was 1950 ± 1021 kcal/d. On an average, UPF accounted for 54.0% of energy (range 0–100%), MPF 36.3% (range 0–100%), PCI 6.2% (range 0–100%) and PF 3.5% (range 0–71.9%). Figure 1 shows the proportion of food energy from the 4 NOVA food categories by quintiles of the energy contribution of UPF. Mean percent energy intake as UPF ranged from 18.5% in quintile 1 to 87.8% in quintile 5, a 69% increase between 1st and 5th quintiles (Figure 1). On the other hand, MPF, PCI, and PF decreased by 59%, 6% and 4%, respectively (Figure 1) between the 1st and 5th quintiles of UPF as percent of food energy.

Table 3. Demographic and lifestyle characteristics of adults 19 years and older from 58 on reserve First Nations communities in British Columbia, Manitoba, Alberta and Ontario (Canada), 2008–2013.

Characteristic	19-30 years	31-50 years	51-70 years	71 + years
n	614	1517	954	191
Women (*n* (%))	382 (62.2)	984 (64.9)	565 (59.2)	117 (61.3)
Men (*n* (%))	232 (37.8)	533 (35.1)	389 (40.8)	74 (38.7)
Education[a] (year)	11.0 ± 2.3	11.3 ± 2.8	10.1 ± 3.6	7.28 ± 4.03
Main source of income				
Wages (*n* (%))	306 (49.8)	928 (61.2)	425 (44.6)	6 (3.14)
Workers comp/EI (*n* (%))	46 (7.49)	110 (7.25)	69 (7.23)	1 (0.52)
Pension/seniors benefits (*n* (%))	5 (0.81)	20 (1.32)	250 (26.2)	179 (93.7)
Social assistance (*n* (%))	257 (41.9)	459 (30.3)	210 (22.0)	5 (2.62)
Employment[b] (*n* (%))	411 (66.9)	1077 (71.0)	561 (58.8)	56 (29.3)
Household size[a] (*n*)	4.21 ± 2.15	4.13 ± 2.35	3.02 ± 2.15	2.70 ± 2.14
Province				
British Columbia (*n* (%))	184 (30.0)	467 (30.8)	301 (31.6)	35 (18.3)
Alberta (*n* (%))	90 (14.7)	271 (17.9)	129 (13.5)	38 (19.9)
Manitoba (*n* (%))	142 (23.1)	294 (19.4)	162 (17.0)	23 (12.0)
Ontario (*n* (%))	1989 (32.3)	485 (32.0)	362 (37.9)	95 (49.7)
TF on day of 24-h recall (*n* (%))	82 (13.4)	312 (20.6)	280 (29.4)	68 (35.6)

Source: FNFNES study. Data are unweighted.
[a]Mean ± standard deviation.
[b]Employment was defined as anyone in the household working for wages either part of full time.

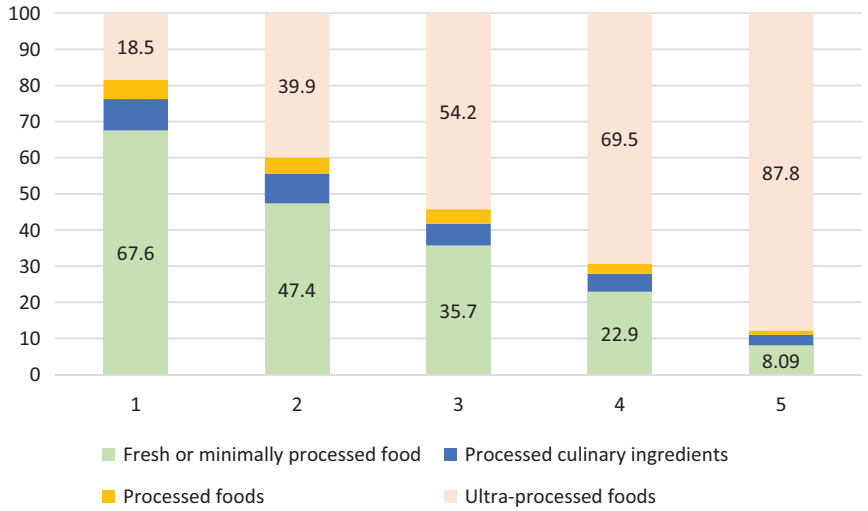

Figure 1. Proportion of energy from the 4 NOVA food categories by quintiles of the percent food energy coming from ultra-processed foods (UPF) in adults 19 years and older from 58 on-reserve First Nations communities in British Columbia, Manitoba, Alberta and Ontario (Canada), 2008–2013 ($n = 3276$). Source: FNFNES study. Data are unweighted.

Unadjusted regression of characteristics with quintiles of the energy contribution of UPF was higher among younger ($p < .01$) and less educated individuals ($p < .01$), people living in larger households ($p < .01$), and wage-earners ($p < .01$), and, lower for those on social assistance ($p < .01$), from British Columbia ($p < .01$) and among TF eaters ($p < .01$, see Table 4).

Multiple regression adjusting for all the characteristics yielded age, household size, province and TF eating as significantly affecting quintiles of percent energy as UPF (Table 4). Results showed that the quintiles of percent energy as UPF decreased with TF consumption, increasing age and household size, and moving from east to west. It is interesting to note that although the quintiles of percent energy as UPF increased with household size, after adjustment for the other variables, percent energy as UPF decreased with increasing household size; thus, it appears that this variable was confounded by other variables. The highest regression coefficient in the model predicting the quintiles of percent energy as UPF, while holding all other variables in the model constant, was eating TF on the day of the recall (Table 4).

Discussion

To our knowledge, this is only the second study to look at the extent of processed food in the diet and the relationship between UPF consumption and socio-demographic characteristics in an Indigenous

Table 4. Linear regression of quintiles of the percent of energy intake as ultra-processed foods (UPF) with sociodemographic and lifestyle characteristics of adults 19 years and older from 58 on reserve First Nations communities in British Columbia, Manitoba, Alberta and Ontario (Canada), 2008–2013.

				Unadjusted			Adjusted		
Characteristic	*n*	Percent energy as UPF	SD	Beta coefficient	SE	*p*	Beta coefficient	SE	*p*
All	3276	54.0	24.6						
Gender									
Women (referent)	2048	54.4	24.4	−0.0450	0.0509	.3764	−0.0020	0.0483	.9668
Men	1228	53.4	25.1						
Age[a]	3276	54.0	24.6	−0.0220	0.0016	<.0001	−0.0192[h]	0.0016	<.0001
Mean years of schooling	3276	54.0	24.6	0.0478	0.0077	<.0001	0.0067	0.0080	.4038
Household size	3276	54.0	24.6	0.0178	0.0106	.0952	−0.0242[h]	0.0103	.0188
Employment[b]									
No work (referent)	1171	51.6	25.6	0.1959	0.0513	<.0001	0.0356	0.0691	.6061
Any work[c]	2105	55.3	24.0						
Main source of income[d]									
Wages (referent)	1665	55.6	23.9	−0.0491	0.0185	.0079	−0.0143	0.0246	.5605
Workers comp/EI[e]	226	54.9	22.9						
Pension/seniors benefits	454	46.6	25.3						
Social assistance	931	54.4	25.5						
Province[f]									
British Columbia (referent)	987	50.0	24.5	0.1055	0.0198	<.0001	0.0583[h]	0.0190	.00242
Alberta	528	54.0	23.9						
Manitoba	621	57.3	24.3						
Ontario	1140	55.7	24.0						
Traditional food eater[g]									
No Traditional food eater (referent)	2534	58.1	23.9	−1.0070	0.0563	<.0001	−0.8670[h]	0.5724	<.0001
Traditional food eater	742	40.1	21.9						

n: number of participants; SD: standard deviation; SE: standard error; comp: compensation; EI: employment insurance. Source: FNFNES study. Data are unweighted.
[a]Age categories coded as 19–30 years: 1, 31–50 years: 2, 51–70 years: 3, 71 + years: 4.
[b]Employment coded as No work: 0, Any work: 1.
[c]Any work refers to anyone in the household working for wages either part of full time.
[d]Main source of income coded as Wages: 1, Workers comp/EI: 2, Pension/senior benefits: 3, Social assistance: 4.
[e]Employment insurance is an insurance provided by the Canadian government for 1 year after an individual loses their job.
[f]Province coded as British Columbia: 1, Alberta: 2, Manitoba: 3, Ontario: 4.
[g]Traditional food eater coded as No Traditional Food eaten: 0, At least one Traditional Food eaten on the day of the recall: 1.
[h]Beta coefficients for model containing only variables with $p < .1$.

population at high risk for the development of diet-related chronic disease (Batal et al. 2017). We observed that First Nations adults living on-reserve in four Canadian provinces consumed, on average, 54.0% of their food energy from UPF as compared with that of the general Canadian population at 47.7% (Moubarac et al. 2017). Tracking the intake of UPF is a useful way to monitor the trend toward more ready-to-eat, packaged and convenience foods and the reduced intake of homemade or minimally processed foods (Pan American Health Organization 2015). UPF are more energy-dense but less nutrient-dense than other foods (Moubarac et al. 2013; Louzada et al. 2015b; Moubarac et al. 2017); therefore, the degree of UPF in the diet is likely a better predictor of diet quality and health for Indigenous peoples (Fardet et al. 2015) than reporting adherence to Canada's Food Guide to Healthy Eating, including Canada's Food Guide to Healthy Eating for First Nations, Inuit and Métis (Health Canada 2007). Both these food guides include examples of processed foods and were not developed using actual healthy eating patterns, unlike the Dietary Guidelines for the Brazilian Population 2014 (Ministry of Health of Brazil 2014).

Despite living in a high-income country, many First Nations peoples in Canada experience a cycle of poverty, violence and educational failure (Kendall 2001) and their living conditions are subpar compared to their non-Indigenous counterparts (Statistics Canada 2015a, 2015b). First Nations systematically endure lower life expectancy and educational attainment, higher unemployment and a poorer economic status as compared to the general Canadian population (Mitrou et al. 2014; Anderson et al. 2016). In 2011, the general Canadian population lived in households with an average size of 2.5 persons (Statistics Canada 2013) as compared with 3.7 persons in our current sample. The greater number of household members suggests a greater likelihood of household crowding, which may be due to more children per household and extended family members living together by choice, in addition to a lack of affordable housing or limited housing availability.

Our data showed a geographic gradient in UPF and TF consumption, with a greater proportion of First

Nations individuals in British Columbia consuming TF and having lower energy intake from UPF than First Nations in the three more easterly provinces. There are differences in food systems and environments between First Nations peoples in Canada that makes it difficult to easily hypothesise the reasons why we see these dissimilarities in food intake (Adelson 2005). Perhaps some differences could be explained by regional variability in TF abundance, and contamination concerns of TF in certain areas (e.g. fish advisories related to mercury, shellfish closures due to sewage), as well as differences in regional historical patterns of colonial marginalisation, treaty-making and resource management approaches. More research is required to understand the reasons for the regional differences in TF and UPF consumption that we observed.

The dietary intake of food energy from the NOVA categories (UPF 54%; MPF 36.3%, PCI 6.2% and PF 3.5%) for First Nations adults in our study is similar to that of the general Canadian population with intakes of 47.7%, 39.2%, 6.1% and 7%, respectively (Moubarac et al. 2017). The percent of food energy from UPF is also similar to other high-income countries such as the USA (57.9%) (Martinez Steele et al. 2016) and the UK (53%) (Adams and White 2015). Even though First Nations may prefer TF, they may choose to eat UPF because they are readily available, highly convenient, and an economical source of energy (Moubarac et al. 2013, 2017). Additionally, many UPF do not require refrigeration and can be stored for a long time, so that they are likely easier to transport to rural and remote locations with less weight and spoilage than perishable fresh and minimally processed foods. UPF may also be associated with social prestige (Renaud 2002) and as a convenient and economical way to prepare meals (Yaghmaei 2016).

In this study of the sociodemographic determinants of UPF intake, we used TF as a proxy for adherence to indigenous cultural ways and our strongest and most important finding was the strong inverse association between TF and UPF intake after adjusting for confounders such as gender, age, household size and province. TF nutritional benefits have been shown repeatedly in First Nations populations (Batal et al. 2005; Johnson-Down and Egeland 2013; Johnson-Down et al. 2015). That TF eating is inversely associated with quintiles of energy as UPF suggests that intake of culturally significant First Nations foods contributes to a healthy dietary pattern, in addition to improved nutrient intake. This a validation of the belief that TF promote health in these peoples.

A strength of our study was the use of reported dietary intake. Because 24-h food recalls use an open-ended method, they are considered the best way of collecting data for categorisation into NOVA categories (Food and Agriculture Organization 2015). We used standardised methods (Raper et al. 2004) to surmount the potential bias of underestimating food consumption with a 24-h recall (Livingstone and Black 2003). It must be noted however that 24-h recalls do tend to underestimate total intake as well as overestimate foods that are considered healthy such as TF while concurrently underestimating unhealthy ones. Our multiple regression model was designed to analyse group intake because one 24-h recall is a good measure of this (Willett 2012). It is possible that our results had a social desirability bias (that is, valuing fresh foods and TF more than processed foods) resulting in over-reporting of the intake of MPF and the under-reporting of the intake of UPF (Subar et al. 2015); consequently, total energy intake may have been underestimated. The NOVA food categories were created from the self-reported dietary data so social desirability bias may have been minimised compared with using a food-frequency questionnaire containing the different NOVA food groups. The large sample size provided sufficient statistical power to identify associations not found in smaller samples.

Some misclassification of the NOVA food categories may have occurred due to limited food choices on the CNF and a lack of brand names in the database. Data entry originally occurred without consideration for the NOVA classification, which has been noted as a limitation in other studies (Adams and White 2015; Food and Agriculture Organization 2015; Martinez Steele et al. 2016). Because our nutrient analysis software, CANDAT, cannot disaggregate mixed foods based on recipes, it is possible some UPF, such as margarine used in food preparation, may have been included in MPF.

Since Canada is a very geographically diverse country, we would expect differences in dietary intake across the country. Consequently, because we are reporting data from only four western and central provinces, the results may not be representative of all First Nations in Canada: cross-country data from FNFNES will only be available after 2018.

First Nations peoples require improved determinants of health and improved food environments. We found that UPF contribute substantially to the diet of First Nations peoples living on-reserve and have displaced traditional freshly prepared food and MPF. Future analyses should try to identify the optimal combination of store-bought foods that can accompany TF to improve the diet quality of First Nations peoples and allow them to avoid non-communicable

diet-related chronic diseases. It is important to provide physical and economic access to healthy culturally relevant foods and establish dietary advice that will aid public health initiatives for these First Nations peoples.

Acknowledgments

The authors would like to acknowledge the efforts of these individuals in the collection of the data used in this study: Olivier Receveur, Harold Schwartz, William David, Laverne Gervais, Lisa Wabegijig, Judy Mitchell and Kathleen Lindhorst. The authors would also like to thank Katerina Maximova for help with the statistical analyses and interpretation of the results. The authors would like to thank all members of the communities who participated and worked on the study.

Disclosure statement

The authors declare no conflict of interest.

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 nos. 348833 and 334049. The data used in this article originate from the First Nations Food, Nutrition and Environment Study (FNFNES) funded by Health Canada. At the time of this research, Noreen Willows was the recipient of a Health Scholar award from Alberta Innovates Health Solutions.

References

Adams J, White M. 2015. Characterisation of UK diets according to degree of food processing and associations with socio-demographics and obesity: cross-sectional analysis of UK National Diet and Nutrition Survey (2008–12). Int J Behav Nutr Phys Act. 12:160.

Adelson N. 2005. The embodiment of inequity: health disparities in aboriginal Canada. Can J Public Health. 96(Suppl 2):S45–S61.

Anderson I, Robson B, Connolly M, Al-Yaman F, Bjertness E, King A, Tynan M, Madden R, Bang A, Coimbra CE Jr, et al. 2016. Indigenous and tribal peoples' health (The Lancet-Lowitja Institute Global Collaboration): a population study. Lancet. 388:131–157.

Batal M, Gray-Donald K, Kuhnlein HV, Receveur O. 2005. Estimation of traditional food intake in indigenous communities in Denendeh and the Yukon. Int J Circumpolar Health. 64:46–54.

Batal M, Johnson-Down L, Moubarac JC, Ing A, Fediuk K, Sadik T, Tikhonov C, Chan L, Willows N. 2017. 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. [Jul 25];[1–11]. [Epub ahead of print]. doi: 10.1017/S1368980017001677

Chan L, Receveur O, Batal M, David W, Schwartz H, Ing A, Fediuk K, Black A, Tikhonov C. 2012. First Nations Food, Nutrition and Environment Study (FNFNES): results from Manitoba (2010). Prince George, British Columbia, Canada: University of Northern British Columbia.

Chan L, Receveur O, Batal M, David W, Schwartz H, Ing A, Fediuk K, Black A, Tikhonov C. 2014. First Nations Food, Nutrition and Environment Study (FNFNES): Results from Ontario (2011/2012). Ottawa, Ontario, Canada: University of Ottawa.

Chan L, Receveur O, Batal M, David W, Schwartz H, Ing A, Fediuk K, Tikhonov C. 2011. First Nations Food, Nutrition and Environment Study (FNFNES): Results from British Columbia (2008/2009). Prince George, British Columbia, Canada: University of Northern British Columbia.

Chan L, Receveur O, Batal M, David W, Schwartz H, Ing A, Fediuk K, Tikhonov C. 2016. First Nations Food, Nutrition and Environment Study (FNFNES): Results from Alberta 2013. Ottawa, Ontario, Canada: University of Ottawa.

Deur DE, Turner NJ. 2005. Keeping it living traditions of plant use and cultivation on the Northwest Coast of North America. Seattle, Washington, United States: University of Washington Press.

Fardet A, Rock E, Bassama J, Bohuon P, Prabhasankar P, Monteiro C, Moubarac JC, Achir N. 2015. Current food classifications in epidemiological studies do not enable solid nutritional recommendations for preventing diet-related chronic diseases: the impact of food processing. Adv Nutr. 6:629–638.

Food and Agriculture Organization. 2015. Guidelines on the collection of information on food processing through food consumption surveys. Rome, Italy: FAO.

Health Canada. 2007. Eating Well with Canada's Food Guide First Nations, Inuit and Métis. HC Pub.: 3426; [accessed 2009 May 11]. http://www.hc-sc.gc.ca/fn-an/alt_formats/fnihb-dgspni/pdf/pubs/fnim-pnim/2007_fnim-pnim_food-guide-aliment-eng.pdf.

Health Canada. 2010. Canadian Nutrient File. Ottawa, Ontario.

Ho L, Gittelsohn J, Sharma S, Cao X, Treuth M, Rimal R, Ford E, Harris S. 2008. Food-related behavior, physical activity, and dietary intake in First Nations – a population at high risk for diabetes. Ethn Health. 13:335–349.

Institute of Medicine, Food and Nutrition Board. 2005. Dietary reference intakes for energy, carbohydrates, fiber, fat, fatty acids, cholesterol, protein, and amino acids (Macronutrients). Washington (DC) United States.

Johnson-Down L, Egeland GM. 2013. How is the nutrition transition affecting the dietary adequacy in Eeyouch (Cree) adults of Northern Quebec Canada? Appl Physiol Nutr Metabol. 38:300–305.

Johnson-Down L, Labonte ME, Martin ID, Tsuji LJ, Nieboer E, Dewailly E, Egeland G, Lucas M. 2015. Quality of diet is associated with insulin resistance in the Cree (Eeyouch) indigenous population of northern Québec. Nutr Metab Cardiovasc Dis. 25:85–92.

Johnson-Down LM, Egeland GM. 2013. How is nutrition transition affecting dietary adequacy in Eeyouch (Cree) adults of Northern Quebec, Canada? Appl Physiol Nutr Metab. 38:300–305.

Kendall J. 2001. Circles of disadvantage: aboriginal poverty and underdevelopment in Canada. Am Rev Can Stud. 31:43–49.

Kuhnlein H, Delormier T. 1999. Dietary characteristics of eastern James Bay Cree women. Arctic. 52:182–187.

Kuhnlein HV, Receveur O. 1996. Dietary change and traditional food systems of indigenous peoples. Annu Rev Nutr. 16:417–442.

Liu J, Young TK, Zinman B, Harris SB, Connelly PW, Hanley AJ. 2006. Lifestyle variables, non-traditional cardiovascular risk factors, and the metabolic syndrome in an Aboriginal Canadian population. Obesity (Silver Spring). 14:500–508.

Livingstone MB, Black AE. 2003. Markers of the validity of reported energy intake. J Nutr. 133(Suppl 3):895S–920S.

Louzada ML, Baraldi LG, Steele EM, Martins AP, Canella DS, Moubarac JC, Levy RB, Cannon G, Afshin A, Imamura F, et al. 2015a. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. Prev Med. 81:9–15.

Louzada ML, Martins AP, Canella DS, Baraldi LG, Levy RB, Claro RM, Moubarac JC, Cannon G, Monteiro CA. 2015b. Ultra-processed foods and the nutritional dietary profile in Brazil. Rev Saúde Pública. 49:38.

Martinez Steele E, Baraldi LG, Louzada ML, Moubarac JC, Mozaffarian D, Monteiro CA. 2016. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ Open. 6:e009892.

Ministry of Health of Brazil. 2014. Dietary Guidelines of the Brazilian Population [accessed 2017 Mar 16]. http://189.28.128.100/dab/docs/portaldab/publicacoes/guia_alimentar_populacao_ingles.pdf

Mitrou F, Cooke M, Lawrence D, Povah D, Mobilia E, Guimond E, Zubrick SR. 2014. Gaps in indigenous disadvantage not closing: a census cohort study of social determinants of health in Australia, Canada, and New Zealand from 1981–2006. BMC Public Health. 14:201.

Monteiro CA, Levy RB, Claro RM, de Castro IR, Cannon G. 2011. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. Public Health Nutr. 14:5–13.

Moubarac JC, Batal M, Louzada ML, Martinez Steele E, Monteiro CA. 2017. Consumption of ultra-processed foods predicts diet quality in Canada. Appetite. 108:512–520.

Moubarac JC, Batal M, Martins AP, Claro R, Levy RB, Cannon G, Monteiro C. 2014. Processed and ultra-processed food products: consumption trends in Canada from 1938 to 2011. Can J Diet Pract Res. 75:15–21.

Moubarac JC, Martins AP, Claro RM, Levy RB, Cannon G, Monteiro CA. 2013. Consumption of ultra-processed foods and likely impact on human health. Evidence from Canada. Public Health Nutr. 16:2240–2248.

National Aboriginal Health Organization (NAHO). 2007. How we see it! Broader determinants of health within aboriginal contexts. Ottawa, Ontario, Canada.

Pan American Health Organization. 2015. Ultra-processed food and drink products in Latin America. Washington (DC) US.

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

Raper N, Perloff B, Ingwersen L, Steinfeldt L, Anand J. 2004. An overview of USDA's dietary intake data system. J Food Composition Anal. 17:545–555.

Renaud B. 2002. Sang sucré, pouvoirs codés, médecine amère. Diabète et processus de construction identitaire: les dimensions socio-politiques du diabète chez les Innus de Pessamit. Quebec, Quebec, Canada: Les Presses de l'Universite Laval.

Statistics Canada. 2013. Household size, by province and territory (2011 Census) Ottawa, Ontario, Canada; [accessed 2017 Mar 9]. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil53a-eng.htm

Statistics Canada. 2015a. Aboriginal Peoples: Fact Sheet for Canada. Ottawa, Ontario, Canada; [accessed 2016 Sep 28]. http://www.statcan.gc.ca/pub/89-656-x/89-656-x2015001-eng.htm

Statistics Canada. 2015b. Aboriginal statistics at a glance: 2nd edition. Ottawa, Ontario, Canada: Statistics Canada.

Subar AF, Freedman LS, Tooze JA, Kirkpatrick SI, Boushey C, Neuhouser ML, Thompson FE, Potischman N, Guenther PM, Tarasuk V, et al. 2015. Addressing current criticism regarding the value of self-report dietary data. J Nutr. 145:2639–2645.

Wiken EB. 1986. Terrestrial Ecozones of Canada. Ecological Land Classification, Series No. 19. Hull Quebec Canada: Environment Canada; [accessed 2017 April 25]. http://ecozones.ca/english/introduction.html

Willett W. 2012. Nutritional epidemiology. 3rd ed. New York (NY) United States: Oxford University Press.

Willows ND. 2005. Determinants of healthy eating in Aboriginal peoples in Canada: the current state of knowledge and research gaps. Can J Public Health. 96(Suppl 3):S32–S36. S36–41.

Yaghmaei N. 2016. Dietary quality of out of home eating and food processing levels in urban and rural Ecuadorian adolescents. Ghent, Belgium: University of Ghent.

Young TK, Reading J, Elias B, O'neil JD. 2000. Type 2 diabetes mellitus in Canada's first nations: status of an epidemic in progress. CMAJ. 163:561–566.