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The Association Between Food Security and Diet Quality Among First Nations Living On-Reserve in Canada

par Lara Steinhouse

Département de Nutrition, Université de Montréal
Faculté de Médecine

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Résumé

Problématique: La prévalence de l'insécurité alimentaire chez les Premières Nations est plus élevée que chez les Canadiens en général, un fardeau qui s'ajoute aux prévalences inquiétantes de maladies chroniques liées à l'alimentation. Cependant, peu d'information existe sur la relation entre l'IA et la qualité de la diète pour les PN vivant sur réserve.

Objectif: Étudier la corrélation entre l'insécurité alimentaire et la qualité de l'alimentation chez les PN adultes vivant sur-réserve dans 5 régions au Canada (sud du 60ème parallèle).

Méthodes: Des données de rappels alimentaires de 24 heures, issues d'une étude transversale intitulée « Étude sur l'alimentation, la nutrition et l'environnement des Premières Nations », ont été analysées à l'aide de 2 indices de qualité de la diète : une adaptation canadienne du « *Healthy Eating Index* » (HEI) et NOVA, une classification qui se base sur la nature et le degré de la transformation alimentaire. Des analyses de régression ont exploré les facteurs sociodémographiques reliés à l'IA et à la qualité de la diète. Les scores du HEI, ainsi que la contribution énergétique des groupes NOVA ont été comparés par niveau d'IA.

Résultats: La prévalence d'IA était élevée (35,7%), surtout chez les ménages avec des enfants (40,4%), les ménages sans emploi (45,4%), et ceux qui reçoivent l'assistance sociale (55,5%). Le sexe, le groupe d'âge et l'éducation étaient aussi corrélés à l'IA. Le score moyen du HEI était faible (49,0 ± 12,65) et était associé avec le sexe, l'âge, la région, le recours à l'assistance sociale, la consommation d'aliments traditionnels (AT), la participation aux activités d'AT, l'éducation, et l'IA. Les scores totaux du HEI étaient significativement plus élevés pour ceux en sécurité alimentaire (49,7) que ceux en IA (48,1), mais ils ne l'étaient plus après ajustement pour des facteurs sociodémographiques. Cependant, l'IA est demeurée significativement associée à des apports plus élevés en ingrédients culinaires transformés (sucres, huiles végétales), à des apports plus faibles en fruits et légumes et en plats cuisinés à la maison.

Conclusion: Une relation significative, quoique faible, entre l'IA et la qualité de la diète a été observée. Les résultats ont révélé un besoin d'explorer les questions de revenu, d'assistance sociale et d'accès aux AT pour améliorer l'environnement alimentaire des PN.

Mots-clés : HEI, Sécurité alimentaire, Insécurité alimentaire, Qualité de l'alimentation, NOVA, Transformation alimentaire, Autochtones, Premières Nations, Canada.

Abstract

Background: First Nations (FN) experience high levels of food insecurity that greatly exceed those of the non-aboriginal population. Associated with this burden are alarming rates of obesity and nutrition-related chronic disease. Little is known about food insecurity's relationship to diet quality outcomes for FN living on-reserve.

Objective: This study explores the associations between household food insecurity (FI) and poor diet quality for FN adults living on-reserve in 5 Canadian regions (south of the 60th parallel).

Methods: Dietary recall data from the First Nation Food Nutrition and Environment Study (FNFNES), a cross-sectional study, were analyzed using two diet quality indices: a Canadian Healthy Eating Index (HEI) and NOVA, which assesses diet by level of food processing. Regression analyses explored socio-demographic correlates of FI and diet quality. HEI total and component scores and the caloric contribution of NOVA groups and subgroups were compared between food security levels.

Results: FI prevalence was high (35.7%), notably in households with children (40.4%), those where all members are unemployed (45.4%), and those receiving social assistance (55.5%). Sex, age group, and education level were also correlated with FI. The mean total HEI score was low (49.0 ± 12.65). Total HEI mean scores were associated with sex, age group, region, social assistance, traditional food consumption, any household TF activity, and education. They were also significantly higher for people from food secure households compared to FI (49.7 vs. 48.1, respectively), though not after adjusting for socio-demographic variables. After adjustments, FI remained significantly associated with higher intakes of processed culinary ingredients (sugars and plant oils), lower intakes of homemade dishes, and less fruit and vegetable consumption.

Conclusions: This study found a small, but significant, relationship between food insecurity and diet quality. Findings also emphasized the need to address income, social assistance benefits and access to traditional foods to improve food security and nutritional outcomes for First Nations.

Keywords : HEI, Food security, Food insecurity, Diet Quality, NOVA, Food processing, Aboriginal, First Nations, Canada.

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Abbreviations

AB: Alberta

AFN: Assembly of First Nations

ANOVA: Analysis of Variance

AT: Atlantic provinces

BC: British Columbia

BMI: Body mass index

CCHIP: Community Childhood Hunger Identification Project (CCHIP)

CCHS: Canadian Community Health Survey

CERES: Comité d'éthique de la recherche en santé

CNF: Canadian Nutrient File

CRA: Community Research Assistant

EI: Employment Insurance

EWCFG: Eating Well with Canada's Food Guide

FAO: Food and Agriculture Organization of the United Nations

FFQ: Food Frequency Questionnaire

FI: Food insecure

FNFNES: First Nations Food, Nutrition and Environment Study

FNIGC: First Nations Information Governance Centre

FNRHS: First Nations Regional Health Survey

FS: Food secure/Food security

FSC: Food Secure Canada

FSCM: Food Security Core Module

HEI: Healthy Eating Index

HFSSM: Household Food Security Survey Module

HH: Household

INAC: Indian and Northern Affairs Canada

MF: Market food

MN: Manitoba

NNDF: Non-nutrient-dense foods

NNFB: National Nutritious Food Basket

NWT: North-West Territories

OCAP: Ownership, Control, Access and Possession

ON: Ontario

PAHO: Pan American Health Organization

RNFB: Revised Northern Food Basket

SD: Standard Deviation

SE: Standard Error

SES: Socio-economic status

SHLQ: Social, Health and Lifestyle Questionnaire

SOFI: State of Food Insecurity in the World

TF: Traditional food

UPF: Ultra-processed foods

WHO: World Health Organization

24-hr: 24-hour Recall

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Introduction

A rapid change in dietary patterns has occurred for Aboriginal peoples[1] in Canada, mostly over the past 60 years, where traditional foods have been replaced by less nutritious market-based foods, while levels of physical activity have greatly declined (Egeland, Johnson-Down, Cao, Sheikh, & Weiler, 2011; Kuhnlein, Receveur, Soueida, & Egeland, 2004). This transition has had a significant impact on the health of Canadian Indigenous peoples, for whom rates of obesity and chronic disease, such as diabetes and cardiovascular disease, have reached epidemic levels (Elliott & Jayatilaka, 2011; Kirkpatrick & Tarasuk, 2008; Willows, Veugelers, Raine, & Kuhle, 2011b). For instance, the prevalence of diabetes was reported at 24% for First Nations adults living on-reserve in Ontario (2010/2011), while the non-Aboriginal prevalence in Canada was recorded at 5% during this same period (2009/2010) (Chan et al., 2014).

Social determinants of health are also at the root of this disproportionate burden of health disparities experienced by Aboriginal peoples. These determinants operate at different dimensions, with systemic causes extending as far back as colonization, when land dispossession and settlement onto reserves compromised indigenous self-determination and access to traditional food systems. Today, many interrelated proximal determinants of health affect First Nations, including low income, poor education, a lack of adequate employment, and food insecurity (Chan et al., 2016a). Most notably, food insecurity, a situation in which people lack adequate access to food due to financial constraints or other access issues, has been associated with the nutrition transition and poor health outcomes. First Nations are burdened by high levels of food insecurity, with prevalence rates greatly exceeding those of the non-aboriginal population (Tarasuk, Mitchell, & Dachner, 2016). For example, the 2004 Canadian community Health Survey cycle 2.2, which focused on nutrition, found that 9.2% of the

[1] The term "Aboriginal" encompasses all of those who identify as being a part of one of the three Aboriginal groups in Canada (First Nations, Métis, and Inuit), those who have status as a Registered or treaty Indian, and/or those with membership in an Indian band or First Nation (Statistics Canada, 2009).

Canadian population was living in a food insecure household, with this rate being much higher for Aboriginal households (33%) than for non-Aboriginal households (8.8%) (Health Canada, 2007). These findings excluded Aboriginal peoples living on-reserve, whom have been found to experience food insecurity to an even greater extent. The 2008-2010 First Nations Regional Health Survey (FNRHS) reported a food insecurity prevalence rate for First Nations living on-reserve of 52.4% (FNIGC, 2012). More recently, the First Nation Food, Nutrition and Environment Study (FNFNES) was designed to further evaluate the food security and nutrition situation for First Nations living on-reserve below the 60th parallel in 10 Canadian regions. This is the first time such a large data set will be available on these topics, as FN living on-reserve have historically been excluded from national nutrition studies. Results from FNFNES are reported on in the present study.

The main objective of this research was to explore whether associations exist between food insecurity and diet quality. To do so, first a thorough review of the literature was conducted with the intention of better understanding the underlying factors that are responsible for food insecurity and poor diet quality for First Nations. The main themes explored are: 1) Aboriginal peoples: defining indigeneity in Canada and understanding health disparities with the rest of the Canadian population; 2) Social determinants of health and how they operate at the proximal, intermediate, and distal levels for First Nations; 3) Contemporary dietary patterns of Aboriginal peoples in Canada; 4) Diet quality measurements, with emphasis on a Canadian-specific version of the Healthy Eating Index (HEI) and the NOVA classification system; and 5) Food security, including its evolving definition, study metrics, and evidence exploring the relationship between food insecurity and outcomes on diet and health.

Analysis seeks to gain a better understanding of the socio-demographic correlates of food insecurity and poor diet quality for First Nations living on-reserve below the 60th parallel in Canada. It also provides additional evidence to better describe the diets of First Nations, including the proportion of intake from traditional foods. Finally, the interrelationship between food insecurity and diet quality is assessed by developing a novel approach that uses two separate diet quality indicators – a Canadian adaptation of the Healthy Eating Index (HEI) and the NOVA classification system, which categorizes foods based on the extent to which they

have been processed. This work provides a new lens for understanding the relationship between social determinants, notably food insecurity, and diet quality. This comes at a time where many people across the globe are experiencing a double burden of malnutrition, characterized by the coexistence of micronutrient deficiencies with obesity and chronic disease. This contributes to existing evidence for improved, targeted strategies to address the public health burden of obesity and chronic disease.

Chapter II – Literature Review

1 Aboriginal Peoples in Canada

1.1 Defining Indigeneity in Canada and abroad

Indigenous peoples have been described as distinct cultural groups that have been able to subsist in a particular ecological region for an extended, though not specifically defined, period of time (Kuhnlein & Receveur, 1996a). Although there is no internationally accepted definition, the United Nations uses the term "indigenous" to refer to peoples who:

> "I*dentify themselves and are recognized and accepted by their community as indigenous; Demonstrate historical continuity with pre-colonial and/or pre-settler societies; Have strong links to territories and surrounding natural resources; Have distinct social, economic or political systems; Maintain distinct languages, cultures and beliefs; Form non-dominant groups of society; Resolve to maintain and reproduce their ancestral environments and systems as distinctive peoples and communities*."(Erber, Beck, et al., 2010; WHO, 2007).

Approximately 370 million people fit this description worldwide (Egeland & Harrison, 2013). Indigenous people live in over 90 different countries, representing a vast array of cultures, traditions and histories. Regrettably, one commonality indigenous people share is that they continue to be of the most marginalized population groups around the world, regardless of the economic state of their country. Indian and Northern Affairs Canada (INAC) created the Community Well-Being Index, which assesses community income, education, housing, and employment on a scale of 100 (Reading & Wien, 2009). Of the 100 lowest-scoring communities in Canada in 2011, 98 were First Nations (Reading & Wien, 2009). First Nations communities received an average score of 20 points lower than non-Aboriginal communities (Aboriginal Affairs and Northern Development Canada, 2014). The index did, however, find great variation between First Nations communities, many of which are above the Canadian average. Thus, it is worthwhile to continue to study

the causes of variation in the wellbeing of indigenous communities, and to better identify the main underlying factors that contribute to this variation.

In Canada, the term Aboriginal is used to represent all of the descendants of the first peoples in North America (Willows, Veugelers, Raine, & Kuhle, 2011a). In article 35 of the Canadian Constitution Action of 1982, Aboriginal Peoples are identified as belonging to one of three groups: Indians (now referred to as First Nations), Métis and Inuit or Inuk (National Collaborating Center for Aboriginal Health, 2012). Statistics Canada refers to "Aboriginal identity" as any person who meets one or multiple of three criteria: self-identification as an Aboriginal person of one of the three aforementioned groups; status as a Registered or Treaty Indian (registered under the Indian Act of Canada); and, membership in a First Nation or Indian band (Statistics Canada, 2009). The three groups are culturally distinct and concentrated in different geographic spaces. Inuit live mostly in Nunavut and around the coast in the Norwest Territories, Northern Quebec and Labrador. Métis have both European and First Nation ancestry, and have their own distinct nationhood (Canada, 2013; Willows, 2005). Finally, the predominant Aboriginal peoples of Canada living south of the Arctic are First Nations (Haman et al., 2010). Although examples will be taken from different Aboriginal peoples for the purpose of this research, the focus will be on First Nations peoples (FN) living below the 60th parallel.

In Canada, 1,400,685 people self-identified as Aboriginal in 2011, which represented 4.3% of the Canadian population (Statistics Canada, 2013a). Approximately 70% of Aboriginal peoples in Canada live off-reserve, mostly in urban areas, with First Nations representing the largest portion of the Aboriginal population, at 60.8%, while 32.3% identify as Métis and 4.2% as Inuit (Statistics Canada, 2013a; Willows et al., 2011b). There are over 600 recognized First Nations bands in Canada, speaking more than 60 languages (Canada, 2013)

The Canadian Aboriginal population is relatively young and is quickly growing, with a median age of 28, compared with 41 for non-Aboriginal people. Over a quarter of the Aboriginal population is under 14 years old, while 18.2% are between 14 and 24 years old

(Statistics Canada, 2013a). The Inuit population is the youngest among all Aboriginal peoples, with a median age of 23 (Statistics Canada, 2013b). Between 2006 and 2011, Statistics Canada also recorded a population increase of 20.1% amongst Aboriginal peoples in Canada, compared to the general Canadian average of 5.2% (Statistics Canada, 2013a). Higher fertility rates and shorter life expectancy than the non-Aboriginal population are cited as the main reasons for these observations (Statistics Canada, 2011). However, the growth of Aboriginal peoples is also said to have increased between 1996 and 2006 because more people self-identified as Aboriginal, notably among Métis (Gionet & Roshanafshar, 2013).

1.2 Health disparities experienced by Aboriginal Peoples

1.2.1 Overview

Indigenous peoples worldwide disproportionately experience health and economic disadvantages in countries of all income levels. No exception to this, Canadian Aboriginal peoples experience greater rates of morbidity and mortality than the rest of the Canadian population. Discrepancies in health status are observed most prominently in the rates of chronic diseases, as well as in mental, environmental, infant and maternal health outcomes (National Collaborating Center for Aboriginal Health, 2012). Even when controlling for obesity, health behaviours (e.g. smoking and alcohol consumption) and socioeconomic factors, health inequalities remain significant for Aboriginal people compared to the rest of the population (Willows et al., 2011b). Life expectancy for Aboriginal people in Canada is 12 years lower than that of non-Aboriginal Canadians (Kolahdooz, Nader, Yi, & Sharma, 2015), and the infant mortality rate is 50% greater than the Canadian average at 8.5 deaths per 1000 live births in 1999 (Adelson, 2005). Using a measurement of self-rated health, the Canadian Community Health Survey (2010b) found that Aboriginal people were less likely to rate their health as “very good” or “excellent”, when compared to non-aboriginal Canadians (Council of Canadian Academies, 2014).

1.2.2 Overweight and obesity

In Canada, as in other high-income countries such as the United States and Australia, the prevalence of overweight and obesity among the Aboriginal population greatly exceeds

that of the general population (Erber, Hopping, et al., 2010; Garriguet, 2008). Using self-reported height and weight measurement data from the Canadian Community Health Survey (CCHS), collected between 2007 and 2010, Statistics Canada calculated the obesity prevalence for adults 18 years old and over to be 16% among the Canadian non-Aboriginal population, 26% among both First Nations and Inuit, and 22% among Métis (Gionet & Roshanafshar, 2013). However, rates of overweight were similar for all groups (Gionet & Roshanafshar, 2013).

A study conducted by Ho et al. (2008) in 9 Anishinaabe First Nations' communities in Northwestern Ontario found the prevalence of obesity to be 47.7% and overweight to be 32.6%, which was much higher than the Canadian rates of obesity (23.1%) and overweight (36.1%) at the time. This is consistent with results from the 2002/03 First Nations Regional Longitudinal Health Survey, which collected self-reported height and weight data from approximately 9,000 First Nations living on-reserve and found that the prevalence of overweight and obesity was higher for Aboriginal peoples than the non-Aboriginal Canadian population, and highest among First Nations living on-reserve (Katzmarzyk, 2008). Moreover, central obesity, which refers to a high waist-to-hip ratio and is associated with higher risk for diabetes, tends to be most prevalent among Aboriginal people (Young, Reading, Elias, & O'Neil, 2000).

1.2.3 Non-communicable diseases

Canadian Aboriginal peoples are more likely to self-report poorer health and diagnosed chronic disease when compared to the general Canadian population (Council of Canadian Academies, 2014; Gionet & Roshanafshar, 2013). Cardiovascular disease (CVD), which includes hypertension, arteriosclerosis, and heart failure, is more prevalent among Aboriginal peoples, with a 20% higher rate of acute myocardial infarction, and twice the rate of strokes than among the general Canadian population (National Collaborating Center for Aboriginal Health, 2012).

Of particular public health concern is the prevalence of Type 2 diabetes, which has been described as reaching 'epidemic' proportions among First Nations (Chan et al., 2016a; Ho et al., 2008; Seabert et al., 2013). Rates vary significantly across different First Nations

communities. Notably, adults living in Sandy Lake First Nation in northwestern Ontario experience the third highest rate of diabetes in the world (at 26% after adjusting for age) (Harris et al., 1997; Ho et al., 2008; Young et al., 2000). On average, the self-reported rate of diagnosed diabetes is approximately three to five times greater for First Nations people living on-reserve than among the general Canadian population (Chan et al., 2014; Pal et al., 2013; Young et al., 2000). Recent data from for the First Nations Food, Nutrition and Environment Study (FNFNES) revealed a prevalence of self-reported diabetes among First Nations adults of 24% in Ontario and 21% in Manitoba (Chan et al., 2014; Chan, Receveur, Sharp, Schwartz, et al., 2012). In contrast, results from the 2009-2010 Canadian Community Health Survey found the national rate of diabetes to be 5%, while the rate of FN living off-reserve was 10.3% (Chan et al., 2014). The 2008-2010 First Nations Regional Longitudinal Health Survey also found a higher prevalence of diabetes amongst First Nations living on-reserve (17.2%) than FN living off-reserve. All of these prevalence rates were age-standardized to the 1991 Canadian population (Public Health Agency of Canada, 2011). Additionally, Aboriginal peoples are more likely to experience diabetes-related complications, including renal disease and cardiovascular disease (Ho et al., 2008; National Collaborating Center for Aboriginal Health, 2012).

In the case of diabetes, one proposed theory for the disproportionally high burden among Canadian Aboriginal peoples is the "thrifty gene hypothesis", which is based on the idea that genes have adapted to extended periods of food scarcity by promoting rapid insulin production as soon as glucose levels increase, leading to high levels of storage of glucose in fat cells as triglycerides (Egeland & Harrison, 2013; Young et al., 2000). Once food becomes readily available, the result may be hyperinsulinemia, hyperglycemia, obesity and finally, diabetes (Young et al., 2000). However, many researchers largely contest the theory that genetics are to blame for the elevated rates of diabetes. For one, Egeland & Harrison (2013) consider that the thrifty gene hypothesis is myopic in its explanation and that there are perhaps certain epigenetic effects that, though they may not alter DNA sequences, can be passed across generations (Egeland & Harrison, 2013; Halseth, 2015). One exception involves an Oji-Cree community of northern Ontario, where a specific gene (factor-1alpha (HNF1A) G319S) has been associated with a specific form of Type 2 Diabetes, which

differs from the standard Type 2 Diabetes in that it has an earlier age of onset and people tend to have a lower BMI and a higher post-prandial glycemic level. However, this genetic variation has not been found among other populations (Egeland & Harrison, 2013). More commonly, the literature points to high rates of obesity as the main culprit for the elevated diabetes rate in the Canadian Aboriginal population (Erber, Hopping, et al., 2010). Underlying causes will be further explored in the following sections of this review.

2 Social Determinants of Health

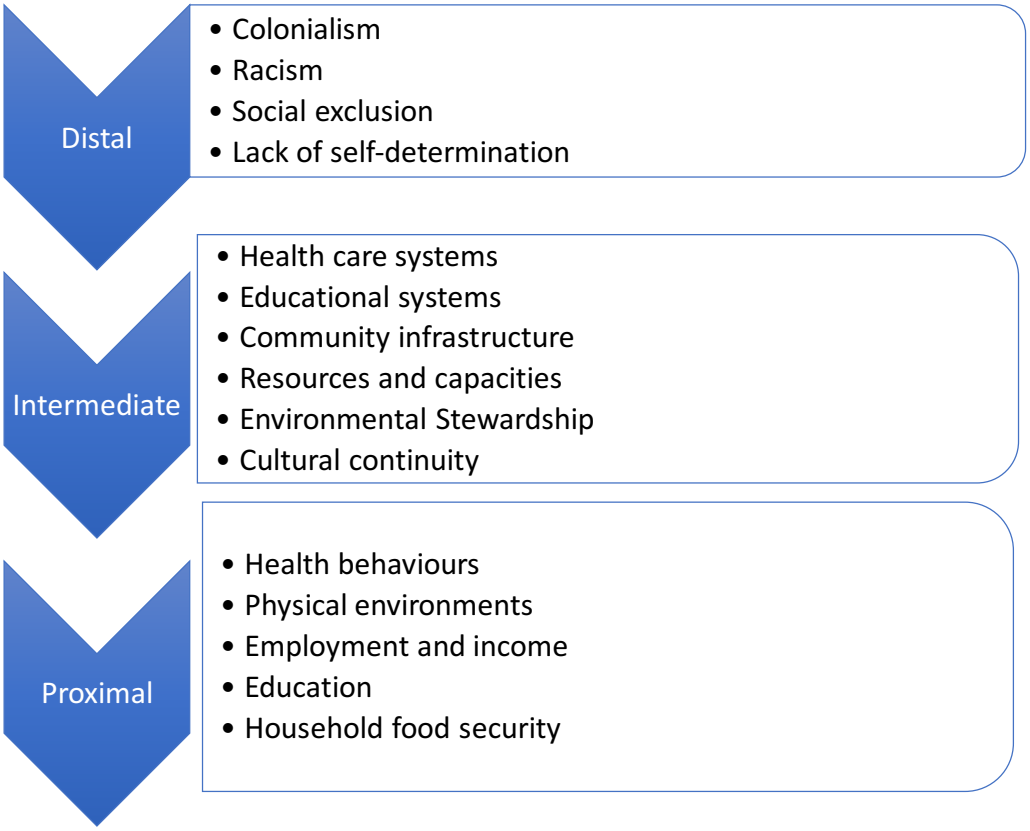
An individual's health status is not determined merely by genetics, but is also the result of a combination of social factors, including environment, income, education, and social support networks (WHO, 2017). The Public Health Agency of Canada has identified twelve key determinants of health: income and social status, social support networks, education and literacy, employment/working conditions, social environments, personal health practices and coping skills, healthy child development, biology and genetic endowment, health services, gender, and culture (Public Health Agency of Canada, 2013). Of these factors, the most influential appears to be social and economic status. Life expectancy is lower and risk of illness is higher among low-income Canadians, irrespective of other factors such as age, sex, and race (Public Health Agency of Canada).

2.1 Determinants of health for Indigenous peoples in Canada

Besides the determinants of health assessed for the Canadian population, emerging evidence suggests that there are more specific social ones to consider for First Nations Peoples (Nesdole, Voigts, Lepnurm, & Roberts, 2014). In "*Health Inequalities and Social Determinants of Aboriginal People's Health*", Reading and Wein (2009) categorize the various determinants of health for Canadian Aboriginal peoples at the proximal, intermediate, and distal levels. Proximal determinants are those that have a direct impact on an individual's state, be it physical, emotional, mental or spiritual. These include health behaviours, physical environments, employment and income, education, and food security. Intermediate determinants of health are those responsible for the proximal determinants, such as: health care systems, educational systems, community infrastructure, resources and capacities, environmental stewardship, and cultural continuity. Finally, distal determinants

are at the root of population health inequities. For First Nations, a history of colonialism, racism and social exclusion, and lack of self-determination represent the most fundamental distal determinants that continue to impact health today (Reading & Wien, 2009). The section below describes in greater detail some of the various social determinants of health that operate at either the distal, intermediate, and/or proximal levels.

Figure 1. Levels of Social Determinants of Health for Aboriginal Peoples



Adapted from (Reading & Wien, 2009)

2.1.1 Colonialism

The existing health discrepancies previously discussed stem from a wide array of underlying factors, such as a history of colonization, racism, loss of cultural practices, lack of financial resources and self-determination, which need to be studied, alongside a legacy of discriminatory laws, and marginalization, to better understand the contemporary issues experienced by Indigenous Peoples (Egeland & Harrison, 2013; Nesdole et al., 2014). Kolahdooze et al. (2015) explain that the foundation in health inequalities for Aboriginal peoples dates back to the Indian Act of 1867. The main objective of this Act was to

assimilate Indigenous peoples and impose upon them a reserve system, where the federal government would be responsible for providing health care, among other services. Aboriginal nations exchanged self-determination in return for a label of "Status Indian". In doing so, they were confined to small parcels of land, which represented a fraction of their traditional territories, where many had been engaged in a nomadic lifestyle with a command of and sovereignty over often abundant resources (Reading & Wien, 2009). The Indian Act is a paternalistic legislation that offered to provide "civilization, protection and assimilation", under the assumption that Indigenous peoples were not able to assume responsibility for overseeing their own affairs (Coates, 2008). First Nations leaders have protested that it has created dependency in restricting Aboriginal peoples from borrowing or owning collateral, which has made it extremely difficult to get a mortgage, start a business or invest in economic development on-reserve (Oster, Grier, Lightning, Mayan, & Toth, 2014). Moreover, it has restricted First Nations rights and privileges, where the government has maintained control over education, land and economic resource management in a way that has often been aggressive and in many cases abusive. The federal government continues to hold the right to manage and supervise traditional lands and funds, and band affairs (Coates, 2008). Despite these criticisms, Aboriginal peoples and the federal government have not yet agreed an alternative governance structure to protect the special rights of Aboriginal Peoples in Canada, and so the Indian Act remains in place, while being surrounded by great contention (Coates, 2008).

2.1.2 The physical environment

Contamination and climate change

Land and health are intrinsically tied together in Aboriginal culture. The historical process of dispossession and settlement onto reserves has compromised traditional culture, reduced access to food resources and hindered community resilience (Richmond & Ross, 2009). Environmental degradation and climate change are also concerns that impact food security and health. Contamination of traditional foods (TF) from pollution and industry, destruction of traditional territories, from deforestation, overfishing and climate change compromise the health of those who continue to rely on TF as a fundamental part of their diets (Elliott & Jayatilaka, 2011; Richmond & Ross, 2009). Additional environmental concerns relate to changes in access and availability of TF sources, notably in northern

communities. Changes in weather patterns and declining wildlife species alter and often diminish hunting and fishing seasons, which in turn affects the safety and availability of foods (National Collaborating Center for Aboriginal Health, 2012). Such changes not only affect species, but also people's ability to travel on the ice to harvest TF (Guyot, Dickson, Paci, Furgal, & Chan, 2006). Focus groups conducted in two northern First Nation communities revealed that community members had been observing changes in migration patterns and population decline in certain animal species, with a rise in others (Guyot et al., 2006). Emerging evidence also reveals an increase in infectious and water-borne diseases related to changing environments in the North (National Collaborating Center for Aboriginal Health, 2012). These issues are of particular concern as TF not only provide essential nutrients, but are also vital for cultural, social, and spiritual health (Richmond & Ross, 2009).

Moreover, studies have shown certain foods to be exposed to contaminants, including pesticides, polychlorinated biphenyls (PCBs) and heavy metals, such as cadmium, lead and mercury (Kuhnlein & Chan, 2000). Contaminants in the soil, plants, or water can bioaccumulate in animal species, reaching toxic levels in humans. This is especially a concern with fish, sea birds, and marine species (Kuhnlein & Chan, 2000). It thus becomes a challenge for Aboriginal peoples to weigh the benefits and risks of consuming traditional foods, which are rich in essential nutrients, but may be toxic or carcinogenic (Kuhnlein & Chan, 2000). In some cases, for instance, fear may prevent people from consuming TF that may be safe to eat. With this in mind, one important objective of the First Nation, Food Nutrition and Health Study (FNFNES) has been to analyze and report on contamination of TF across a representative sample of First Nations communities in Canada. Of the 48 communities studied in British Columbia, Manitoba and Ontario, most TF had detectible levels of chemical contaminants, but not high to pose a risk on health. Levels of mercury found in hair samples were also not of concern in communities surveyed. Reports from the remaining provinces are expected by 2018 and will provide a better picture of the situation, providing information to community-members on whether there is a real concern to allow evidence-based decision making at the community level (Sharp, Black, & Mitchell, 2016).

Moreover, it has been hypothesized that there is an association between environmental contaminants, notably persistent organic pollutants such as polychlorinated biphenyls (e.g. PCBS), heavy metals (e.g. Mercury) and pesticides, and insulin resistance, and eventually the development of Type 2 diabetes. Since First Nations consume more TF than the rest of the Canadian population, they may face up to 7 times greater exposure to certain contaminants (Pal et al., 2013). Pal et al. (2013) tested the associations between diabetes and plasma concentrations of pesticides in First Nations and found that diabetic individuals had higher age and lipid-adjusted plasma concentrations of some pesticides, suggesting that contaminants may play a role in diabetes development.

Housing

Additionally, housing on reserves is often inadequate. Crowded households are defined as those where there is more than one person per room, other than bathrooms, laundry room, hall, and attached shed (Kolahdooz et al., 2015). Canada's National Health Survey revealed that in 2011, almost a third (27.2%) of First Nations living on reserves lived in crowded households, compared to 4% of non-Aboriginals (Statistics Canada, 2015). There is not only a problem with insufficient housing on reserves, but also of poor quality of dwellings. The First Nations Regional Longitudinal Health Survey i(FNRHS) in 2002-2003 showed that 33.6% of homes were in need of major repairs (i.e. for plumbing, electrical wiring, ceilings, etc.), whereas this was the case in only 7.5 % of Canadian households (Reading & Wien, 2009). Mold from inappropriate ventilation is also a widespread issue on many reserves. Household crowding has been associated with certain infectious diseases, asthma, poor mental health, stress, and allergies (Reading & Wien, 2009). Further, household crowding may also be a precursor to substance abuse and parenting issues, as well as youth behavioural problems (Reading & Wien, 2009).

2.1.3 Residential schools and cultural continuity

The high-school dropout rate among Aboriginal peoples is estimated at 50% (Neegan, 2005; Reading & Wien, 2009). In their report on the state of Band-Operated Schools, Anderson and Richards (2016) found that while 9 out of 10 non-Aboriginal young adults graduated from high-school, this was the case for 7 out of 10 First Nations living off-

reserve and only 4 out 10 FN living on-reserve (Anderson & Richards, 2016). Schools on-reserve have been found to be of much poorer quality than provincial schools for reasons that include remoteness, inherent social problems, lack of resources and complex administration between federal and provincial governments (Anderson & Richards, 2016).

Education is an important determinant of health at the proximal level, since poor education leads to a cycle of low literacy, unemployment and poverty for generations (Anderson & Richards, 2016; Kolahdooz et al., 2015). Poor literacy has also been associated with poor food skills and nutrition knowledge (Kolahdooz et al., 2015). However, distal causes are also responsible for the failure of educational systems to meet the needs of First Nations peoples in Canada. Residential schools, which were opened as early as the 1870s, with the last one closing in 1996, were church-run schools that aimed to turn Aboriginal children into "civilized people" by forcing them to leave their families and culture in exchange for a European way of life, void of all Aboriginal cultural practices, including speaking traditional languages, holding traditional beliefs, and eating according to traditional dietary patterns (Council of Canadian Academies, 2014; Neegan, 2005). Reports continue to surface to this day, revealing the trauma and its potential impact on the health of Indigenous peoples, generations later. A recent article explains that hunger in residential schools was widespread and likely to blame for the high mortality rates of students (Mosby & Galloway, 2017). Moreover, there are reports of inedible and rotten food being served, as well as force feeding. Such experiences may have caused traumatic memories and possibly created distorted relationships with foods for some survivors (Mosby, 2013). Another horror is that leading Canadian nutrition researchers went as far as conducting randomized controlled experiments on approximately 1000 malnourished children in six Residential Schools, without informed consent, between 1948 and 1952 (Mosby, 2013; Mosby & Galloway, 2017). Half of the malnourished test subjects were given micronutrient supplements, while the rest acted as a control group, and none were given additional caloric intake, despite researchers knowing that students were not receiving enough calories to meet their needs. Although nutrition was a young science, the notion of minimal caloric requirements to prevent starving was well understood by scientists at the time (Mosby, 2013). This unethical nutrition experiment is an example of the oppressive and dehumanizing nature of

these schools. The impact of this trans-generational trauma is still being felt today and has been related to many health issues, including mental health issues, suicide, alcohol and drug dependencies, and violence (Kolahdooz et al., 2015). In a focus group discussion, survivors listed a broad array of impacts of the residential schools, including diabetes, broken communities, loss of parenting skills, addictions and suicide (Oster et al., 2014).

Another potential impact of residential schools on health is that the experience of hunger, consistently reported by residential school survivors, may explain high rates of obesity and early-onset of insulin resistance and diabetes amongst Aboriginal peoples today (Mosby & Galloway, 2017). Survivors of residential schools recount a diet insufficient in energy, protein, and fat, little availability of fruits and vegetables, and low food hygienic quality, resulting in many food-borne infections (Mosby & Galloway, 2017). Population studies that have looked at the impact of famines or severe food restrictions in the 20th century have shown that chronic undernutrition can cause height stunting, with an increased risk for insulin sensitivity and greater fat-mass accumulation later in life (Mosby & Galloway, 2017). Through this pathway, stunting puts children at risk of becoming obese and developing Type 2 diabetes as adults, when sufficient calories become available (Mosby & Galloway, 2017).What's more, these effects appear to extend across generations, where infants of mothers who experienced childhood undernutrition and later became obese and developed diabetes, have a higher risk of developing insulin resistance and diabetes. Some studies have shown effects to extend even to adult grandchildren of famine survivors (Mosby & Galloway, 2017).

In addition to the countless cases of abuse, ranging from spiritual and psychological, to sexual that have since been reported, one of the most significant repercussions of residential school was eroding cultural continuity (Kolahdooz et al., 2015). Cultural continuity describes "the degree of social and cultural cohesion within a community" and encompasses how knowledge is passed on from one generation to the next (Reading & Wien, 2009). Residential schools purposefully prevented indigenous forms of education, in which parents and elders commonly taught young people through observation, connection with the natural world, and giving children active roles and responsibilities

within the household. Furthermore, traditional foods, such as dried meats and berries, were considered lowly, and were confiscated from children whose parents would bring some for them (Neegan, 2005). In these ways, residential schools not only failed to meet the nutritional needs of the students, they also interfered with the passing of traditional food knowledge between generations.

Ground-breaking research in the 1990s showed that cultural continuity today is protective against suicide (Chandler & Lalonde, 1998). More recent work has since looked at other health impacts of cultural continuity. For instance, a mixed methods study that looked at the relationship between cultural continuity, self-determination, and diabetes in 31 First Nations communities in Alberta found an inverse relationship between diabetes prevalence and cultural continuity (Oster et al., 2014). Of all socio-demographic predictors of diabetes explored (income, employment, education, language), only Indigenous language knowledge, used as a proxy for cultural continuity, was found to be significantly associated with diabetes prevalence, even after adjustment for socio-economic factors. Traditional food intake has also been associated with cultural continuity (Oster et al., 2014). Thus, as research builds on the importance of cultural continuity, there is increasing evidence in favour of reforming educational institutions for Aboriginal youth, with an emphasis on integrating traditional forms of education and practices into the classroom. There has been a call for additional funding to ensure that language and culture are adequately covered in school curricula on-reserves, as such programs have been shown to improve high school retention (Anderson & Richards, 2016; Reading & Wien, 2009).

2.1.4 Employment, income, and food security

Despite representing roughly 5 % of the global population, indigenous peoples make up 15% of the global poor worldwide (FAO, 2010). In Canada, the poverty rate is double that of the non-aboriginal population and Aboriginal peoples receive greater amounts of social assistance (Egeland & Harrison, 2013; Reading & Wien, 2009). The unemployment rate for Aboriginal peoples in Canada has been said to be 2 to 3 times more than for the non-Aboriginal population (Reading & Wien, 2009). Income is a well-recognized determinant of health. In the case of Aboriginal peoples in Canada, low-income has been associated with increased likelihood of chronic diseases and poor mental health (Kolahdooz et al.,

2015). It is no surprise that when poverty is compounded with the high cost-of-living and high food prices, food insecurity becomes of particular concern in remote northern communities. As one example, The First Nations Food, Nutrition and Environment Study found that the cost of a nutritious food basket[1] varied significantly among First Nations communities in Ontario (from $175 to $344 per week), while the cost in remote communities in the Yukon and Alberta have been found to be 80 to 200% more than in southern cities (Chan et al., 2014; Lawn & Harvey, 2003). Moreover, poverty affects the availability and accessibility Aboriginal peoples have to not only purchase foods from markets, but also to participate in traditional food activities, which have associated costs such as fuel and equipment (Domingo, 2016; Reading & Wien, 2009).

2.1.5 Health behaviours and health care systems

While Aboriginal peoples in Canada experience more chronic disease even when controlling for a number of behaviour and socioeconomic factors, their higher rates of smoking, obesity, lack of physical activity, and poor dietary habits are widely understood as lifestyle behaviours that compound the problem (Council of Canadian Academies, 2014; Pal et al., 2013; Reading & Wien, 2009; Willows et al., 2011b). Smoking cigarettes is more than twice as common amongst Aboriginal peoples in Canada compared to the rest of the Canadian adult population (Gionet & Roshanafshar, 2013). FNFNES data found that 39 % of First Nations adults in British Columbia reported smoking (2008-09), 49% in Ontario (2011-2012), 56% in Alberta (2013), and 59% in Manitoba (2010), while the Canadian average of people 12 years old and up was observed at 18.1% in 2014 (Chan et al., 2014; Statistics Canada, 2016). As a result, Aboriginal peoples have greater risk of contracting the diseases associated with smoking, and Aboriginal non-smokers are also more likely to be exposed to second-hand smoke.

Excessive alcohol consumption is another proximal determinant of health, associated with all-cause mortality (Reading and Wield, 2009). All three groups of Aboriginal peoples

[1] Health Canada's Nutritious Food Basket (NNFB) is a tool used to monitor the cost of about 60 foods that make up a healthy diet for Canadians (Health Canada, 2009).

living off-reserve were found to have greater alcohol consumption than non-Aboriginals (L. Gionet & Roshanafshar, 2011). Alcohol intake during pregnancy is also a concern for Aboriginal health, notably causing Fetal Alcohol Syndrome, which can have a range of impacts on child development (Reading & Wien, 2009). It is worthwhile to note that prior to European contact, there were no traditions of distillation or fermentation in Indigenous cultures in North America and that alcohol may only have been introduced to nations living in the Midwestern and western regions of North America as late as the mid-19th century. Alcohol's relative newness has been identified as a key element that led to the development of harmful drinking practices, which have persisted across generations (Frank, Moore, & Ames, 2000).

Health care systems in Canada have also been widely criticized as not meeting the needs of Aboriginal peoples, be it for a lack of attention paid to the real issues at hand, such as chronic disease prevention, or due to limited social access, where services may not be culturally-appropriate or offered in people's first language (Adelson, 2005; Egeland & Harrison, 2013; Reading & Wien, 2009). In many cases there is a lack of confidence in medical institutions, where traditional values may not be adequately regarded or integrated into care practices (Kuhnlein & Receveur, 1996b). Since health is more than simply the absence of illness, a broader vision of health, which extends beyond physical well-being, to include mental, emotional, and spiritual health, should be considered for First Nations Peoples (Kolahdooz et al., 2015; Nesdole et al., 2014).

2.1.6 Cultural norms

Some research has suggested that cultural preference may dictate body image perceptions and thereby influence body size and eating habits. For instance, a study in an Ojibway-Cree community in northern Ontario revealed that older adults preferred a heavier build. A possible explanation is that people consider larger body size to be a sign of strength, whereas thinness may evoke memories of times where infectious diseases were rampant (Willows, 2005). However, body image preferences are not homogenous, with some First Nation and Métis girls and women, mostly living in proximity to urban areas, viewing thinness as more desirable and have reported using restrictive eating behaviours in order to control their body weight (Willows, 2005).

3 Dietary Patterns of Aboriginal Peoples

3.1 Aboriginal peoples and the nutrition transition

Although the human diet has been evolving continuously since the Paleolithic period, changes have accelerated in the last three centuries, mostly, occurring rapidly over the last few generations (Haman et al., 2010; Popkin, 2006). This change in lifestyle is referred to as the "Nutrition Transition" and has occurred to varying degrees around the world (Popkin, 2006). The rate and extent of this shift has varied greatly amongst different Aboriginal groups across the country, but the overall impact of this change on health has been widespread (Willows, 2005).

Prior to contact with Europeans, varying traditional food systems offered Aboriginal peoples a wide diversity of foods from the land and water. Through hunting, fishing, gathering and agriculture, people engaged in physical activity and subsisted on diets largely high in animal protein, while being relatively low in fat and carbohydrates (Chard, 2010; Willows, 2005). There are reports that indicate that Aboriginal northern communities were mostly self-sufficient up to the 1950s, in some cases, relying only on staples such as flour and sugar to complement traditional food, in addition to some local gardens (Thompson et al., 2011). The catalyst of changing dietary patterns can be traced back to colonisation and settlement onto reserves in the 1900s (Chard, 2010). Reserves were often set up in remote locations where the soil was not fertile or it was difficult for previously nomadic nations to begin growing foods, especially in a northern climate. During the Great Depression, incomes from the fur trade fell, while animal populations declined largely due to over-hunting by non-Aboriginal trappers in preceding decades, compromising the availability and accessibility of traditional food sources (Mosby, 2013). As previously discussed, the abrupt severing of cultural continuity, which occurred during the residential school era, also played an important role in escalating changes in dietary patterns (Neegan, 2005). These varying factors led to an increased dependency on store-bought foods, a dependency that continues to rise in many communities today (Chard, 2010; Willows, 2005).

3.2 Assessments of dietary patterns in Aboriginal populations in Canada

Despite the fact that many of the health disparities experienced by Aboriginal peoples in Canada have been linked to poor dietary quality, there is little information available on their consumption patterns, especially of First Nations living below the 60th parallel (Willows, 2005). The little research that has been conducted in select communities has largely studied the Arctic region among Inuit populations, where low intakes of fruit, vegetables, and fibre and excessive intakes of fat and sugar have been observed. For instance, in a study conducted among adults in Inuvialuit in the Northwest Territories (NWT), Erber and colleagues (2010) reported low intakes of fruits and vegetables, and traditional foods (TF), while the diet was seemingly very high in non-nutrient-dense foods (NNDF), such as sugar-sweetened beverages and highly processed foods. This study helped explain the results of previous research conducted among the same population that exposed low intakes of vitamins A and C, total folate and fibre (Erber, Beck, et al., 2010). Other studies have revealed dietary patterns that are often deficient or low in certain micronutrients, such as iron, folacin, calcium, vitamin D, and fibre (Willows, 2005).

Market foods most frequently consumed have been found to be processed, containing excessive amounts of energy, refined carbohydrates, free sugar and saturated fats, and when they make up the greatest proportion of the diet, they jeopardize overall diet quality (Batal et al., 2017; Chard, 2010; Erber, Hopping, et al., 2010; Halseth, 2015; Hopping et al., 2010; Kuhnlein et al., 2004; Popkin, 2006; Popkin & Gordon-Larsen, 2004; Receveur, Boulay, & Kuhnlein, 1997; Sheehy, Kolahdooz, Roache, & Sharma, 2015). For instance, a dietary quality study conducted in the Mohawk nation of Kahnawake found that fourth- to sixth-grade children exceeded the World Health Organization's (WHO) recommended limit for free sugar intake, set at 10% of total food energy (Trifonopoulos, Kuhnlein, & Receveur, 1998). Research for Hopi, Sahtu Dene/Métis and Aboriginal children in Northern Alberta also found intakes of sugar to be high for school-children (Trifonopoulos et al., 1998). Data from the 2004 Canadian Community Health Survey (CCHS) cycle 2.2, which looked at Aboriginal adults living off-reserve in Ontario and western provinces, found that women between 19 and 50 years old and men between 31-50 years old

consumed significantly higher amounts of soft drinks than non-Aboriginal Canadians (Health Canada, 2012). Soft drinks add sugar and energy to the diet, without contributing essential nutrients (Health Canada, 2012).

A paradox exists, as the increase in variety of food stuffs to northern remote communities has not necessarily increased dietary diversity (i.e. diversity in terms of food groups), as people consume fewer traditional foods and only a restricted variety of market foods (Kuhnlein & Receveur, 1996a). And so, it is no surprising that many of the biggest health concerns for Aboriginal peoples are now associated with this new dietary pattern, including: obesity, diabetes, cardiovascular disease, anemia, and dental cavities (Batal, Gray-Donald, Kuhnlein, & Receveur, 2005; Willows, 2005).

3.3 Traditional food consumption

Aboriginal diets are unique in that they are made up of market foods and traditional foods. Traditional foods are "culturally accepted foods available from local natural resources that constitute the food systems of Aboriginal peoples' diets" (Kuhnlein & Receveur, 1996a; Willows, 2005). In general, the term TF is used by First Nations and Métis, while Inuit prefer the term "country food" (Council of Canadian Academies, 2014). TF have been praised for their nutritional value, diversity, and cultural and spiritual significant and have been associated with protective effects against chronic diseases (Arvaniti & Panagiotakos, 2008). In fact, traditional food systems around the world, despite differing greatly, have been composed of a great variety of plant and animal foods, providing adequate amounts of micronutrients, fibre, while being low in refined carbohydrates or saturated fats (Kuhnlein & Receveur, 1996a). Research in the Canadian Arctic found that the decrease in TF availability and consumption to correspond with a decreased intake of vitamins A, C, D and E, as well as other nutrients, including iron, calcium, folate, omega-3 fatty acids, and fibre (Batal et al., 2005; Donaldson et al., 2010). Moreover, the benefits of consuming TF also encompass the physical activity required to harvest them, as well as their lower cost relative to healthy market foods (Halseth, 2015).

As previously discussed, in Aboriginal communities there has been a significant decline in the consumption of TF, notably for youth, who are more likely to consume processed store-bought food (Donaldson et al., 2010; Loring & Gerlach, 2015). Inuit populations went from consuming 100% of their dietary intake from traditional foods in the 19th century, to approximately one-quarter of their energy from these foods today (Erber, Beck, et al., 2010; Kuhnlein, Receveur, Soueida, & Berti, 2008; Mirindi, 2013). Though, another study revealed great variations in the amounts depending on the season, gender and age –with higher intakes reported for men compared to women and older people compared to younger people (Kuhnlein & Chan, 2000; National Collaborating Center for Aboriginal Health, 2012). In the Baffin Inuit community studied, the average amount of TF harvested for the entire community of about 400 people varied from 180 kg/day during the late summer harvest, to 100 kg/day in the early winter (Kuhnlein & Chan, 2000). Since little is known about current harvesting and consumption practices of First Nations living on-reserve in Canada, the First Nation Food, Nutrition and Environment Study set out to gather this data. To date, data collected by FNFNES in Manitoba in 2010 found that only 20% of participants reported harvesting traditional foods, with caribou being the most important traditional food consumed in the Taiga shield/sub-arctic ecozone, with an average of 113 days per year (Chan, Receveur, Sharp, Schwatz, et al., 2012; Council of Canadian Academies, 2014).

4 Diet quality

It is widely recognized that a well-balanced diet contributes to good health and that a poor diet is a risk factor for the development of chronic diseases (World Health Organization and Food and Agriculture Organization, 2003; Alberti et al., 2007). Choosing the appropriate metric to measure diet quality is essential to adequately understand its relationship with disease. A "single-nutrient approach", focusing on individual nutrients was traditionally used in nutritional epidemiology (Arvaniti & Panagiotakos, 2008; Hu, 2002). However, it fails to assess interactions, such as influence on bioavailability and absorption, and it is often difficult to identify causality between one nutrient and disease due to confounding with other nutrients and/or foods. Since people do not consume single nutrients, but rather combinations of foods, this approach has been critiqued and has given

way to new methods that aim to assess dietary patterns in relationship to chronic diseases (Hu, 2002; Kourlaba & Panagiotakos, 2009; Waijers, Feskens, & Ocke, 2007).

Two main approaches have been developed in order to measure dietary patterns: *a priori* methods (known as "diet quality indices"), which use predefined dietary patterns, generally national dietary guidelines, as a framework with which to evaluate diets; and alternatively, empirically derived or *a posteriori* methods, either factor analysis or cluster analysis, which rely on statistical modelling of nutritional data collected from a sample population (Kourlaba & Panagiotakos, 2009; Mirindi, 2013; Perry et al., 2015; Vandevijvere et al., 2013). Since a posteriori methods do not reflect predetermined nutritional recommendations, they may not necessarily highlight optimal eating patterns, rather, they provide more of a snapshot account of the current eating patterns and behaviours of a population (Hu, 2002). Alternatively, if the dietary indices are based on standing nutritional recommendations that do not reflect the most up-to-date evidence in nutrition, there is a risk of overlooking certain correlations between diet and disease (Hu, 2002). As nutrition is a relatively new and constantly evolving science, this may also present a limitation if nutritional epidemiological research moves forward faster than the development of indices to measure diet quality.

4.1 Global diet quality indicators

With the main public health nutrition burden shifting away from micronutrient deficiencies to excessive energy and unbalanced macronutrient intakes, there is greater interest in using indices that consider global diet quality, which includes concepts such as adequacy, variety, balance, and moderation (Arvaniti & Panagiotakos, 2008; Garriguet, 2009). A great number of such indices have been developed and used in Canada and the United States. In an effort to identify the most appropriate diet quality indicator for use in the North American context, Dubois and colleagues compared three of the most popular indices with data from the Quebec Nutrition Survey conducted in 1990: the Diet Quality index (DQI), the healthy eating index (HEI), and the healthy diet indicator (HDI) (Dubois, Girard, & Bergeron, 2000). The authors concluded that the HEI was most suitable as it is a mixed-method dietary index, which means it is based on both nutrient content and the contribution

of each food group to the diet, reflecting standing nutrient recommendations and dietary guidelines. Previously, Kant (1996) had classified indices into three categories, according to their approach, as either being: 1) based on nutrients; 2) based on specific foods or groups; 3) a combination of both (Arvaniti & Panagiotakos, 2008; Kant, 1996). The HEI falls into this last category, where nutrients and foods included in the metric are associated with general wellbeing or specific health outcomes. They also found that of the three indicators, the HEI produced the highest correlation coefficient with the mean adequacy ratio[1] (MAR) for each nutrient, as well as a stronger correlation with people's perceptions of their diets (Chard, 2010; Dubois et al., 2000). Another strength is that its classification is easily interpreted, as it is a continuous measure, rather than a discrete one, as is based on a total score of 100 (Dubois et al., 2000; Woodruff & Hanning, 2010). HEI will be discussed in greater detail below.

4.2 The Healthy Eating Index

The HEI was initially developed by Kennedy and colleagues from the United States Department of Agriculture (USDA) in 1995 to assess how closely the American population was following dietary recommendations (Buhendwa, 2013; Kennedy, Ohls, Carlson, & Fleming, 1995). It is based on two main concepts: adequacy, a measure of nutrient sufficiency, and moderation, a measure of excessive consumption (Garriguet, 2009).

The first HEI included the following 10 components: grains, vegetables, fruits, milk, meat, total fat, saturated fat, cholesterol, sodium and dietary variety (Vandevijvere et al., 2013). Scores are assigned for each component, each worth 10 points, adding up to a total score of 100. Since its inception, the HEI has been continuously adapted to keep up with the changing Dietary Guidelines for Americans (Guenther, Reedy, & Krebs-Smith, 2008). It was first updated with the release of the 2005 Dietary Guidelines for Americans, which put a greater emphasis on the inclusion of whole grains in the diet, consideration of types of fats, and the "other food" category. In this version, diets that meet the minimum food-group recommendation for the nine adequacy components (total fruit, total vegetables, dark green

[1] The MAR is the ratio of an individual's nutrient intake to dietary recommendation for that specific nutrient (Woodruff & Hanning, 2010)

and orange vegetables and legumes, total grains, whole grains, milk, meat and beans, and oils) are awarded the maximum scores. For the moderation components (saturated fat, sodium, and calories from solid fats, alcoholic beverages and added sugars), maximum scores are allotted to diets that do not exceed the set standard, as established by the Adequate Intake and/or Tolerable Upper Intake Level (Guenther et al., 2008). For example, the people who consume at or below the limit for sodium (≤7 g) would receive the maximum score of 10 points for this component (Guenther et al., 2008). In this version, components are worth 10 points each, except for "other foods" which were given twice the weight (20 points) due to their significant impact on diet quality (Vandevijvere et al., 2013). The American HEI was again adapted in 2010, when additional categories were added, including seafood and plant proteins and a ratio of polyunsaturated/monounsaturated fatty acids to saturated fats as adequacy components and the introduction of refined grains as a moderation component, to again reflect more updated nutritional recommendations (Vandevijvere et al., 2013).

4.2.1 Canadian adaptations of the HEI

Several versions have also been adapted for use in Canada. The initial Canadian Healthy Eating Index (C-HEI) was developed by Shatenstein and colleagues in 2005 by substituting American dietary recommendations for those promoted in the 1992 version of Canada's Food Guide. They used it to assess the diet quality of adults (18-82 years old) in Montreal by applying it to results from a 73-item semi-quantitative food frequency questionnaire (FFQ) (Shatenstein, Nadon, Godin, & Ferland, 2005) The following year, Glanville and McIntyre published their work using a similarly adapted HEI, termed the HEI-C, to assess diet quality of household members of low-income mothers and children in Atlantic Canada (Glanville & Mcintyre, 2006). When Eating Well with Canada's Food Guide (EWCFG) was updated in 2007, two other groups of researchers developed new indices to reflect the changes. In 2009, Garriguet from Statistics Canada published his version in Statistics Canada's Health Reports publication, while less than a year later Woodruff and Hanning (2010) published their peer-reviewed article on the HEIC-2009.

Since two canadian adaptations of the HEI-2005 were developed in parallel, it is important to understand how they differ in order to determine the best one to use for this study. The HEIC-2009, developed by Woodruff & Hanning (2010) has nine components, all worth 10 points, with the exception of the vegetables and fruit component, which is rated on a scale of 20 points, adding up to a total of 100 points. The main adaptation made to this version from the previous one was to change the number of servings for each age and sex category to match the updated EWCFG (Woodruff & Hanning, 2010). They also discussed other changes presented in the new food guide, such as the recommendations about consuming at least half of grain products in the form of whole grains, but did not integrate such criteria into their HEIC-2009. Moreover, they retained the variety component, which allots points based on the consumption of at least one serving from each food group, even though this category was removed in the American HEI-2005. What's more is that in their review on diet quality indicators published 3 years prior, Waijers et al. had recommended excluding variety as a separate component of the score (Waijers et al., 2007). Their reasoning was that it would be more advantageous to include additional categories that better reflect dietary diversity. Following this recommendation, Garriguet (2009) removed the "variety component" and included greater considerations for variety by alloting points to subgroups such as whole fruits, dark green and orange vegetables and whole grains. His version, or rather, Statitics Canada's also adapted scoring metrics to fit the updated serving recommendations of the 2007 EWCFG. It also more closely mirrors the USDA's HEI-2005, which is an important advantage considering the HEI-2005 has been extensively studied and validated (Garriguet, 2009). Finally, Garriguet's version provides the added advantage of offering Canadian reference scores with which to compare future diet quality analyses, as it was used to assess the diet quality of a representative sample of 33,664 Canadians from the 2004 Canadian Community Health Survey-Nutrition (Garriguet, 2009). For all the reasons explained here, Statistics Canada's version was found to be more aligned with current nutrition recommendations and was the indicator selected for the present study.

Statistics Canada's 2009 HEI is made up of 12 components, where 60 points are allotted to eight adequacy components (total fruits and vegetables, whole fruits, dark green and

orange vegetables, total grain products, whole grains, milk and alternatives, meat and alternatives, unsaturated fats) and the remaining 40 points for three moderation components (saturated fats, sodium, other foods), adding up to a total of 100 points. Scores are allocated linearly for each component based on EWCFG recommendations for respective sex and age categories (18-50, 51+), as presented in APPENDIX I (Fraser, 2014; Garriguet, 2009). Using the HEI, people's diets are classified into the following categories: "poor" (<51 points), "needs improvement" (51-80 points), and "good"(> 80 points) (Garriguet, 2009). Index scores over 80 points have been found to correspond with a 99% likelihood of meeting the RDA for most nutrients (The United States Department of Agriculture, 1995).

4.2.2 Other adaptations of the HEI

There have also been HEI adapted for youth ("Youth HEI"), which emphasizes junk foods and sugar-sweetened beverages, as well as eating behaviours (Mirindi, 2013). Another recent adaptation, the Alternative HEI (AHEI), was developed to study in greater depth the relationship between diet and chronic disease (Vandevijvere et al., 2013). This version included higher fruit and vegetables requirements, placed emphasis on choosing polyunsaturated fats, and introduced new components, such as: plant-based proteins (e.g. nuts, seeds) and fish, cereal fibre, a white to red meat ratio, and a consideration for alcohol consumption, where moderate intake is associated with higher AHEI scores (McCullough & Willett, 2006). An updated version of AHEI was developed in 2010 (AHEI-2010) and included yet another food group component, sugar-sweetened beverages, as well as made changes to the sodium criteria (Chiuve et al., 2012). These more recent HEIs have not yet been validated in Canada. To date, no diet quality indicators have specifically been validated for Aboriginal populations living on reserves. However, the Canadian Food Guide has been adapted for First Nations, Inuit and Métis Food Guide, which contains similar recommendations as the standard EWCFG, but has several specifications that more closely reflect food choices of Canadian Aboriginal peoples. This version of the food guide can be used to classify foods into HEI food groups.

4.2.3 Validity and uses

Both content and construct validity of HEI have been tested. Content validity is a qualitative assessment that evaluates the ability of an index to encompass all the attributes it aims to measure, in this case, how well the HEI reflects the accepted dietary guidelines (Garriguet, 2009; Guenther, Reedy, Krebs-Smith, Reeve, & Basiotis, 2007). One way this has been tested is by looking at each component of the HEI against the main recommendations specified in the Dietary Guidelines for Americans and Eating Well with Canada's Food Guide (Garriguet, 2009; Guenther et al., 2007). In the US, 24-hour recalls from the NHANES (2001-2002) study were sorted and given to nutrition professionals who were then asked to assess whether they believed diets that scored high on the HEI were qualitatively better than those with low scores. They concluded that this was in fact the case (Guenther et al., 2007).

Construct validity, on the other hand, is a quantitative assessment of whether the index measures what it is intended to. In other words, that the metric "behaves" in the way it is theoretically expected to. Construct validity of a measure can only be established after studying the relationship between the measure and theoretical hypotheses. Evidence that has supported the construct validity of the HEI-2005 in the USA is that menus developed by nutrition experts to be of high diet quality, such as menus based on the *USDA's My Pyramid*, the *DASH Eating Plan*, and *Harvard's Healthy Eating Pyramid*, scored high on the American Health Eating Index (Guenther et al., 2007). In Canada, a similar exercise was completed by Garriguet (2009), who confirmed that 500 simulated diets which correspond with Canada's Food Guide recommendations scored above 95 on the HEI. (Garriguet, 2009). Another form of construct validity performed was concurrent-criterion validity. This consisted of verifying if the index picked up significant differences between groups that are known to have disparities in diet quality, for instance, smokers vs. non-smokers (Guenther et al., 2007). Both the American and Canadian adaptation of the HEI-2005 found that smokers scored significantly lower on the index, even after adjusting for various socio-economic factors (Garriguet, 2009). Construct validity of the HEI was also evaluated in the USA by verifying that the HEI measures diet quality, independent of diet quantity. Using Pearson correlations, Guenther (2007) et al. found that for the HEI-2005,

there was a low correlation between the total and component scores and energy intake. However, unlike for the American index the Canadian HEI scores are not adjusted according to total energy intake, since the EWCFG already includes recommended servings for each age and sex group that account for the average mean energy intakes. Consequently, the Canadian HEI was found to present slight correlation between calorie intake and HEI scores. However, Garriguet argues that this may also be due to underreporting on 24-hour recalls.

4.2.4 Predicting health outcomes

One of the main interest in studying diet quality stems from a desire to better understand and predict health and disease outcomes. Many studies have been conducted to support the use of the HEI as an indicator of diet quality, nutrient deficiencies, and disease prevention (Champagne et al., 2007). As previously presented, Dubois et al. (2000) found the HEI to be more strongly associated with the mean adequacy ratio (MAR) of nutrients, when compared with two other prevalent indices (Dubois et al., 2000). The HEI and the AHEI have been correlated with the risk of chronic disease, where an inverse relationship between scores and risk of cardiovascular disease was found, though the AHEA appears to be even more sensitive than the original HEI (McCullough & Willett, 2006). Chiuve et al. (2012) found similar results using data from two large cohort studies: the Nurses' Health Study (n=71,495, women) and the Health Professionals Follow-Up Study (n=41,029, men). They looked at the associations between two diet quality indices (AHEI-2010 and HEI - 2005) and the risk of major chronic disease and found that both showed associations with chronic disease outcomes, however the AHEI-2010 was more strongly correlated, notably for coronary heart disease and diabetes (Chiuve et al., 2012). Another study by Fung et al. (2005) found the AHEI to be inversely related to chronic disease risk but not the original HEI (Vandevijvere et al., 2013). This can be explained by the fact that AHEI-2010 was designed to better predict chronic disease risk by including categories of foods and nutrients found to be predictive of chronic disease, such as nuts and legumes, sugar-sweetened beverages and fruit juice, red/processed means, trans fat, long-chain (n-3) fatty acids, and polyunsaturated fats (Chiuve et al., 2012). However, no Canadian adaptation of the AHEI has been validated. Moreover, this version may not be useful when studying a

population that has very little diet variety and consumes mostly processed foods, as it will be more difficult to pick up differences between individuals if many people would receive the minimum scores (0) for several components (e.g for nuts and legumes).

4.3 Food processing

A research team at the Faculty of Public Health at the University of Sao Paulo, led by Carlos Monteiro, has made a case for understanding the relationship between food processing, diet quality and health. Food processing, defined as "all methods and techniques used by industry to turn whole fresh foods into food products", is not a health concern in and of itself (Monteiro, Levy, Claro, Castro, & Cannon, 2010). Cooking, smoking, and fermentation are forms of food processing that have helped preserve food, increase palatability, and settle human populations (Popkin, 2006). Up until the first half of the 20th century, food development consisted of processes such as pasteurisation, bleaching flour, canning and packaging, hydrogenation of oils, and fortification of foods, such as margarine with vitamins A and D (Popkin, 2006; Welch & Mitchell, 2000). These advancements in food processing provided many advantages to human populations, such as improving food safety, and reducing food insecurity and nutritional deficiencies. However, a shift from economic and political instability to more widespread ease in high-income countries over the course of the 20th century made way for a different type of food processing concentrated on increasing convenience and palatability, rather than simply guaranteeing a safe food supply (Welch & Mitchell, 2000). The most recent wave of technological advances in food science began in the 1980s and led to an abundance of cheap convenience foods, high in refined carbohydrates and fats by the end of the 20th century (Popkin, 2006). Since this time, the development and marketing of processed foods has been scaled-up at a rate never previously witnessed and the result is that the food industry is now the most influential player in determining what people are consuming on a global scale (Monteiro et al., 2016). This trend was initially witnessed in high-income countries, but is now being observed across the globe (Popkin, 2006). In such an environment, Monteiro et al. (2016) explain that seeing as most food is processed to some degree, we must move beyond the dichotomous classification of processed or unprocessed

food to a categorization that considers the extent and purpose of processing (Monteiro et al., 2016).

4.3.5 NOVA Classification

Monteiro and his team of researchers developed the NOVA classification system to look at the extent and purpose of food processing as a way of assessing the quality of the diet. Foods and beverages are classified into four groups: 1) Fresh or minimally processed; 2) Processed culinary ingredients; 3) Processed foods; and 4) Ultra-processed foods (UPF).

Table I- Classification of foods into NOVA groups

NOVA group	Examples
Fresh or Minimally processed	• Fresh, dried, frozen fruits and vegetables, meats, pulses, eggs, grains, pasta, algae and pasteurized milk and plain yogurt, water • Homemade dishes • Raw fruit juices
Processed culinary ingredients	• Sugar, oils, animal fats, salt
Processed foods	• Canned foods, artisanal breads, cheese, smoked or fermented foods • Preserved fruits, vegetables, pulses, meat and fish
Ultra-processed foods	• Industrial breads • Reconstituted meats • Carbonated, sports, energy drinks, fruit juices and drinks • Highly-processed breakfast cereals • Packaged snacks, sweet milks, sweets, and baked goods • Instant soups and noodles • Margarine, • Fast food and ready-to-eat dishes

(Moubarac, Batal, Louzada, Martinez Steele, & Monteiro, 2017)

The first group includes fresh (natural) foods directly from plants and animals, as well as water, fungi, and algae. Minimally processed foods in this group are those altered from natural foods for conservation purposes by processes such as drying, crushing, roasting, boiling, pasteurization, refrigeration, freezing, and non-alcoholic fermentation. Group 2 includes foods that result from transformation of group 1 foods by pressing, refining, grinding, milling, and spray drying to be used as seasoning or for cooking. They're

generally used as ingredients in recipes and are rarely consumed on their own. Processed foods (Group 3) are a combination of groups 1 and 2. For instance they are made by adding sugar, oil, or salt to group 1 foods and rarely contain more than 3 ingredients. Ultra-processed foods (UPF) (Group 4) are produced by the food industry and generally contain more than five ingredients. They are described as formulations of substances that are extracted or derived from natural foods (e.g. casein, lactose, whey, hydrogenated oils, hydrolyzed proteins, soy protein isolate, and high fructose corn syrup) and additives (Monteiro et al., 2016; Vandevijvere et al., 2013). These foods are generally "ready-to-eat", "ready-to-heat" and are described as being "hyper-palatable" (Monteiro et al., 2016). They include processed snack foods, both sweet and savoury, sugar-sweetened beverages and carbonated drinks, ready-to-eat meals, sweetened breakfast cereals, most industrial breads and buns, fast food products, reconstituted meat products, etc. (Moodie et al., 2013; Vandevijvere et al., 2013)

4.3.6 UPFs and diet quality

Previous research has demonstrated that diets high in ultra-processed foods have a low nutritional value, while being energy-dense and high in saturated fats, sodium, and free sugars[1]. Recent data from the First Nations Food, Nutrition and Environment Study (FNFNES) found that the portion of the diet coming from UPF had a much poorer nutritional value, including less potassium, fibre, iron, vitamin A, and protein. Nutrients that increased with UPF intake were carbohydrates, free sugars, saturated fat, sodium, calcium, vitamin C and the NA:K ratio (Batal et al., 2017). Ultra-processed foods are the source of about 90% of added sugars in the US diet, where energy intake from added sugars increases linearly as calories from ultra-processed foods increase, regardless of age, sex, race, income, or education. A vast majority (82.1%) of Americans who were ranked as the highest consumers of ultra-processed food exceeded the World Health Organization's recommended limit for free sugar or 10% (Martinez Steele et al., 2016). Unsurprisingly,

[1] Defined by the World Health Organization's Nutrition Guidance Advisory Group (NUGAG) Subgroup on Diet and Health and encompasses "monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates"(World Health Organization, 2015).

the study of UPF consumption in Canada found diet quality to decrease with increasing intake of ultra-processed foods. Only the quintile of Canadians with the lowest consumption of ultra-processed foods (making up about 33.2% of their calories) were close to meeting nutritional recommendations for the prevention of chronic diseases (Moubarac et al., 2013).

4.3.7 Ultra-processed food, obesity, and chronic disease

Monteiro and colleagues have argued that food processing, rather than intake or lack of specific foods or nutrients, has become the most important factor that affects nutrition and public health (Monteiro, Levy, Claro, de Castro, & Cannon, 2011). For one, factors including high palatability, large portion sizes, and intensive marketing make ultra-processed foods likely to be consumed in excess (Canella et al., 2014). Additionally, high levels of sugar, salt, and fat, and high glycaemic load in ultra-processed foods have been identified as leading culprits in promoting excessive weight and increased risk for diabetes, independently of overall energy intake (Canella et al., 2014; Pereira et al., 2005). Finally, as discussed, many ultra-processed foods are almost deplete of vitamins and minerals, which may in part explain the prevalent phenomenon of the double burden of malnutrition, where people are consuming more calories than they require, while simultaneously being undernourished (Martinez Steele et al., 2016).

Although strong evidence is lacking, several studies in recent years have shown a relationship between the consumption of ultra-processed food and obesity, and chronic diseases, such as the metabolic syndrome (Batal et al., 2017; Canella et al., 2014; Costa Louzada et al., 2015; Mendonca et al., 2016; Monteiro et al., 2016; Moubarac et al., 2013; Vandevijvere et al., 2013). For example, a cross-sectional study by Louzada et al. (2015) found that Brazilians living in households with the highest purchases of ultra-processed foods were more likely to be obese or carry excess weight (Louzada et al., 2015). Another study in Brazil, which used a national representative sample of all age groups, found similar associations with ultra-processed foods, but not processed foods (Canella et al., 2014). A prospective study on fast-food habits and insulin resistance in the USA found that people who consumed fast-food frequently (categorized as UPF) resulted in a 4.5 kg weight gain and a two-fold increase in insulin resistance at follow-up, compared to those who didn't

consume fast-food often, after controlling for confounding factors (Pereira et al., 2005). Using cross-sectional data from the Nituuchischaayihititaau Aschii Environment-and-Health Study, Lavigne-Robichaud et al. (2016) recently assessed the contribution of UPF in the diet based on NOVA and metabolic syndrome (MetS) in adults from seven James Bay Cree (Eeyouch) communities (n=811). They found that the caloric contribution of UPF was significantly associated with MetS (Lavigne-Robichaud et al., 2017)

4.3.8 NOVA as a diet quality indicator

Most diet quality indicators examine intakes of different foods/food groups and/or nutrients, while disregarding any relation to how food has been transformed and processed (Vandevijvere et al., 2013). Healthy diet promotion continues to largely be focused on increasing intake of foods rich in vitamins, minerals and important nutrients, despite emerging evidence linking obesity and chronic disease to excessive intakes of convenience foods (Monteiro, 2009). However, things are slowly changing and food processing is beginning to be included in national dietary recommendations, with Brazil leading the way. The World Health Organisation (WHO) and the Pan American Health Organization (PAHO) have called for the consideration of UPF as an indicator of diet quality (Pan American Health Organization & World Health Organization, 2015). By calculating the proportion of calories from UPF in the diet, NOVA is used as a proxy measure for foods of low-nutritional value, high-energy density and high free sugar content. As previously discussed, Lavigne-Robichaud (2017) presented a novel study in that they used NOVA, in addition to other more traditional diet quality indicators, the 2010 Alternative-Healthy Eating Index (AHEI-2010) and the Food Quality Score (FQS), to assess the relationship between diet quality and MetS. They found that neither the alternative-Healthy eating index (AHEA-2010), nor the Food Quality Score (FQS) were predictive of metabolic outcomes, while caloric contribution of UPF was significantly associated with MetS (Lavigne-Robichaud et al., 2017). Results from this study present a strong argument for including NOVA as a diet quality index in future research on diet quality in a Canadian Indigenous context. Moreover, results using food consumption data from First Nations communities showed a strong association between UPF and diet quality, further supporting the importance of using NOVA as a diet quality indicator in the present study (Batal et al., 2017).

4.3.9 Ultra-processed food consumption in North America: what we know

Data on ultra-processed food intake can be gathered using various measures, including: food consumption data, food expenditure data, and household budget surveys. Statistics Canada's Food Expenditure Survey (FOODEX), which is used to estimate expenditures and amounts of foods purchased by households, as well as to gather socio-demographic data, found that 61.7% of total energy available in Canadian households in 2001 was from UPFs. What's even more alarming is that the amount of UPF in the diet appeared to be greater than half of calories consumed for 80% of Canadians (Moubarac et al., 2013). Moubarac and colleagues (2014) conducted another study using data from six household food budget surveys in Canada and found that the caloric contribution of UPFs for families rose from 24% to 55% between 1938 and 2011, while the budget share of ultra-processed and ready-to-eat foods rose from 37.3% to 54.4% between 1953 and 2011 (Moubarac et al., 2014; Pan American Health Organization, 2016). Simultaneously, spending on unprocessed, minimally processed foods, and processed culinary ingredients decreased (Moubarac et al., 2014). Using food consumption data from the 2004 CCHS cycle 2.2, people from Quebec (aged 2 and up) consumed 47% of their caloric intake as ultra-processed foods, where UPF exceeded 40% of energy for all socio-demographic groups studied (Moubarac & Batal, 2016). A cross-sectional study of a nationally representative sample of Americans (2009-2010) over 1 year of age found that, on average, roughly 57.9% of people's caloric intake was from ultra-processed foods (Martinez Steele et al., 2016). More recently, food consumption data (24-hour recalls) from 3700 First Nations adults participating in the FNFNES study in four Canadian provinces showed that UPF accounted for 53.9% of calories consumed (Batal et al., 2017).

5 Food Security

5.1 Food Security: an evolving definition

The concept of food security emerged in the 1970s as the international community became increasingly concerned with levels of food shortages across the globe. In 1974, the World Food Summit laid out a framework for the first food security definition, which focused principally on availability of world food supplies (Jones, Ngure, Pelto, & Young, 2013).

Since this first milestone, there have been over 200 definitions and 450 indicators of food security (Council of Canadian Academies, 2014). A more comprehensive definition was necessary when it became evident that inequalities within countries greatly influenced people's access to food, and thus, national-level food availability data was no longer an appropriate predictor of food security. This significant breakthrough occurred in 1981, with the publication of Amartya Sen's thesis "Poverty and Famines: An Essay on Entitlement and Deprivation", which discussed the importance of looking at access as an additional component of food security (Sen, 1981). Thereafter, the 1983 food security definition was adapted to include the concept of "physical and economic access to basic food" (Jones et al., 2013). In later years, discrepancies in levels of food security were observed within households, justifying the need to study intra-household behaviours and decision-making to obtain a more accurate portrait of food consumption patterns of individuals, particularly of vulnerable population groups, such as women and children (Jones et al., 2013). This new focus on household dynamics, as well as on differences in nutrient absorption and metabolism between individuals, resulted in the development of a new concept, referred to as food 'utilization', which "reflects differences in the allocation of food within households, the nutritional quality of that food, and variation in the extent to which the nutrients in food are able to be absorbed and metabolized by individuals within households (e.g., because of differences in health status or the bioavailability of micronutrients)" (Jones et al., 2013). Moreover, the most important nutrition concern in the 1990s became micronutrient deficiencies, rather than energy insufficiency, thus shifting the focus from food quantity to diet quality (Jones et al., 2013).

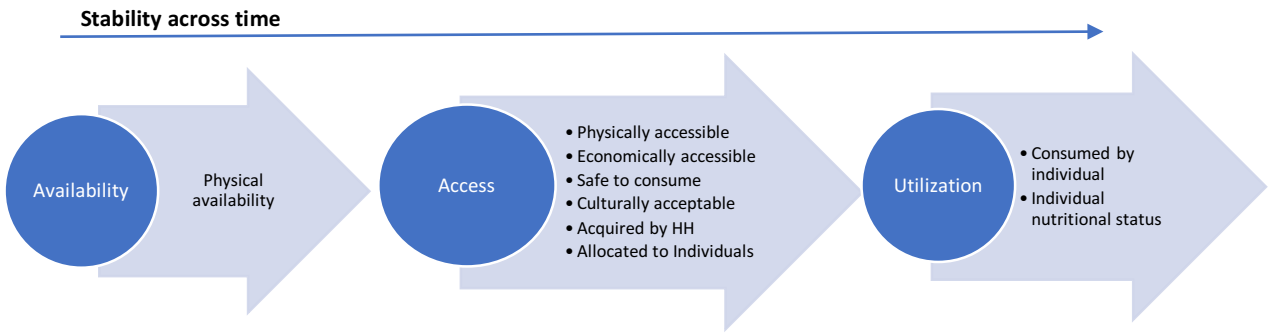
The most commonly referenced definition for food security, adopted at the 1996 World Food Summit, was the first to consider all the aforementioned concepts. It reads: "*Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*" (FAO, 1996). This definition encompasses various dimensions of food security: physical availability of food, economic and physical access to food, food utilization, and stability (FAO, 2008). Stability is reflected in the words "at all times" to emphasize the importance of sustainability in food security. Because the temporal factor is

so critical for food security, two types of food insecurity have also been identified: chronic food insecurity and transitory food insecurity. The first is persistent over time, while the second is related to sudden, though generally temporary, changes in food production, food prices, or household incomes (FAO, 2008). Seasonal food insecurity is another category occasionally used. It describes a situation that falls between the two preceding ones because seasonal changes are predictable in nature, but are limited in duration.

Due to the ever-evolving definition of food security and the various levels at which it can be measured (individuals, household, community, national, global), one of the challenges in food security work is grasping the subtleties of differing definitions and using the correct terminology. For one, food insecurity is not simply the absence of food security. For instance, at the household level, food insecurity concerns a lack of access to food due to inadequate financial resources. On the other hand, food security goes beyond simply having access to food to include having readily available food that is nutritionally adequate and safe, and is acquired in socially acceptable ways (Power, 2016). To this day, the 1996 World Food Summit definition remains the most universally used definition to date, with the addition of the "social" as an additional form of access to emphasize that food must not only be nutritionally adequate and safe, but must be acquired in socially acceptable ways, without resorting to coping strategies such as stealing, relying on food aid or other forms of emergency (CFS, 2012; Franklin et al., 2012; Willows et al., 2011b).

Jones et al. (2013) reviewed the literature on food security definitions and metrics used to study it around the globe. Their paper presented a conceptual pathway of food security that describes the interrelations between the loci of each food security dimension: availability, access, and utilization, with stability across time as the overarching element. In this view, there is an accumulative hierarchy, where the preceding locus is necessary but not adequate to reach food security at the following level (Jones et al., 2013). Jones and colleagues (2013) consider the barriers and promoters of FS as being "climate, policy, infrastructure, social programs, household resources, household composition, social dynamics, knowledge, beliefs, sanitation, life stage, physical activity, and disease status". An adaptation of their framework is presented below (Figure 2).

Figure 2. Conceptual framework of food security



Adapted from (Jones et al., 2013)

One limitation of the food security concept is that it does not explicitly encompass nutritional status nor does it indicate criteria for improved nutrition. To address this gap in terminology, the concept of "nutrition security" was developed. In 1995, the International Food Policy Research Institute proposed the following definition: "Nutrition security can be defined as adequate nutritional status in terms of protein, energy, vitamins, and minerals for all household members at all times" (CFS, 2012). In 2013, the FAO Committee on World Food Security proposed an alternative concept that incorporates nutrition into the definition of food security by including considerations of sanitation, health services and care (Council of Canadian Academies, 2014). The term "Food and Nutrition Security" has since been proposed as a means of merging issues related to food systems as a whole, from production all the way to the biological aspects of the people they nourish (CFS, 2012; Council of Canadian Academies, 2014). The FAO offers the following definition:

> *"Nutrition security exists when all people at all times consume food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care."* (FAO/AGN, March 2012)

Another concept of food security that has been discussed in Canada is that of community food security. The Dietitians of Canada have defined it as a state "when all community

residents obtain a safe, personally acceptable, nutritious diet through a sustainable food system that maximizes healthy choices, community self-reliance, and equal access for everyone" (Dieitians of Canada, 2007). Having a strong sense of community has been identified as a positive determinant of health for Canadians. This is a particularly relevant concept when approaching the topic of food security within First Nations communities in Canada, as the health of an individual and that of a community are seen as mutually dependent, where "health does not stop at the individual or with physical health; it includes relational features of life in community" (Council of Canadian Academies, 2014). Indeed, household food insecurity has been associated with weak community belonging in Aboriginal communities (Council of Canadian Academies, 2014).

5.2 Food security measurement

Even before the concept of food security existed, and as early as the post-World War I period, many countries had already started collecting national food data in the form of food balance sheets to assess food needs, especially during times of conflict (Jones et al., 2013). As the concept of food security evolved, it became necessary to develop accompanying metrics. Some have focused on specific elements of food security, such as availability, access, utilization, or stability, while others assess a combination of them. Depending on who is collecting the information and for what purpose, food security can be measured at the individual, household, regional, or national level (Jones et al., 2013).

At the international-scale, food balance sheets continue to be used as a method to assess food availability and adequacy at the country-level. In this way, the Food and Agriculture Organization of the United Nations (FAO) calculates a very broad measurement of undernourishment prevalence by comparing a country's food production and importation with its utilization. The results are released yearly in the FAO's State of Food Insecurity in the World (SOFI) series. These publications have been used to track country progress towards meeting the hunger reduction targets from the 1996 World Food Summit, as well as the former Millennium Development Goal of halving the proportion of undernourishment in developing countries by 2015 (FAO, 2016; Jones et al., 2013). However, this is an imprecise assessment of malnutrition and food insecurity because it

only considers calories in and calories out at the national level. Results from food balance sheets are limited in their ability to assist national governments in planning nutrition and agricultural programs, investments, and policies. To do so, it is more useful to understand what is happening at the individual and household levels to highlight inequalities within a country and provide evidence for targeting resources to vulnerable population groups (Cafiero, Melgar-Quinonez, Ballard, & Kepple, 2014). It is also important to understand people's experiences and behaviours in response to food resource scarcity at the household level (Toronto Public Health, 2006). For these reasons, this review focuses on household food security measurement tools.

5.2.1 Development of household food security metrics

Several metrics have been developed to measure household food security. Cafiero and colleagues (2014) have categorized food security indicators into two main groups: those that exclusively consider adequacy of consumption and those that are concerned with people's experiences, referred to as "experience-based food security scales" (Cafiero et al., 2014). Alternatively, Leroy and al. (2015) make the distinction between three different categories of food insecurity indicators: experience-based, coping strategies, and dietary diversity. Existing metrics assess components of dietary quantity and quality related to food access. The other dimensions of food security, such as cultural acceptability or safety have not been included in current metrics. Currently, experience-based metrics are the most widely used and have been extensively validated to measure food insecurity at the household level (Leroy et al., 2015).

5.2.2 Experience-Based Scales

The most common experienced-based scales used in North American studies are: the Food Sufficiency Status Question; the Community Childhood Hunger Identification Project (CCHIP) instrument; the Radimer/Cornell instrument; and the Food Security Core Module (FSCM), now most commonly referred to as the Food Security Survey Module (FSSM) or the Household Food Security Survey Module (HFSSM) (Tarasuk, 2001b; Toronto Public Health, 2006). The CCHIP was designed specifically to assess levels of hunger in American children (FRAC, 1991). The Radimer/Cornell questionnaire was laid out by researchers at Cornell University who interviewed low-income women in New York to

find out "if they had ever gone hungry or had been close to going hungry" and to describe such a situation (Tarasuk, 2001b). The data from their study was critical for developing the conceptual framework of the manifestations of household food insecurity (Tarasuk, 2001b). In a similar light, each instrument in this list was developed and inspired by the previous one, with the FSSM being the most recently developed metric and thus, the most comprehensive one to date (Tarasuk, 2001b).

5.2.2.1 The Household Food Survey Module (HFSSM)

The HFSSM tool was originally developed by an American interagency working group, coordinated by the USDA, known as the Food Security Measurement Project (1992). The scale was originally used in the US Department of Agriculture's 1995 annual Current Population Survey (CPS), and after a few minor modifications it has been included in the CPS ever since (Health Canada, 2007; National Research Council, 2006; Tarasuk, 2001b). It has since been adapted for other population surveys in the US, as well as in Canada, and is considered a gold standard food security measurement tool (Toronto Public Health, 2006).

Questions address food sufficiency over the previous 12-months, with ten questions focused on adults living in the household, while the remaining eight focus on children (Bickel, Nord, Price, Hamilton, & Cook, 2000). The complete questionnaire can be found at the end of APPENDIX II. It is relatively easy to administer, taking on average less than 4 minutes (Wolfe & Frongillo, 2001). The questionnaire ensures that reports of anxiety or harmful eating behaviours at the household-level are related to a lack of financial resources to meet the dietary needs of the members of the household, ruling out other reasons for reduced dietary intake, such as dieting and voluntary fasting (Coleman-Jensen, Gregory, & Singh, September 2014; National Research Council, 2006). In this way, income is considered as one of the most important determinants of food security (Health Canada, 2007). The 18-item questionnaire follows the Rasch model, whereby questions are ordered based on a scale of increasing severity, ranging from "worry about running out of food" to the most severe situation described as "children ever not eating for a whole day" (National Research Council, 2006). The additive scale helps determine the level of severity of food

insecurity, with each affirmative response giving one point. Tarasuk et al. (2001) emphasized that the main strength of the U.S. Food Security Core Module was a "major advance over earlier instruments because it enables household food insecurity to be measured along a unidimensional, thoroughly calibrated scale of severity". Household experiences and behaviours have been found to be comparable, following a similar pattern, when food resources become scarce. What begins as anxiety about not being able to purchase enough food often leads to reductions in quality, and eventually in quantity, of foods consumed. Compromised intakes generally are observed amongst adults in the household before affecting children (Bickel, Nord, Price, Hamilton, & Cook, 2000; Toronto Public Health, 2006). In fact, some previous literature even demonstrated that children's intake was very seldom altered when the household food resources became precarious and was only perturbed in very serious situations (Radimer, Olson, Greene, Campbell, & Habicht, 1992; Toronto Public Health, 2006).

In the US, the HFSSM originally classified households into four levels: "food secure", "food insecure with no hunger evident", "food insecure with moderate hunger", and "food insecure with severe hunger" (Tarasuk, 2001b). The USDA has replaced the previous descriptors in the most recent version of the questionnaire, and now uses the terms "low food security", "very low food security", and "very low food security among children" (Health Canada, 2007). The most severe form of food insecurity is 'child hunger', which is said to be present when affirmative responses are given to at least five of the eight questions regarding children in the household (Toronto Public Health, 2006).

A 6-item version of the survey also exists as a time-saving alternative, though it has been found to be slightly less reliable. It classifies households into being either "food secure" or "food insecure, with or without hunger". There are no questions regarding children. When compared to the 18-question version, it has been found to be 98% accurate in determining whether households are food secure or insecure (Toronto Public Health, 2006).

5.2.3 Measuring household food insecurity in Canada

Most of the instruments described above have been adapted and used to measure food insecurity in Canada, notably the CCHIP, the Radimer questionnaire, and the HFFSM.

Additionally, “red flag” approaches have been used for surveys in Canada, which means that a few questions related to food insecurity were included in health surveys. The frequency of responses to each question were then calculated to get a generalized account of food insecurity vulnerability in the group (Tarasuk, 2001b). However, such approaches have been found to be limited in their applicability and their ability to provide useful information that can be compared with other samples or surveys (Tarasuk, 2001b). As is the case in the US, the HFSSM is the metric most commonly used in population health surveys.

In Canada, the scale classifies households into three categories: food secure, moderately food insecure, and severely food insecure, based on the number of affirmative responses (Table II). People who experience moderate food insecurity begin to compromise the quality and/or quantity of their food intake. People with severe food insecurity have had to change their eating habits, skip meals or go hungry because they lack money to buy enough food (Tarasuk et al., 2016).

Table II - Classification of food Security status, based on Household Food Security Module

Status	Adult food security scale	Child food security scale	Description
Food Secure	0 to 1 affirmative responses	0 to 1 affirmative responses	No signs, or one, indication of income-related problems related to food access
Moderate Food Insecurity	2 to 5 affirmative responses	2 to 4 affirmative responses	Sign of compromised quality and/or quantity of food consumed
Severe Food Insecurity	>6 affirmative responses	>5 affirmative responses	Signs of disrupted eating patterns and reduced food intake

Adapted from: Canadian Community Health Survey, cycle 2.2, Nutrition (Income related Household Food Security in Canada (Health Canada, 2007)

One particularity in FS measurements in Canada is that researchers from the PROOF Food Insecurity Policy Research team have begun classifying food insecurity status into three levels: marginal, moderate and severe food insecurity (Tarasuk et al., 2016). Marginal food insecurity is described as a situation in which there is some worry about having enough

food to last them or to limit food selection, but does not necessarily result in compromised eating patterns. People experiencing marginal food insecurity have been found to share more characteristics with people from food insecure households than those considered to be food secure (Power, 2016). However, Statistics Canada has not begun using this approach for nation-wide data collected from the Canadian Community Health Survey. Therefore, rates of food security calculated from CCHS data will be greater than those found in studies conducted by PROOF (Power, Abercrombie, St-Germain, & Vanderkooy, 2016).

5.2.4 Adaptation of HFSSM for Aboriginal populations

Several researchers have looked at how food security should be defined and measured for Indigenous peoples (Power, 2008; Ready, 2016). In their work on food security and nutrition in Kugaaruk, Nunvavut, Lawn and Harvey (2003 and 2004) modified the HFSSM to make it more appropriate for the Inuit population. The main difference was the inclusion of "*Some families might say*" to the beginning of each question in the survey instead of directly presenting the statement. For instance, one question changed from "*You and other household members worried that food would run out before you got money to buy more,*" to "*Some families might say 'We worried whether our food would run out before we got money to buy more'* (Health Canada, 2007; Lawn & Harvey, 2003; Lawn, Harvey, & Canada. Affaires indiennes et du Nord, 2004). This less direct approach was considered to be more culturally acceptable (Lawn & Harvey, 2003). Another subtle change was using the term "healthy meals" to replace "balanced meals", as it was believed to be more meaningful for the Inuit, for whom healthy meals may not correspond with food guide-type nutritional recommendations of having an appropriate balance of the four food groups on their plate (Lawn & Harvey, 2003; Ready, 2016). Finally, the last adaptation was to remove the word "true" from the response option ("always true", "sometimes true", or "never true", in order to avoid seemingly putting into question the honesty or "truthfulness" of respondents' answers (Lawn & Harvey, 2003). This adapted questionnaire was tested in the first year of the First Nations Food, Nutrition and Environment Study, but reverted to the original HFSSM in subsequent years because statements were not well understood and its pertinence was not supported for First Nations living on-reserve.

5.2.5 Limitations of the current methods

The definition of food security encompasses a wide array of factors, including, psychological and social causes and repercussions of food insecurity. Despite our understanding that food insecurity is not experienced the same way by all household members, these factors are not measured by most metrics, since household surveys do not assess the food security experience at the individual level (Domingo, 2016; Tarasuk, 2001b). There is also no indicator that directly measures coping behaviours within food insecure households, nor one which evaluates the impact of reduced mobility and social isolation on compromised food access and intake (Bickel et al., 2000).

Another limitation of current surveys is their failure to account for respondents who consistently, and over long periods of time, have adopted disordered eating patterns due to financial constraints. For some, suboptimal eating habits may have become normalized and, as such, respondents may fail to identify and or report worry about them (Tarasuk, 2001b). And so, Tarasuk (2001) has argued the need to identify a "baseline" level of anxiety regarding food adequacy. Moreover, the HFSSM does not provide any indication regarding duration or frequency of food insecurity (Tarasuk, 2001b). The most common version of the HFSSM uses a 12 month reference point, which fails to assess whether households are experiencing food insecurity on a daily basis, or whether there are unexpected or even predictable fluctuations over the course of the year, such as seasonally or according to scheduling of pay or receipt of social assistance (Tarasuk, 2001b; Toronto Public Health, 2006). These temporal aspects of food insecurity are particularly significant when attempting to understand associations between food insecurity and health (Toronto Public Health, 2006). They may also prove insightful when considering seasonality of traditional foods for Aboriginal Peoples. A final limitation that has been identified is that although cut-points used to categorize levels are drawn according to the Rasch scale of severity in order to gain more insight into the distribution of food security levels in a population, they have been set in a somewhat arbitrary way. More research is needed to ensure they further validate their limits (Tarasuk, 2001b).

5.3 Food security statistics

Globally, it is estimated that between 2010 and 2012, 2 billion people were food insecure and that 870 million people experienced chronic hunger, a severe consequence of food insecurity caused by continuous inadequate energy intake (Food and Agriculture Organization, WFP, & IFAD, 2012; Loring & Gerlach, 2015; Urke, Cao, & Egeland, 2014). In Canada, using data from the most recent Canadian Community Health Survey (CCHS) in 2014[1], PROOF found that 3.2 million individuals, roughly 12% of the population, were food insecure (including marginal food insecurity), with the following break-down: 3.7% were classified as marginally food insecure, 5.5% as moderately food insecure, and 2.7% as severely food insecure (Tarasuk et al., 2016). If Statistics Canada's classification is applied, 8.2% of households would have been classified as food insecure, which is similar to the prevalence from the 2011-2012 CCHS (8.3%), though at the time only 2.5% were classified as severe (Statistics canada, 2013c). At the provincial and territorial level, Nunavut has the most exorbitant rates of food insecurity in the country – 36.4% in 2011 (Tarasuk et al., 2016). While the greatest majority of food insecure households (84%) were in the most populated provinces: Ontario, Quebec, British Columbia and Alberta (Tarasuk et al., 2016).

5.3.6 Food insecurity among Canadian Aboriginal Peoples

Although often described as an issue of the "Global South", food insecurity is not only present in Canada, but has reached alarmingly high proportions in certain Aboriginal communities, notably in northern remote communities (Loring & Gerlach, 2015). Research assessing food security among Canadian Aboriginal populations has evolved over the years, following a similar trend as within the international community, from focusing principally on adequacy and availability of food supplies to trying to better understand behaviours and experiences of food insecurity at the household and community levels (Loring & Gerlach, 2015).

[1] Food security data in the 2014 CCHS was not available from Newfoundland, Manitoba, British Columbia, or the Yukon

Prevalence of hunger amongst Aboriginal peoples in Canada has been found to be 60% greater than amongst the non-Aboriginal population (Toronto Public Health, 2006). Data from the 2014 CCHS illustrated that 25.7% of Aboriginal households off reserves experienced some level of household food insecurity (including marginal food insecurity), which is more than twice the rate of food insecurity found for Canadian households in participating provinces and territories of the 2014 CCHS (12%) (Tarasuk et al., 2016). However, Aboriginal peoples living on-reserve were excluded from the CCHS and there remains a need to gather additional data to get a more comprehensive picture of the situation for First Nations. Of the few ad-hoc studies that have been conducted in First Nation communities, Skinner and colleagues (2014) assessed the household food insecurity prevalence (n=64) in a remote community in sub-arctic Ontario. Using Health Canada's HFSSM, they reported a food insecurity rate of 70%, where 17% of households classified as severely food insecure (Skinner, Hanning, & Tsuji, 2014). Similarly, another study in 14 First Nations communities in Northern Manitoba (n=534) found that 75% of households were classified as food insecure, with 33% experiencing severe food insecurity and 42% moderate food insecurity. There was a very large range of prevalence rates in the communities studied, varying from 47% to 100% in one community (n=46) (Thompson et al., 2011). These studies show that the food insecurity rate may be as much as six to eight times higher in remote on-reserve communities than in the rest of Canada.

The First Nations Regional Health Survey (FNRHS) (2008-2010) used a 9-item food security questionnaire to get a prevalence of First Nations living on-reserve in 216 communities across 10 First Nations Regions (n=10,371). On average, 54.2% of households were food insecure, with 14.1% categorized as severely food insecure (FNIGC, 2012). Around this same time, and in response to the little representative data available, the First Nations Food Nutrition and Environment Study set out to gather food security statistics from a representative sample of FN living on-reserve below the 60th parallel across Canada. The full 18-item HFSSM was used in order to be comparative with national CCHS data. FNFNES reported a food insecurity rate in remote communities in northern Manitoba in 2010 that was similar to previous studies in the region (73%) (Thompson et al., 2011). To this date, regional results from British Columbia, Alberta, Ontario, and

Manitoba have been published. FNFNES results are presented in the table below (Table II). As expected, food insecurity rates were much higher than for the rest of the Canadian population.

Table III - Published food security rates from the FNFNES study (2008-2013)

Region	Food secure	Food insecure, moderate	Food insecure, severe	Food insecure, total
Alberta, 2013 (n=401)	53%	34%	13%	47%
Ontario, 2011-2012 (n=928)	71%	21%	8%	29%
British Columbia, 2008-2009 (n=1103)	59%	34%	7%	41%
Manitoba, 2010 (n=646)	62%	32%	6%	38%

(Chan et al., 2016a; Chan et al., 2014; Chan, Receveur, Sharp, Schwartz, et al., 2012; Chan et al., 2011)

5.4 Food insecurity and health

There is a two-way relationship between food security and health, where health can be both a cause and a consequence of food insecurity (Council of Canadian Academies, 2014). Although starvation remains rare in North America, food insecurity has been associated with compromised nutritional status, infections, mental health problems, chronic diseases, and overall poor health (Bhattacharya, Currie, & Haider, 2004; Council of Canadian Academies, 2014; Fieldhouse & Thompson, 2012; Lamdein, Receveur, Marshall, & Kuhnlein, 2006; Willows et al., 2011b). For young children, poor cognitive development and compromised learning abilities have been associated with food insecurity (Urke et al., 2014). Willows and colleagues (2011) used data from the 2004 Canadian Community Health Survey (CCCHS 2.2) to look at the relationship between household food insecurity and health and found that food insecurity was predictive of poor overall self-reported health and life satisfaction, high stress, and a weak feeling of community (Willows et al., 2011a).

Poor mental health has also been linked to food insecurity (Council of Canadian Academies, 2014). For one, mental health issues may stem from food insecurity, considering that by definition it is a situation that creates worry or anxiety about food access. For example, consequences may include preoccupation over food adequacy, feeling a loss of control and struggling psychologically (Lamdein et al., 2006). In addition,

depression, social exclusion and learning disabilities have also been observed in people who reported food insecurity (Council of Canadian Academies, 2014). This is particularly noteworthy in the Canadian Indigenous context, where mental health issues, notably suicide, depression, and substance abuse, are known to be widespread.

5.4.7 Food insecurity and body weight

Rates of obesity have been found to follow a socioeconomic gradient, where Body mass index (BMI) increases as income and education level decrease (Drewnowski & Specter, 2004). In a review of food insecurity and obesity, Franklin et al. (2012) found positive, though mixed, evidence of the relationship between food insecurity and obesity across the lifecycle. The link between food insecurity and obesity is strongest among women, while there is little evidence demonstrating a correlation among men and children (Franklin et al., 2012; Morales & Berkowitz, 2016). For example, data from the NHANES (1999-2002) found that for women who experienced "food insecurity with hunger" (severe food insecurity) has a 67% increased risk of overweight when compared to fully food secure women (Franklin et al., 2012). This relationship was not observed in men. In fact, men experiencing "food insecurity without hunger" (moderate food insecurity) had an increased likelihood of having a lower BMI and a reduced risk of being overweight or obese, when compared with men who were food secure (Franklin et al., 2012). Another study using data from the NHANES III examined the relationship between food insufficiency and weight for women 19 to 55 years old who did not live on their own (n= 5,241) (Basiotis & Lino, 2002). Although caloric intake was found to be similar, a significantly greater proportion of women living in households classified as food insufficient were overweight, while no difference in obesity prevalence was noted (Basiotis & Lino, 2002). In examining the association between food insecurity and weight status for 4,338 men and 4,127 women, Hanson et al. found that at a "low food security level" (similar to moderate food security in the Canadian HFSSM) men were less likely to be overweight or obese, while women had an increased risk of obesity (Hanson, Sobal, & Frongillo, 2007). Other studies have reported a similar pattern, where food insecurity is associated with obesity in women but not men, and mostly at intermediate levels of food insecurity (Adams, Grummer-Strawn, & Chavez, 2003; Dinour, Bergen, & Yeh, 2007; Drewnowski & Specter, 2004; Hanson et

al., 2007; Morales & Berkowitz, 2016; Townsend, Peerson, Love, Achterberg, & Murphy, 2001b; Wilde & Peterman, 2006).

Bhattacharya and colleagues (2004) observed that poverty in adults was associated with obesity. However, poor food insecure elderly were more likely to have low BMI when compared to food secure elderly. This showed that access to sufficient calories was not an issue for younger adults, but was for the elderly – likely due to factors such as difficulty getting to grocery stores or with food preparation. Their work also supported the theory that, although the consequences of poverty and food insecurity may overlap, they remain separate concepts that can affect body weight and health in different ways (Bhattacharya et al., 2004).

5.4.7.1 Studies in Aboriginal populations

Cooke and colleagues (2013), using data from the 2006 Aboriginal Peoples Survey which included socio-economic data and reported anthropometric measurements of 4060 Métis children aged 6 to 14 years old, observed a higher risk of obesity for boys (6-10 years old) who experienced hunger (Cooke, Wilk, Paul, & Gonneville, 2013). Using FNFNES data, Domingo (2016) found that there was a non-linear relationship between household food insecurity and obesity. When compared to their food secure counterparts, marginally food insecure women and men had significantly higher odds of obesity, while severely food insecure men had lower odds of obesity (Domingo, 2016). In this way, FNFNES data was consistent with previous studies that found low and intermediate levels of food insecurity to be associated with higher levels of overweight and obesity for women.

5.4.8 Food insecurity and obesity: understanding the paradox

Although this relationship may seem paradoxical, as one would assume that people experiencing food insecurity would be underweight from prolonged exposure to insufficient energy intake, it has been shown that food insecurity, a chronic stressor, may induce an opposite effect in certain situations (Townsend et al., 2001b). Several mechanisms have been proposed to explain the relationship between food insecurity and obesity. Dietz (1995) was the first to hypothesize that a body may respond to periods of food shortages by increasing its ability to store fat. When food resources are scarce, or

there is fear that they may become limited, individuals may also be driven to over-consume suboptimal foods as a compensation mechanism (Franklin et al., 2012). Studies of food assistance recipients in the USA have labelled this occurrence as the "boom and bust cycle" or the "food stamp cycle", where recipients may follow a cyclical pattern in which they are more likely to binge-eat upon receiving food stamps (or social assistance cheques) and decrease caloric intake over the rest of the month (DeBono, Ross, & Berrang-Ford, 2012; Shapiro, 2005; Townsend et al., 2001b). Some observational studies have found recipients of food assistance programs, such as the Supplemental Nutrition Assistance Program (SNAP), to have an increased risk of obesity, with this association often remaining significant for women and not men (DeBono et al., 2012; Morales & Berkowitz, 2016; Townsend, Peerson, Love, Achterberg, & Murphy, 2001a; Zizza, Duffy, & Gerrior, 2008). However, it has been difficult to determine causality and directionality or this relationship due to the observational nature of the studies conducted and so evidence to support this relationship remains inconclusive (DeBono et al., 2012). Another theory is that individuals may increase their energy intake, especially of highly palatable foods, in order to help relieve some of the harmful effects of this stress on the brain (Leung, Epel, Ritchie, Crawford, & Laraia, 2014). In this way, food insecurity can cause disordered eating patterns, which may in turn promote weight gain (Townsend et al., 2001b). Moreover, calorically dense foods, generally high in refined carbohydrates and fat, have been found to be readily available and cheaper per calorie than healthier whole foods, further explaining the occurrence (Morales & Berkowitz, 2016). Recent research from the US has also suggested additional factors are correlated with the obesity-food insecurity relationship, including maternal stressors, marital status, and high-costs associated with exercise, such as gym memberships, or lack of access to safe spaces to be active in low-income neighbourhoods (Bhattacharya et al., 2004; Franklin et al., 2012; Hanson et al., 2007). Finally, food insecurity often correlates with lower levels of education, which may result in low levels of health and nutrition literacy, putting food insecure individuals at risk of obesity (Bhattacharya et al., 2004).

5.5 Food insecurity and diet quality: A Review of the evidence

The pathway between food insecurity and obesity is likely mediated by diet quality, as described in the previous section. The high cost of fresh produce and other nutritious foods compared with processed convenience foods, often cheaper and more accessible, make it easy to understand how those with restrained food dollars may approach food purchasing decisions (Leung et al., 2014). As previously discussed, it has also been suggested that people who experience a chronic stress, such as poverty, tend to prefer more highly palatable foods that are rich in fats, sugars and/or salts, and so lean towards less nutritious options (Leung et al., 2014). There have been a great number of observational studies conducted over the last 30 years to support this theoretical pathway. Presented below are some of the findings from the United States and Canada. Tables summarizing the relevant literature from the United States and Canada are presented in APPENDIX III.

5.5.9 United States

In the United States, several studies have used data from the NHANES III, a national sample of people over 2 years old conducted between 1988 and 1994 (n=34,000), to study the associations between food insecurity, poverty, diet quality and nutritional outcomes. For one, Bhattacharya and colleagues (2004) aimed to understand how a food insecurity assessment compared to the standard poverty measurement in its ability to predict nutritional outcomes. They did not use the HFSSM, but rather a 6-item food security questionnaire that categorizes households into four groups: food secure, food insecure without hunger, food insecure with hunger (moderate), and food insecure with hunger (severe). USDA's original Health Eating Index was used to assess diet quality, while BMI and serum vitamins and minerals were also taken as measures of nutritional status. They observed differences in the relationship between food insecurity and diet quality across age groups. After controlling for poverty, food insecurity did not appear to offer predictive power of nutritional outcomes for children. Food insecurity was significantly associated with nutritional outcomes, including lower HEI scores and obesity, for food insecure adults. However, it is worth noting that the overall differences in HEI across food insecurity groups were quite minimal (Bhattacharya et al., 2004). Again using data from NHANES III, Dixon and colleagues (2001) found that younger food insufficient adults

were found to have lower nutrient intakes (calcium, vitamin E, vitamin A, carotenoids, serum levels of total cholesterol, and albumin). Food insufficient older adults (>60 years old) consumed fewer calories and had lower intakes of certain nutrients (vitamin B6, magnesium, iron and zinc, as well as lower serum levels of cholesterol, albumin, vitamin A, β-cryptoxanthin and vitamin E) (Dixon, Winkleby, & Radimer, 2001). Lee and Colleagues (2001) also explored the relationship between food insecurity and nutrition in elderly Americans using the same NHANES data (1988-1994). They found food insecurity to be predictive of lower intakes of certain macronutrients (energy, protein, carbohydrate, saturated fat) and micronutrients (niacin, riboflavin, vitamins B-6 and B-12, magnesium, iron and zinc). Overall, food insecure elderly had poorer nutritional status than those considered food secure (Lee & Frongillo, 2001).

As far back as 1996, the Radimer/Cornell hunger and food insecurity questionnaire was used to look at the association with diet quality in a sample of women with children who were living in rural New York State (n=193). The authors found that intake of fruits and vegetables and total energy intake were associated with food insecurity status (Kendall, Olson, & Frongillo Jr, 1996). Food insecure participants consumed significantly fewer fruits and vegetables, and had lower vitamin C, potassium, and fibre intakes than food secure women (Kendall et al., 1996). Using an eating disorder score for women which measures likelihood to engage in disordered eating behaviours, such as bingeing, the authors found that FI women scored higher, meaning they were more likely to have disordered eating patterns (Kendall et al., 1996). Champagne et al. (2007) studied a representative sample of adults (n= 1607) living in 36 counties in the Lower Delta region of Arkansas, Louisiana, and Mississippi as a part of the "Foods of our Delta Study". Researchers used a series of 3 telephone interviews to gather information about participants' socio-demographic characteristics, a 24-hour recall and questions regarding usual dietary intake, water consumption, general health questions and self-reported anthropometric measurements. The final interview included the 18-item Household Food Security Module. Researchers found that food insecurity was related to HEI scores, but that this relationship did not remain significant when socio-demographic variables were controlled for (Champagne et al., 2007). In fact, There appeared to be a stronger correlation

between diet quality, age and education (Champagne et al., 2007). In their study exploring food insufficiency, weight status, and diet quality of women who did not live on their own (n=5,241), Basiotis & Lino (2002) found that although most women fell into the "needs improvement" category, the difference in mean HEI score between women from food insufficient households and those in food sufficient households was statistically significant, 58.8 and 62.7 respectively (Basiotis & Lino, 2002). Statistically significant lower scores were also noted for food insufficient women for several HEI components, including vegetables, fruits, milk, cholesterol, and food variety.

Using data from a more recent NHANES (1999-2008), Leung et al (2014) showed that food insecurity affected diet quality in low-income adults (n=8,129), independently of poverty. Selection criteria included being between the ages of 20 and 65, not being pregnant, and having a household income less than or equal to 300% of the federal poverty level. Researchers used the US HFSSM to assess food security status and the HEI-2005 and AHEI-2010 as indicators of total diet quality. They found that food insecure adults consumed greater amounts of high-fat dairy, sugar-sweetened beverages, salty snacks, red/processed meat, and fewer vegetables, and sweets and bakery products (Leung et al., 2014). Overall adults from food insecure households scored lower on the HEI-20005 and the AHEI-2010 (Leung et al., 2014). Another study examined the relationship between food security status, fruit and vegetable consumption, and BMI amongst food assistance recipients in Hartford, CT (n=212) (Robaina & Martin, 2013). Food insecurity reduced people's likelihood to consume fruits, vegetables, and fibre by half (Robaina & Martin, 2013). Zizza et al. (2008) explained that although food stamps and food assistance may address emergency food needs, they do not improve dietary behaviours of food-insecure women. Nguyen and colleagues (2014) also studied the impact of nutrition assistance on diet quality, using diet quality indicators, including the HEI-2010, and reported similar results. They found that recipients of the Supplemental Nutrition Assistance Program (SNAP) had lower HEI-2010 scores, they also consumed fewer fruits and vegetables, seafood and plant proteins, and more added sugars and empty calories (Nguyen, Shuval, Bertmann, & Yaroch, 2015). However, this study did not look at food insecurity. A prospective longitudinal cohort study of Puerto Rican adults with diabetes (n=516) found

food insecurity to be associated with lower HEI-2005 scores, as well as lower intake of fruits and vegetables. No significant differences were found with any other food group (Berkowitz, Gao, & Tucker, 2014).

Rose and Oliveira (1997) studied preschool children (n=1379), adult women (n=3774) and the elderly (n=2215). They found significant associations between food insufficiency and lower intakes of protein, calcium, vitamins A and B6, and energy in the elderly and of vitamins A, E, C and B6 and magnesium in adult women, while no relationship between food insufficiency and nutrient intakes were observed for children (Rose & Oliveira, 1997). As found supported by other studies, the predictive power of food insecurity on diet quality may not apply to school-aged children, whose diets may be influenced by other factors outside of the household. Younger children in the household are also said to be protected, likely as a result of family members, notably mothers, sacrificing their own intake (McIntyre et al., 2003). Similarly, data of pregnant women from the NHANES 1999-2008 study did not reveal an association between HEI scores and household food insecurity. This is possibly due to a buffering mechanism that may occur in households to protect pregnant women, though this theory has not yet been studied (Gamba, Leung, Guendelman, Lahiff, & Laraia, 2016).

As previously discussed, food insecurity may also perturb eating behaviours and meal patterns. Using data from a more recent NHANES (1999-2002), Zizza and colleagues (2008) assessed dietary and meal patterns across food security levels for adults between the ages of 18 and 60 years old. What they found was that FI women were more likely to skip meals than FS women, but this was accompanied by an increase in energy intake during snacking. Moreover, women who were food insecure without hunger (moderate FI) consumed more at meal times, while men in the same category had higher intakes of energy per snack than food secure individuals. Their results showed that FI men and women may be compensating for skipping meals by increasing the size of meals and intake as snacks. One explanation for skipping meals is that FI individuals may have greater time constraints, possibly from working more than one job (Zizza et al., 2008).

5.5.10 Canada

To date, several studies in Canada have found associations between food insecurity and low diet quality, however, results have been inconsistent. Results are summarized in Appendix III. Tarasuk and Beaton (1999) studied women receiving food assistance in Toronto (n=153) and found that household food insecurity over the past 30 days was associated with lower mean intakes of vitamin A, folate, iron, magnesium, and total energy, even when controlling for potential confounding variables (Tarasuk & Beaton, 1999). Kirkpatrick and Tarasuk (2008) also analyzed data from the CCHS 2.2 (n=35,107) of people between the ages of 1 and 70. They found food insecurity to be associated with poor diet quality in adults. The authors suggest that the relationship is strong enough to increase the risk of nutritional deficiencies.

5.5.10.1 Studies among Aboriginal populations

Using data for the IPY Inuit Health survey, Huet et al. (2012) found that people living in food insecure households had lower Health Eating Index scores. FI adults also consumed fewer vegetables and fruit, milk and alternatives, grain products, and had a higher energy-intake from high-sugar foods (Huet, Rosol, & Egeland, 2012). Egeland and colleagues (2011) studied the relationship between food insecurity and nutrient intakes among adult Inuit in the 36 Arctic Inuit communities (2007-2008) and found FI to be associated with lower hemoglobin and serum ferritin levels. In gender-stratified analyses, FI men had lower intakes of energy, fibre, vitamin C, iron, zinc and magnesium, while FI women had lower intakes of fibre, dietary folate equivalent, vitamin C, iron, magnesium, calcium, and vitamin D, though a greater consumption of carbohydrates (Egeland et al., 2011).

The First Nations Regional Health Survey (2008/10) (n=10,196) did not use HEI as a measure of diet quality, but rather respondents were asked if they ate a nutritious balanced diet “always of almost always”, “sometimes”, “rarely”, or “never”. Due to the subjective nature of these questions, they cannot be compared with other results covered in this review. However, it is interesting to report that adults from food-secure households were much more likely to report “always or almost always” eating a healthy diet (41.4%), then did those from moderately food-insecure (24.2%) or severely food-insecure (17.3%) households (First Nations Information Governance Centre (FNIGC), 2012).

A few academic theses have been completed using FNFNES data to explore the relationship between food insecurity and diet quality for First Nations living on-reserve in Canada. Looking exclusively at data gathered from Manitoba (n=550), Decelles (2014), found that, after adjusting for energy intake, the only difference that remained significant was that food insecure women (31-70 years old) had lower intakes of vitamin B6 (Decelles, 2014). In 21 communities in British Columbia (n=849), Eid (2011) did not find a single significant difference between levels of food insecurity status and nutrient intakes. Due to the limited evidence emanating from studies conducted amongst Aboriginal people in Canada, a call to study this phenomenon more closely has been made. There is a need to ensure surveillance to better develop policies that target food insecure households.

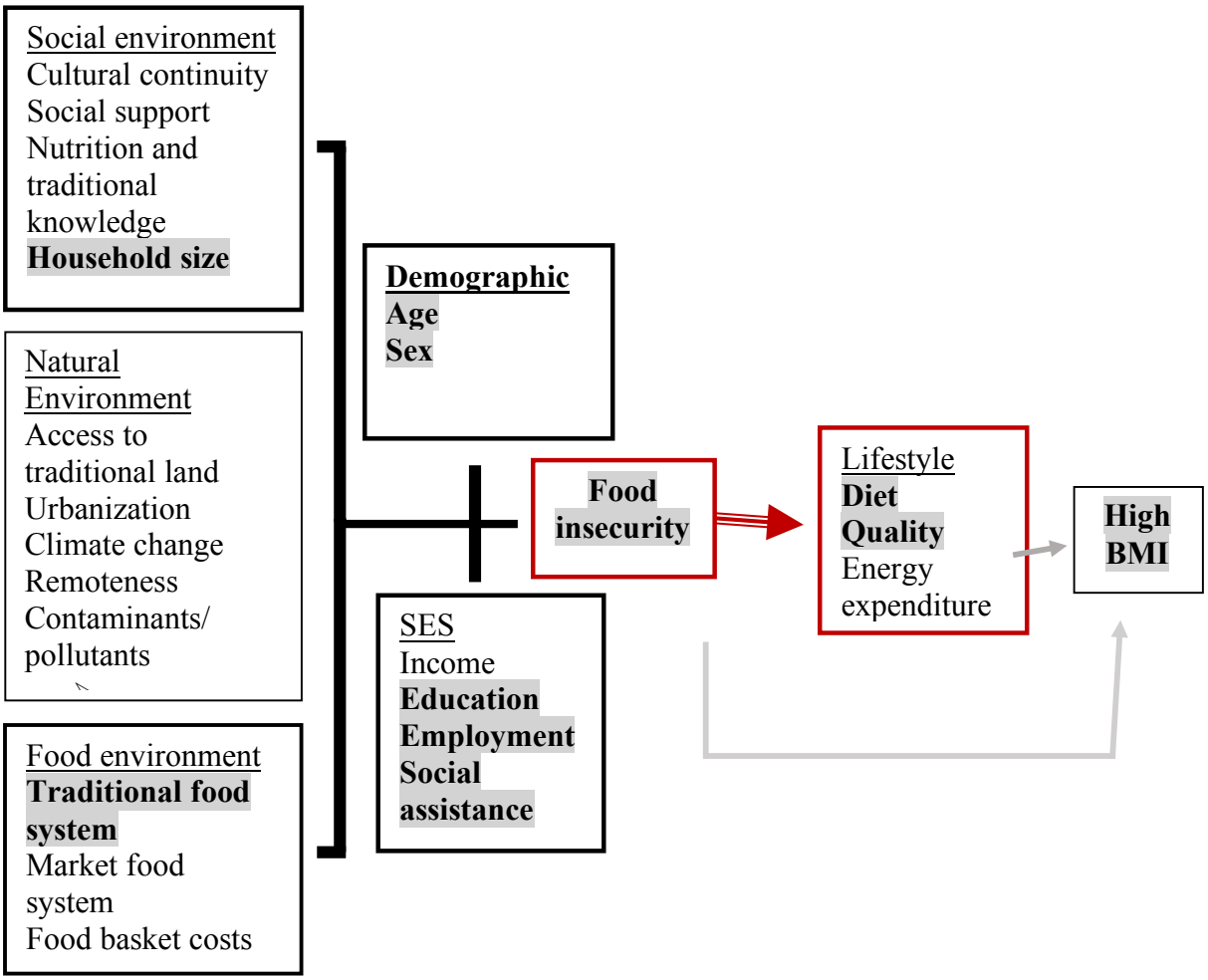
Chapter III: Research Rationale, Context and Objectives

1 Rationale

First Nations have a more than twice the rate of food insecurity than the rest of the Canadian population (25.7% for Aboriginals living off-reserve vs. 12%) (Tarasuk et al., 2016). Food insecurity has been linked with detrimental effects on health and wellness, including obesity – of particular concern for First Nations adults who experience a much higher prevalence of obesity than the non-aboriginal population in Canada (26% vs. 16% in 2007-2010) (Gionet & Roshanafshar, 2013). One proposed theory is that food insecurity's impact on health is related to its negative effect on diet quality (Egeland et al., 2011; Laraia, 2013; Townsend et al., 2001a). Household food insecurity has been found to be related to inadequate nutrient intakes for Canadians adults (Kirkpatrick & Tarasuk, 2008). A few studies have found similar results with the Inuit (Egeland et al., 2011; Huet et al., 2012). However, aside from a few academic theses that have looked at the relationship between food insecurity and nutrient intakes for First Nations living on-reserve (Decelles, 2014; Eid, 2011; Mirindi, 2013), the direct association between food insecurity and global nutritional quality remains unclear for this population (Kirkpatrick & Tarasuk, 2008). Now that data from the First Nation, Food, Nutrition and Environment Study (FNFNES) is available from five Canadian regions: British Columbia, Alberta, Manitoba, Ontario, and the Atlantic provinces, it is possible to study how food insecurity is associated with diet quality for First Nations living on-reserve in these regions. And so, the present study will assess this relationship, while also gathering additional insight into other socio-demographic correlates of both food insecurity and poor diet quality, with an emphasis on how traditional food consumption and participation in traditional food activities are associated with these occurrences. Traditional foods remain an important contributor of the diet for many Aboriginal peoples across Canada, however little is known of their inclusion in the diet of FN living on-reserve below the 60th parallel in contemporary diets. The overarching vision is that this work contributes to the existing and evolving literature focused on developing a better understanding of the root causes of the obesity and chronic

disease epidemics experienced by First Nations living on-reserve in Canada, with the intention to help guide future actions in public health and nutrition policy.

Figure 3. Conceptual framework of the relationship between socio-demographic variables, food insecurity, diet quality, and high BMI in First Nations communities.



Adapted from: (Domingo, 2016; Townsend et al., 2001b)

The conceptual framework presented in Figure 3 is guided by the literature, notably Townsend et al. (2001) who studied the association between food insecurity and overweight in women, as well as the work of Domingo (2016) who assessed the relationship between food insecurity and high BMI in First Nations communities, using FNFNES data. In this way, the present study helps build on existing literature, contributing progressively towards a clearer picture of the contemporary food environment on FN

reserves in Canada. Highlighted in grey in Figure 3 are the variables that will be explored in the present study.

The model shows the various levels of factors that act on food insecurity, diet quality and obesity. However, this study focuses on interactions between food insecurity and diet quality. Obesity is an ultimate outcome in the conceptual framework, but was only studied as a control variable in the present work. Socio-demographic variables (Traditional food intake, household size, age, sex, education, employment, and social assistance) were included to test their associations with both diet quality and food insecurity. Not all variables in the conceptual model will be assessed in this study; however, their inclusion in the illustration helps to contextualize and frame the research, building on themes, such as cultural continuity, climate change and traditional food systems, explored in chapter 2 of the present work.

2 Primary objectives and questions

The principal research objective was to examine the relationship between food security and the quality of the diet amongst First Nations living on reserves in Canada.
The more specific objectives are:

1. Identify and describe socio-demographic, socio-cultural (including access to traditional food), and health correlates of food insecurity;
2. Describe the overall quality of the diet for First Nations communities using two measurements of diet quality: a Canadian version of the HEI-2005 (Garriguet, 2009), and the NOVA classification system, which will identify the proportion of dietary energy received from ultra-processed products (UPPs);
3. To quantify the associations between food security and diet quality, taking into account socio-demographic, socio-cultural (including access to and use of traditional food) variables in this relationship.

The study aims to address the following questions:

1. Do individuals living in food insecure households have lower Health-Eating Index (HEI) scores?
2. Do individuals living in food insecure households obtain a higher proportion of

their energy intake from ultra-processed foods (UPF), based on the NOVA classification system?

3. Does traditional food intake and/or household traditional food activity affect the quality of the diet for First Nations?

Chapter IV - Methodology

1 The Study: First Nation Food, Nutrition and Environment Study (FNFNES)

The First National Food, Nutrition and Environment Study (FNFNES) is a cross-sectional study aimed at describing the present-day dietary patterns of First Nations adults and to assess the availability and accessibility of traditional and market-based food systems on reserves and weigh the risks and benefits of each of these two food systems (Chan et al., 2016a). FNFNES came as an answer to a resolution passed in 2007 by Chiefs-in-Assembly and the Assembly of First Nations to better understand the dietary composition, food security prevalence, and the level of contaminants in traditional foods and water for First Nations peoples living on-reserve below the 60th parallel (Batal et al., 2017; Chan et al., 2016b). The project's coordination is a collaboration between the Assembly of First Nations (AFN), the University of Ottawa, the Université de Montréal, and the University of Northern British Columbia, and technical support and funding is received from Health Canada. The target was to include approximately 100 communities of the 598 First Nations communities over a 10-year period. Data collection began in British Columbia in 2008 and the final round occurred in Quebec 2016. However, only data from the following regions were available at the time of this study and therefore included in this analysis: British Columbia (2008 & 2009), Manitoba (2010), Ontario (2011/2012), Alberta (2013), and the Atlantic provinces (2014). The number of participating First Nations communities out of the total number of FN communities in each region was as follows: 11 out of 31 FN communities in the Atlantic region (35%); 10 out of 45 in Alberta (22%); 18 out of 126 in Ontario (14%); 21 out of 198 in British Columbia (11%); and 9 out of 63 communities in Manitoba (14%). More information about the details of the study can be found in the FNFNES reports, available online: www.fnfnes.ca (Chan et al., 2016a).

There are five main components of the study: 1) Tap water collection for trace metal analysis; 2) Surface water sampling for pharmaceuticals; 3) Traditional food collection to

test for contaminants, such as heavy metals; 4) Hair sampling for mercury analysis; and finally; 5) A Social, Health and Lifestyle Questionnaire at the household level, which includes a 24-hour recall and a Food Security Questionnaire.

2 Sampling

An ecozone sampling framework was used to ensure that a representative sample of First Nations' adults over 19 years old was selected. Ecozones are geographic areas defined by the distribution of plants and animals and separated according to ecological features, such as oceans, deserts and mountain ranges (Chan et al., 2016b). There are 15 ecozones in Canada, however, First Nations inhabit 11 of them. This framework was chosen to reflect the fact that First Nations have relied on ecozone-dependent foods systems for thousands of years (Chan et al., 2016b).

Random sampling occurred at three main levels: the community, the household, and the individual.

1. Firstly, systemic random sampling within each region was carried out by Statistics Canada, where the number of communities selected was proportional to the square root of the number of communities in each ecozone (Chan et al., 2016b). In ecozones with a low number of First Nations, participation of at least two communities was required, whereas the maximum was four for the strata with a high number of communities. The probability of selection was also proportional to the size of communities in order to include the most populated communities. Alternate communities were randomly selected to replace communities that refused to participate or did not have enough members (fewer than 30). In some instances, no alternate communities could be found because of the large size of the original community.
2. The second stage of sampling occurred at the community level. In each community, the Nutrition Research Coordinator obtained a community list of every household and proceeded with systematic random sampling to select 125 households. If there were less than 125 households in a community, all were selected to participate. The objective was to survey 100 households from each

community, expecting a 25% non-response rate (Chan et al., 2016b).

3. Finally, at the household level, only one adult in each selected household was invited to participate in the study, so long as they were 19 years of age or older, self-identified as being a First Nations person living on-reserve, and could provide written informed consent. If more than one person met the criteria in a given household, the person whose birthday was next was invited to participate (Chan et al., 2016b). If that person refused to participate, the household was not included as nobody else could fill in the survey on their behalf.

This thesis is a secondary analysis of the FNFNES data collected in five regions: British Columbia, Ontario, Alberta, Manitoba, and the Atlantic Provinces. Pregnant and breastfeeding women and those who did not report any dietary intake on the 24hr recall were excluded from this study. The number of participants from each region is reported in the Table below.

Table IV - Number of households surveyed, participation rates, and number of participants included in this study for each region

Region	No. eligible HH[1] contacted	Refusals	Accepted but no survey	No. incomplete records	No. HHs participated (complete records)	HH Participation Rate	No. of participants included for this study
Alberta	869	160	68	28	609	70%	573
Atlantic Provinces	1139	64	33	18	1025	90%	991
British Columbia	1624	298	161	64	1103	68%	1059
Manitoba	865	110	41	8	706	82%	681
Ontario	1809	290	55	37	1429	79%	1387
Total	**6306**	**922**	**358**	**155**	**4872**	**77%**	**4691**

[1]HH: Households

3 Ethics and Confidentiality

FNFNES was guided by the highest standards of research ethics, following the principles of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, with particular attention to Chapter 9, which relates to Research involving the First Nations, Inuit and Metis Peoples of Canada (*Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*, 2010). FNFNES also respected the First Nations data-related principles of Ownership, Control, Access and Possession (OCAP). In accordance with such guidelines, the Assembly of First Nations (AFN) was an equal partner in the study and was involved in all aspects of the study design, methodology workshops, communication materials, contact with participating communities, and dissemination of results. Furthermore, FNFNES recognized the value of capacity development and made great efforts to include and support First Nations in the research process at all stages, including data collection, analysis, and dissemination (FNFNES, 2010). Every spring, representatives from each randomly selected community were invited to participate in a one to two-day methodology workshop. This provided an opportunity to refine the survey questions and to ensure that all appropriate traditional foods available in the region were included on the traditional food frequency questionnaire. It also provided a space for the principle investigators to go over all aspects of the study, prior to signing the community research agreement with Chief and Council.

In keeping consistent with a participatory approach to research, community members were hired and trained to work on the project. Furthermore, all original data, as well as community and regional reports were first returned to the communities for revision and approval prior to publication (Batal et al., 2017). A data training workshop was also provided in each AFN region to selected community representatives at follow-up, during which raw data files were returned to the community, as participating First Nations are the owners of all data resources collected from their community.

Finally, informed written consent was obtained from all participants prior to administering surveys. Measures for maintaining confidentiality were taken, such as assigning each participant an identification number, with a list linking the code to the participant

conserved only for the purposes of returning results to community members, such as for hair and tap water samples. This list and hard copies of surveys will be kept for 7 years following the end of the study in a double-locked filing cabinet at the University of Ottawa by Dr. Laurie Chan, one of the principle investigators of the project. The data used for this study were completely anonymous at the individual and community levels. Finally, the "Comité d'éthique de la recherche en santé (CERES)" of the University of Montreal provided ethics approval for this thesis, under the title "Pulling together for health: Food security in First Nations Communities". Renewals were approved for each year of research.

4 Data Collection

Data collection occurred between September and December of each year, to control for seasonality. Community Research Assistants (CRA) were hired, trained, and supervised by a Registered Dietitian in each community to administer the household questionnaire. Interviews were conducted in English, French, or the respective First Nation language. Household interviews took on average 45 minutes to complete (Chan et al., 2016a). The questionnaire consisted of 5 sections:

1. One-year Traditional Food Frequency questionnaire
2. Water frequency questionnaire
3. 24-hr recall
4. Social, Health and Lifestyle Questionnaire (SHLQ)
5. Food Security Questionnaire

For this thesis, only data collected from the Social, Health and Lifestyle Questionnaire (SHLQ) (APPENDIX II), which includes the food security questionnaire, and the 24-hour dietary recall, were used. The SHLQ incorporates many questions included in the Canadian Community Health Survey 2.2 (CCHS 2.2), a nation-wide representative survey conducted by Statistics Canada in 2004 to gather health-related and nutrition data on the Canadian population.

Anthropometric measurements were taken, when possible, otherwise they were reported. A SECA 803 digital scale (SECA Measuring Systems and Scales, Maryland, United States [US]) was used to measure weight, with two measurements taken for accuracy. To measure

height, participants were asked to remove their shoes and stand on an even surface against a wall. A pencil mark was made on a post-it using a right-angle protractor laying on the top of the participant's head. A tape measure was then used to measure the distance between the floor and the pencil mark. Whenever possible, BMI was calculated using measured height and weight, otherwise reported measures were recorded, to which adjustments were made. To do so, paired t-tests by gender were conducted to assess differences between measured and reported heights and weights for participants who provided both these values, for each region separately. If differences were statistically significant, a gender-specific estimate bias value was calculated for the region. This value was then added to the reported BMI of any participant who only provided reported anthropometric measurements. There were also 390 participants who had missing anthropometric values, so no BMI was calculated (Batal et al., 2017).

5 Dietary Assessment and data entry

For the 24-hour recall, a 3-stage multiple pass method was used. This consisted of an initial quick list of all foods consumed in a 24-hour period prior to the recall. The list of food and beverages was then re-examined to gather a more detailed description of each item, including information such as portion size, brand name and cooking method. Research assistants used 3-dimensional food models to more accurately estimate portions sizes. Finally, a review was done to go over the list and help participants remember any foods they might have missed throughout the day (Raper, Perloff, Ingwersen, Steinfeldt, & Anand, 2004). If participants knew details of recipes consumed, this information was recorded and the amount of each ingredient consumed was calculated.

Information from the SHLQ was entered using Epi-Info version 3.5.4 (CDC, Atlanta, Georgia, US) Batal et al. (2017). The CANDAT software (Godin London Incorporated, London, Ontario) was used to enter and analyze the 24-hour recalls, which contained data from the Canadian Nutrient File (CNF) version 2010b in combination with a food file created by the FNFNES data analyst, to calculate the nutrient composition of reported foods. The supplementary food file contained nutrient profiles of traditional recipes and new food products that had been added to the market after the CNF food file was created. Default codes, created from previous recalls, were applied consistently in cases where

reported foods were not well defined. Data was entered by graduate students at the Université de Montréal, with 10% of recalls double-verified and corrected. If recalls contained a high proportion of errors, then an additional 10% were verified. Additionally, to ensure data accuracy, a review for outliers, consisting of +/- 2 SD for energy or certain nutrients was conducted (Batal et al., 2017).

6 Variables

6.1 Household food security status

The 18-item Household food security survey module (HFSSM), as proposed by Health Canada and described in chapter 2 section 5.2.2, was used to measure food security (APPENDIX II). Participants were classified into one of the three categories of food security (food secure, moderately food insecure, severely food insecure) based on the number of affirmative responses ("yes", "often true", "sometimes true"). A general prevalence of marginal food insecurity was also included. As discussed in chapter 2 section 5.2.2, Tarasuk and colleagues from PROOF have proposed measuring marginal food insecurity, since even household with a single affirmative response have been shown to be at increased vulnerability (Power, 2016). However, it was considered beneficial to maintain the same metric as Statistics Canada for more in-depth analysis to be able to compare our results with rates from the rest of the country. Including the marginal food insecurity category would inflate rates of food insecurity, making results difficult to compare with most of the literature (Power et al., 2016). It would also result in grouping together people who report some worry about not having enough food with those who may not eat for an entire day because of a lack of money to buy food – these are quite different experiences. For these reasons, food security was generally collapsed into a dichotomous variable: food secure and food insecure (moderate and severe) as the outcome variable for most analyses.

6.2 Socio-demographic correlates

Individual and household level variables were explored as correlates of food insecurity and diet quality in Table IV. It is important to note that many of these are individual characteristics, even though food security is measured at the household level (Guo et al., 2015).

Table V - Individual and household level variables explored as correlates of food insecurity and diet quality among First Nations adults

Variable	Description	Type
Individual- level variables		
Sex	Female; Male	Categorical/ Dichotomous
Age group	19-30; 31-50; 51-70; 71+	Categorical
Region	British Columbia (BC); Alberta (AB); Manitoba (MB); Ontario (ON); Atlantic provinces (AT)	Categorical
Income Source	Wages; Pensions; Social assistance; Employment insurance/Workers' compensation; Other	Categorical
Years Education	Number of years of education of participant. High (≥11 years) Low (< 11 years)	Continuous Categorical
Traditional Food Consumer	The respondent reported at least 1 traditional food in their 24-hour recall: yes or no	Categorical/ Dichotomous
BMI category	Underweight: <18.5 kg/m^2 Normal 18.5 - <25 kg/ m^2 Overweight: ≥25 - <30 kg/m^2 Obese: ≥30·0 kg/m^2	Categorical
Smoker	Respondent reported whether they smoked day prior to interview: Yes / no	Categorical/ Dichotomous
Household-level variables		
Presence of children in the house	Respondent reported there was at least one child (<15 years old) in the household: yes/ no	Categorical/ Dichotomous
Household traditional food activity[1]	Participant reported that they or any member of their household participated in any traditional food activity: yes / no	Categorical/ Dichotomous
Household size	Number of people living in the household Small (<3 members) Large (≥3 members)	Continuous Categorical/ Dichotomous
Employment	Respondent reported at least one person living in household had full-time or part-time work: yes/ no	Categorical/ Dichotomous

[1]Responses to questions 5 and 6 of the SHLQ: "*During the past year, did you or anyone else in your household, hunt or set snares for food? Fish? Collect wild plant food? Collect seafood? Plant a garden?"*

6.3 Measures of Diet Quality

Two main indices were used to evaluate the quality of the diet: a Canadian Healthy Eating Index and the Nova classification system.

6.3.1 The Healthy Eating Index –Canada

As discussed in chapter II, section 4.2, many HEIs have been developed and adapted over the years. Based on a thorough review of the literature, the version proposed by Garriguet (2009) from Statistics Canada was found to be the most appropriate one for this study (Chard, 2010; Dubois et al., 2000). To conduct diet quality analyses, all foods reported in 24-hour recalls (n=2954) were initially classified into the respective HEI food groups: total fruits and vegetables, whole fruits, dark green and orange vegetables, total grains, whole grains, dairy products, meat and alternatives, other foods. Decisions on which foods to include in the "other foods" group were made based on the existing literature, as well as by consulting with nutrition professionals and researchers. Mostly, the rational followed was that foods not classified into any of the four main food groups were considered as "other foods" (Health Canada, 2011). This included fats and oils, foods that are mostly made of sugar (jams, honey, syrup, etc.), foods high in fat and/or salt (chips, packaged snacks, ice cream, high-fat dairy, etc.), beverages (coffee, tea, soft drinks, sports drinks, juices and drinks, except for 100% juice), condiments (Chard, 2010; Guarriguet, 2007). A conservative approach was taken, meaning that certain mixed foods, such as granola bars, were considered "other foods", despite containing grain products, to account for their high-sugar content. This is consistent with Health Canada's recommendation to avoid foods made up of mostly sugar, fat, and/or salt: "Baked goods such as cakes, croissants, doughnuts, pastries, pies and most cookies and muffins will add extra calories, fat, sugar or salt (sodium) to the diet and should be limited. These foods are typically low in fibre and are not usually made with whole grains" (Chard, 2010; Health Canada, 2011). A CFG serving size was assigned to each food to be able to calculate the number of food servings consumed by each participant. Reference serving sizes assigned (in grams) followed data from *Food Habits of Canadians* (Starkey, Johnson-Down, & Gray-Donald, 2001), as well as CFG serving references from the CANDAT software (Godin London Incorporated, London, Ontario), which used nutrient values from the Canadian Nutrient File (CNF) version 2010b. Mixed dishes were disaggregated into the food groups they contained and were allotted a serving of each one. A

reference of serving sizes by weight for mixed food had already been adopted by the FNFNES data analyst and was adapted from a predetermined framework established by researchers from previous studies (APPENDIX IV). For example, pasta with tomato sauce would be classified as grains and vegetables, where a serving size is 150g, including 2 servings of grain products and 1 of vegetables.

A SAS program (APPENDIX V) was developed to calculate HEI scores for each participant, according to their age and sex, following the scoring criteria presented in table V below. Each participant was assigned a total HEI score, as well as individual component scores. Only one 24-hour recall was available for each participant to calculate HEI scores.

Table VI - Components and scoring of the Canadian Healthy Eating Index

Components	Maximum points	Criteria for maximum score, by sex and age				Criteria for minimum score
Adequacy	**60**	Female 19-50	Male 19-50	Female 51+	Male 51+	
Total fruits and vegetables	10	7	8	7	7	0 servings
Whole fruits	5	1.5	2	1.5	1.5	0 servings
Dark green and orange vegetables	5	1.5	2	1.5	1.5	0 servings
Total grain products	5	6	8	6	7	0 servings
Whole grains	5	3	4	3	3.5	0 servings
Milk and alternatives	10	2	3	2	3	0 servings
Meat and alternatives	10	2	3	2	3	0 servings
Unsaturated fats	10	30 g	45g	30 g	45 g	0 grams
Moderation	**40**					
Saturated fats	10	7% of kcal				≥ 15% of kcal
Sodium	10	≤1500 mg				≥ 4600 mg
Other foods	20	≤5% of kcal				≥ 40% of kcal

Adapted from: (Garriguet, 2009).

6.3.2 NOVA

For this study, a list of all foods and drinks reported in 24-hour recalls which had already been sorted into NOVA groups and subgroups was reviewed, while foods that had not been classified were coded, following the same grouping used by Batal and colleagues (2017) (APPENDIX VI). The subgroups differed slightly from other lists found in the current literature, as they included food subgroups specifically for traditional foods, such as traditional meats, berries, and

grain products. The mean estimates and standard errors for caloric contribution (percentage of calories) were calculated for each NOVA group and subgroup to first describe the diet quality of the sample, and then to investigate any potential differences in dietary patterns, particularly regarding UPFs, between food security groups.

6.4 Missing Data

Participants were dropped from the food security analyses if they either refused to answer the questionnaire, or answered "Don't know/refused" to any of the first 3 questions on the Household Food Security Survey Module (HFSSM). It was important to exclude these participants from food security analyses to prevent under-estimating the food insecurity situation, as these participants' household would have been classified as "food secure". Additionally, the initial survey conducted in British Columbia, which was the first region where data collection occurred, did not include a question pertaining to highest level of education achieved: "*Have you obtained the following diplomas, certificates, or degrees?"* (SHLQ Question 4b). Due to high missing data for the educational categories (n=299), this question was not included in analysis, instead, years of education was used as a measure of education, which had much less missing data (n=87). When a categorical variable was preferred, years of education was collapsed into two categories: high and low level of education, using the median years of education (11) to separate the sample accordingly. There were also 390 surveys with missing BMI data who were excluded from BMI analysis.

6.5 Statistical analysis

All statistical analyses were performed using SAS version 9.4 (SAS Institute). Pooled analyses for data from BC, AB, MN, ON, and AT were performed. Nonparametric descriptive statistics of socio-demographic characteristics were analyzed, including distribution of the sample across region, sex, and BMI groups. The overall food insecurity status prevalence estimates were calculated, at all three levels of food insecurity (marginal, moderate, and severe). Next, gender-specific prevalence rates of socio-demographic variables were determined to obtain a portrait of the sample, using the frequency procedure in SAS for categorical variables and the proc means procedure for continuous variables. At the household level region, income source, household size, employment, household traditional food activity, presence of children in the household,

and food security status were measured. At the individual-level, the following variables were included: age group, years of education, traditional food consumption, BMI category and obesity class, smoking, and physical activity.

6.5.3 Predictors of food insecurity

6.5.3.1 Bivariate analysis

First, correlates of food security status were analyzed. Variables included were selected based on an extensive review of the literature on food security (Domingo, 2016; Guo et al., 2015; Huet et al., 2012; Li, Dachner, & Tarasuk, 2016; McIntyre, Pow, & Emery, 2015; Tarasuk et al., 2016). Pearson's chi-squared (χ^2) tests of independence were done to calculate if there are differences in prevalence rates for categorical variables between food secure and food insecure households (moderate and severe food insecure combined). The categorical variables assessed were sex, region, age group, traditional food consumption, Social assistance, household traditional food activity, employment, children under 15 years old in the household. Two-sample independent *t*-tests were used to test whether the mean of the continuous predictor variables (household size and mean years of education) were different across Household FS categories.

6.5.3.2 Multivariate Analysis

Next, a multivariate logistic regression analysis, using the proc logistic with a backward elimination selection method in SAS, was performed to determine the most significant correlates of food insecurity, with food security status as the response variable and socio-demographic and household variables as independent variables: sex, region, age group, traditional food consumption, social assistance, household traditional food activity, employment, children under 15 years old in the household. The two continuous variables, household size and years of education, were dichotomized into categorical values by splitting the sample across their median and assigning categories so that years of education would be split into high/low and household size into large/small categories. The backward elimination selection method starts with the full model and eliminates non-significant predictor variables, one at a time, using a default alpha of 0.05 (Guo et al., 2015).Variables that remained significant were retained in the model and their Odd's Ratio's and 95% CL reported.

6.5.4 Predictors of diet quality

6.5.4.1 Bivariate analysis

First, the percentage distribution of index score categories ("good", "needs improvement", and "poor") for the overall sample was calculated. The normality of mean HEI scores across the sample was assessed and found to be approximately normally distributed. One-way ANOVAs and Student t-tests were carried out to compare mean differences in total HEI scores for various socio-demographic variables. The variables included: region, age group, social assistance, household traditional food activity, employment, food security status, traditional food consumption, presence of children in the household, household size, and educational level. Since a one-way ANOVA does not indicate which specific groups differ from one another, post-hoc tests, using the Least-squared means (LS means) method, were conducted with the variables that were found to be significant to determine significant differences ($\alpha \leq 0.05$) between each level of the variable. Finally, the Bonferonni correction was applied to adjust for multiplicity of test by dividing the alpha by the number of comparisons in each procedure in stratified analysis. The alpha of 0.05 was thus divided by 10 for the socio-demographic variables assessed ($p \leq 0.05/10$ $p \leq 0.005$).

6.5.4.2 Multivariate Regression

All independent categorical variables (region, age group, social assistance, household traditional food activity, employment, food security status, traditional food consumption, presence of children <15 years old in the household, Household size, and Education) were added into a factorial ANOVA, using proc GLM in SAS, with the mean HEI score as the response variable in the model statement. The purpose was to assess which variables were independently associated with mean HEI score. Final variables that were maintained in the model had a significance level of ≤ 0.05.

6.5.5 Association between food insecurity and diet quality

A Pearson's chi-squared (χ^2) tests of independence was conducted to test whether there were differences in the prevalence in each HEI category between the food secure and food insecure groups, for both men and women. Next, ANOVA tests were conducted to determine statistical significances in mean diet quality indicators (HEI component scores, and NOVA groups and

subgroups) between respondents from FS and FI households, using proc GLM in SAS. Three models were built: 1) Unadjusted; 2) Adjusted for age group, gender, region; 3) Adjusted for age group, gender, region, years of education, household size, income, household traditional food activity, traditional food intake (as per 24-hour recall). The Bonferonni correction was applied to adjust for multiplicity of test by dividing the alpha by the number of comparisons in each procedure.

7 Contribution of this study to FNFNES

The present study is a secondary data analysis of a large-scale study for which many research projects have already been done. It is therefore important to situate the present study within the existing body of work. To date, many academic theses have been produced by students at the Université de Montréal, the University of British Columbia and the University of Ottawa. Of these, several have also looked at the relationship between food insecurity and diet quality using data from different provinces. For one, Eid (2011) looked at the association between food insecurity and dietary quality for First Nations living on-reserve in British-Columbia. However, diet quality was assessed by comparing nutrient intakes between food security categories (Eid, 2011). Similar work was done by Decelles (2014) using data from Manitoba. The limitation of these studies is that they focused on individual nutrients, rather than looking at global diet quality. They found small differences across food security categories for only a few nutrients of interest. Mirindi (2013) explored the nexus between food insecurity, diet quality and obesity in his PhD dissertation. His work focused on three aspects: i) the relationship between diet quality and the risk of excess weight; ii) the link between household food insecurity and diet quality; iii) how diet quality and food insecurity might lead to excess weight (Mirindi, 2013). Mirindi used several indicators to assess diet quality, including a Canadian version of the Healthy Eating Index (HEI). He found that household food insecurity was associated with diet quality through saturated fatty acids. However, despite his comprehensive approach, he only analysed data from British Columbia, which limited the generalisability of his results. Using data from 4 Canadian regions (British Columbia, Alberta, Manitoba and Ontario), Domingo (2016) explored the relationship between food insecurity and obesity. She found that obesity was higher for people from marginally food insecure households than those from food secure households. Whereas,

individuals from severely food insecure households had a lower odds of obesity compared to food secure households. These findings highlighted a need to better understand the relationship between food insecurity and obesity. And so, the present study sought to explore whether food insecurity might be associated with obesity through its impact on diet quality. Finally, this study also builds on the recent work by Batal et al. (2017), which looked at the share of ultra-processed foods in the diet of First Nations living in British Columbia, Alberta, Manitoba and Ontario. Batal et al. (2017) used the NOVA food processing classification as a way of assessing of overall diet quality of First Nations peoples from this sample. They found that First Nations adults consumed a great proportion of their caloric intake as ultra-processed foods (UPF) and that the fraction of the diet made up of UPF had a poorer nutritional value. Their work showed the value of using NOVA as a diet quality indicator for this population and a need to better identify socio-demographic factors that contribute to the consumption of a greater amount of UPF. Therefore, this was one of the indicators used to assess the relationship between food insecurity and diet quality in the present study.

While I wasn't involved in the data collected in BC, MB, ON and AB, I had the opportunity to be part of the research team and supervise data collection in two communities of the Quebec-Labrador AFN region in the fall of 2016. This gave me a stronger appreciation and a more intimate understanding of the collected data as the same questionnaire was used across the regions. The research questions posited in the present work have been developed by myself under the guidance of my thesis supervisor, Malek Batal. All analyses performed for this work were independent of any analysis carried out by the rest of the team

Chapter V - Results

1 Descriptive Analysis

In the 5 regions included in this study, a total of 4872 respondents in 69 communities participated, giving a participation rate of 77%. The final sample size included in this study was 4691 individuals after excluding pregnant and breastfeeding women (n=171), and those who did not report any dietary intake on the 24hr recall (n=10).

The regional distribution of the sample was as follows: 22.6% from British Columbia, 12.2% from Alberta, 14.5% from Manitoba, 29.6% from Ontario, and 21.1% from the Atlantic region. There were more females (63.1%) sampled than males (36.9%). Most participants fell within the 31 to 50 years of age category (46.8%), while 18.8% were 19-30 years old, 28.9% were between 51 and 70 years old, and only 5.5% were older than 71. Socio-demographic and health variables assessed by gender are presented in table VI below.

Table VII - Socio-economic characteristics by gender for First Nations adults living on-reserve in 5 Canadian regions

Variables	Female N= 2961 % (n)	Male N= 1730 % (n)	Total N=4691 % (n)
Household characteristics			
Region	63.1 (2961)	36.9 (1730)	100 (4691)
British Columbia	22.4 (662)	23 (397)	22.5 (1059)
Alberta	11.9 (351)	12.8 (222)	12.2 (573)
Manitoba	15.3 (452)	13.2 (229)	14.5 (681)
Ontario	29 (856)	30.7 (531)	29.6 (387)
Atlantic provinces	21.6 (640)	20.3 (351)	21.2 (991)
Income source	63.2 (2932)	36.8 (1710)	100 (4642)
Wages	51.2 (1501)	48.7 (832)	50.2 (2333)
Pension	12.8 (374)	12.4 (212)	12.6 (586)
Social Assistance	27.5 (805)	29.2 (500)	28.1 (1305)
Employment Insurance/ Worker's Compensation	6.3 (184)	8.1 (139)	7 (323)
Other[1]	2.3 (68)	1.6 (27)	2.1 (95)
Mean Household Size± SE[2]	3.8± 2.2	3.2± 2.2	3.6± 2.2

Variables	Female N= 2961 % (n)	Male N= 1730 % (n)	Total N=4691 % (n)
Employment[3]	63.2 (2952)	36.8 (1721)	100 (4673)
Anyone in HH working Full-time or Part-time	65.5 (1934)	62.5 (1075)	65.4 (3009)
No	34.5 (1018)	37.5 (646)	35.6 (1664)
HH TF[4] **Activity**	63.1 (2961)	36.9 (1730)	100 (4691)
Yes	63.4 (1876)	71 (1229)	66.2 (3105)
No	36.6 (1085)	29 (501)	33.8 (1586)
Children in household[5]	63.1 (2960)	36.9(1730)	100 (4690)
Yes	56.6 (1674)	38.6 (667 ()	49.9 (2341)
No	43.5 (1286)	61.5 (1063)	50.1 (2349)
Food Security Status	63.4 (2862)	36.6 (1654)	100 (4516)
Food Secure	63.1 (1806)	66.4 (1098)	64.3 (2904)
Moderately Food Insecure	27.7 (793)	24.4 (404)	26.5 (1197)
Severely Food Insecure	9.2 (263)	9.2 (152)	9.2 (415)
Individual Characteristics			
Age group	63.1 (2945)	36.9 (1721)	100 (4666)
19-30	18.7 (551)	19.1 (328)	18.8 (879)
31-50	48.3 (1421)	44.4 (764)	46.8 (2185)
51-70	27.6 (814)	31 (533)	28.9 (1347)
71+	5.4 (159)	5.6 (96)	5.5 (255)
Mean Years of Education ± SE[2]	11.1 ±3.3	10.5 ± 3.1	10.9 ± 3.3
TF consumption	63.1 (2961)	36.9 (1730)	100 (4691)
Yes	18 (533)	21.5 (372)	19.3 (905)
No	82 (2428)	78.5 (1358)	80.7 (3786)
BMI category	61.5 (2646)	38.5 (1655)	100 (4301)
Underweight (<18.5 kg/m^2)	1 (27)	0.9 (14)	1 (41)
Normal Weight (18.5-<25 kg/m^2)	19 (501)	19.8 (327)	19.3 (828)
Overweight (25 – <30 kg/m^2)	30.8 (815)	37 (613)	33.2 (1428)
Obese (>30 kg/m^2)	49.2 (1303)	42.4 (701)	46.6 (2004)
Class 1 (30 – <35 kg/m^2)	52 (677)	60.3 (423)	54.9 (1100)
Class 2 (35 - <40 kg/m^2)	30.2 (394)	27.3 (191)	29.2 (585)
Class 3 (≥ 40 kg/m^2)	17.8 (232)	12.4 (87)	15.9 (319)
Smoking[6]	63.1 (2960)	36.9 (1729)	100 (4689)
Yes	52.8 (1564)	51 (881)	52.1 (2445)
No	47.2 (1396)	49.1 (848)	47.9 (2244)
Physical Activity[7]	63.1 (2952)	36.9 (1724)	100 (4676)
Sedentary	22.6 (667)	15.8 (273)	20.1(940)
Somewhat Active	46 (1358)	36.9 (636)	42.6 (1994)
Moderately Active	25.9 (763)	26.4 (455)	26.1 (1218)

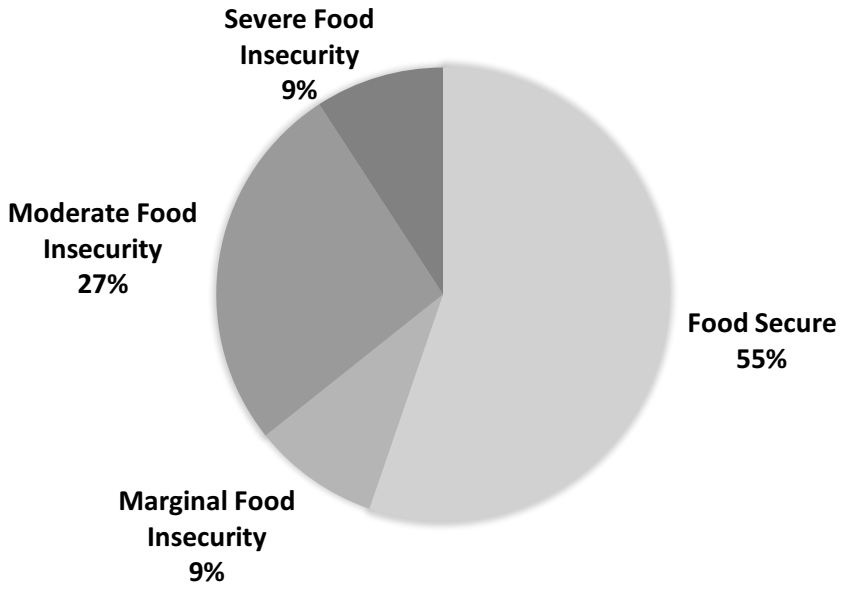
Variables	Female N= 2961 % (n)	Male N= 1730 % (n)	Total N=4691 % (n)
Highly Active	5.6 (164)	20.9 (360)	11.2 (524)

[1]Other income category includes: None, savings/trust fund, support from parent or spouse, training/school allowance; [2] SE; [3]Anyone in the household working either full-time or part-time in the month of the survey;
[4] Traditional Food. [5]Presence of children in the house includes all children < 15 years old; [6] Respondents reported smoking on the day prior of survey; [7]Physical activity includes only self-reported activity from SHLQ question 12.

The total prevalence of overweight in the sample was 33%, and obesity was 47%, adding to a total of 80% of the population that fell within either category. Obese individuals were further classified into 3 obesity levels: class 1 (55%), class 2 (29%), and class 3 (16%).

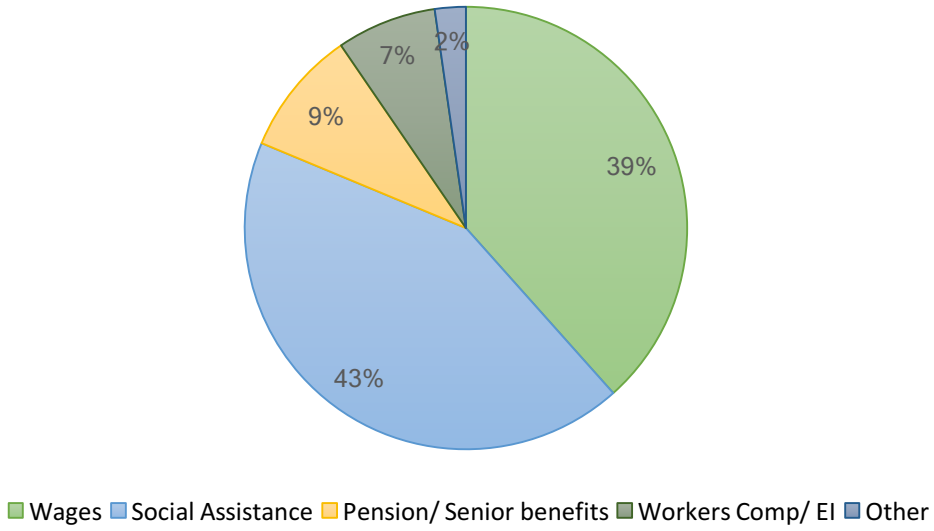
The food security status of the sample was distributed as follows: 64% households were found to be food secure, 27% moderately food insecure, and 9% were severely food insecure. The total food insecurity prevalence was therefore 36% when using Health Canada's HFSSM classification (Health Canada, 2007). In gender-stratified analysis, food security rates were slightly higher for men (66.4%) than women (63.1%), where women having a slightly higher prevalence of moderate food insecurity (27.7%) than men (24.4%), but had the same rate of severe food insecurity (9.2%). When marginal food insecurity was considered, 55% of the population was classified as food secure, bringing the total food insecurity prevalence up to 45% (Figure 5).

Figure 4. Household food security prevalence rates, including marginal food insecurity, for First Nations Living On-Reserve in 5 Canadian Regions (n=4,516)



Income source has been closely related to food insecurity status. Figure 6 shows the prevalence of food insecurity (moderate and severe) by mains sources of income. The greatest proportion of food insecure households receive social assistance (43%), following by earning wages (39%), pension and senior benefits (9%), and worker's compensation (7%).

Figure 5. Percentage of food insecure households by main household source of income for First Nations adults living in BC, AB, MN, ON and AT (2008-2014) (n=4642)



1.1 Missing data

There was some missing data for the food security questionnaire (n=175), but this represented a very small percentage of the total sample (3.7%). Of these, 57% were women, similar to the proportion of women in the overall sample (63%). The age distribution of participants with missing FS data was similar to the overall sample, with the exception of those 71 years or older, who were over-represented among those with missing FS data. This age group made up 13% of those with missing FS data, but only represented 6% of participants in the total sample. There were also some differences in regional representation, where 34% of participants with missing FS data were from Manitoba, compared to 15% of participants in the total sample. Fewer people from the Atlantic provinces had missing FS data (6%) than in the total sample (21%). A greater

proportion of people receiving social assistance (43%) refused to answer the first 3 questions of the HFSSM than the proportion in the total sample (28%). Receiving social assistance may make people more likely to refuse to answer such a sensitive questionnaire honestly. On the other hand, people receiving wages were less likely to refuse to answer (35% of people with missing data received wages versus 50% of the total sample). The profile of participants with missing data differed slightly from that of the sample, which could result in a bias of the results. However, due to the very small amount of missing data and the large sample size, it is assumed that the impact on results would be negligible.

Predictors of Food Security

Results from bivariate analyses are presented below, illustrating differences in socio-demographic variable distribution across food security status. Significant differences were observed for all variables assessed, except for household traditional food activity. Households receiving social assistance, as well as those with children, those with a greater number of members, and those in which nobody was employed had greater prevalence of food insecurity ($p<0.0001$). Region and age group were also significantly associated with food security status ($p<0.0001$), as well as gender ($p<0.005$). Having an active hunter in the household did not seem to affect food insecurity status in bivariate analyses.

Table VIII - Prevalence and bivariate analysis of correlates of food insecurity

Predictor	Sample size	Food Secure (%)	Food insecure (%)
Sex	4516		
Female	2862	1806 (63.1)	1056 (36.9)$^{\pm}$
Male	1654	1098 (66.4)	556 (33.6)
Age group	4495		
19-30	843	516 (61.2)	327 (38.8) *
31-50	2103	1280 (60.9)	823 (39.1)
51-70	1307	911 (69.7)	396 (30.3)
71+	242	186 (76.9)	56 (23.1)
Region	4516		
AB[1]	558	331 (59.3)	227 (40.7)*
AT[2]	980	658 (67.1)	322 (32.9)
BC[3]	1021	641 (62.8)	380 (37.2)
MB[4]	622	370 (59.5)	252 (40.5)
ON[5]	1335	904 (67.7)	431 (32.3)

Predictor	Sample size	Food Secure (%)	Food insecure (%)
Household size (mean ± SD[6])	4515	3.4 ± 2.1	3.8 ± 2.4*
Big (≥3 people)	2758	1694 (61.4)	1064 (38.6) *
Small (< 3 people)	1758	1210 (68.8)	548 (31.2)
Children in household (<15 years)	4515		
Yes	2232	1332 (59.7)	900 (40.3) *
No	2283	1571 (68.8)	712 (31.2)
TF[7] consumption	4516		
Yes	865	521 (60.2)	344 (39.8) *
No	3651	2383 (65.3)	1268 (34.7)
Years Education (mean ± SD)	4439	11.2 ± 3.3	10.5± 3*
Low (<11 years)	1943	1131 (58.2)	812 (41.8) *
High (≥11 years)	2573	1773 (68.9)	800 (31.1)
Social Assistance	4516		
Yes	1229	547 (44.5)	682 (55.5) *
No	3287	2357 (71.7)	930 (28.3)
Household TF Activity	4516		
Yes	3004	1908 (63.5)	1096 (36.5)
No	1512	996 (65.9)	516 (34.1)
Employment	4500		
Anyone in HH[8] with FT[9] or PT[10] work	2911	2027 (69.6)	884 (30.4) *
No work	1589	868 (54.6)	721 (45.4)

*P<0.0001 for differences within the same group (Two-sample independent *t*-tests and Pearson's chi-squared (χ^2) tests of independence); ±P<0.005 for differences within the same group (Two-sample independent *t*-tests and Pearson's chi-squared (χ^2) tests of independence). [1] Alberta.[2] Atlantic region. [3]British Columbia. [4]Manitoba. [5]Ontario. [6]Standard Deviation. [7]Traditional Food. [8]Household. [9]Full-time. [10]Part-time

For the Multivariate logistic regression with food security status as its response variable, the following variables were retained in the model: sex, age group, income source, the presence of children in the household, household traditional food activity, and educational level. Region, income, and household size were removed from the model. Females were found to report household food security more than males. There appeared to be a relationship between age group and reporting of food insecurity, with younger adults (19-50) more likely to report FI compared to elderly adults (71+). Compared to people earning wages, those on social assistance reported household food insecurity to the greatest extent, followed by those receiving worker's compensation/ EI and those with "other" income sources. Households that reported having any household TF activity were more likely to report food insecurity in the multivariate logistic

regression. Those who were considered to have "low" education (<11 years) were also more likely to report food insecurity compared to those with a higher level of education.

Table IX - Multivariate logistic regression results of food insecurity correlations

Correlate	OR[1] Estimate	95% Confidence Limits		P-value
Sex				
Male	Ref			
Female	1.16	1.008	1.327	0.0392
Age group				
71+	Ref			
19-30	1.52	1	2.327	0.0518
31-50	1.81	1.214	2.721	0.0039
51-70	1.30	0.895	1.891	0.1743
Income Source				
Wages/salary/self-employment	Ref			
Other	1.70	1.087	2.62	0.0181
Pension/Senior benefits	1.28	0.97	1.688	0.0777
Social Assistance	3.30	2.829	3.854	<.0001
Workers comp/EI	1.62	1.253	2.073	0.0002
Presence of children in the household (<15 years)				
No	**Ref**			
Yes	1.30	1.127	1.496	0.0003
HH[2] TF[3] activity				
No	Ref			
Yes	1.26	1.090	1.447	0.0016
Education				
High (≥11 years)	Ref			
Low (<11 years)	1.47	1.281	1.684	<0.0001

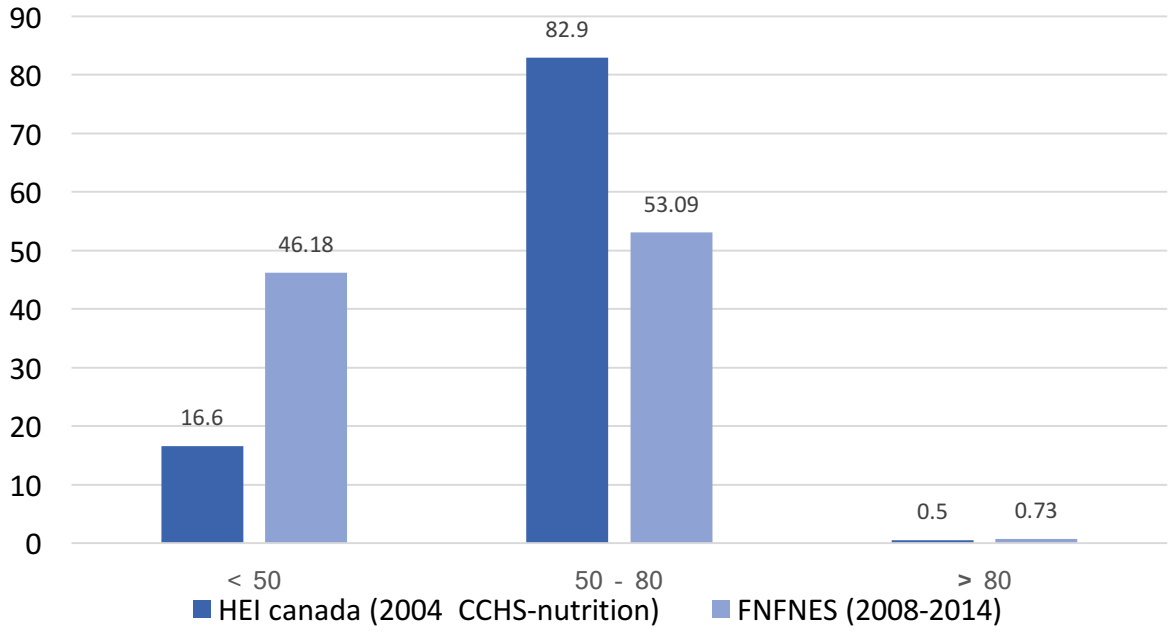
All variables included in the model sex, age group, income source, the presence of children in the household, household traditional food activity, educational level, region, income, and household size. (n = 4445). [1]Odd's ratio. [2]Household. [3]Traditional Food.

2 Diet Quality

An overall distribution of how the sample falls into the respective HEI score categories is presented in Figure 7. This shows that the majority (53.1%) of the respondents had 24-hr recalls that fell into the "needs improvement" category, while 46.2% had scores in the "poor" category,

and less than 1% in the "good" category. HEI results from the general Canadian population (also presented in figure 7) reveal a much larger proportion of the population falling into the "needs improvement" category, rather than the "poor" category. Overall, few Canadians had mean scores over 80 points on the HEI. However, caution must be applied in comparing the two, since the CCHS 2004 results include people aged 2 years and up, while our data only includes adults 19 years and older.

Figure 6. Percentage distribution of HEI score categories for the general Canadian population aged 2 or older (2004 Canadian Community Health Survey – Nutrition) and First Nation adults living on-reserve in 5 Canadian regions (2008-2014)



With data from (Garriguet, 2009)

The overall mean ± SE score for the sample was 49.0 ± 12.65 out of 100, with scores ranging between 10.1 and 88.2. The mean HEI score of the upper quartile was 57.9 points and only 0.64% were considered to have good diet quality. Table IX presents the mean HEI scores (SE) for different subgroups. After applying the Bonferroni correction for multiplicity of analysis, the following variables were found to be significantly associated with mean HEI scores ($p<0.0001$): sex, region, age group, receiving social assistance, household food security status, and traditional food consumption. Having a large household size and the presence of any children in the household were significantly associated with lower mean HEI scores, but only

for women. Food insecurity was associated with lower mean HEI scores for women and the total sample. Overall, females had higher mean scores than men. Scores were found to improve significantly with older age groups, though no differences were observed between the 51-70 and the ≥71 groups. Statistical significances were observed across regions, but did not follow any pattern. The highest means score was found in Ontario (50.9 ± 0.34) and the lowest in Manitoba (46.9 ± 0.48). Those receiving social assistance have significantly lower HEI scores (46.8 ± 0.36) than any other income source (49.9 ± 0.21) ($p<0.0001$). Employment and education level did not appear to show associations with total diet quality.

Table X - Healthy Eating Index mean (SE) scores by socio-demographic variables

		Female		Male		Total	
		N	**HEI mean1(SE2)**	**N**	**HEI mean(SE)**	**N**	**HEI mean(SE)**
Sex		2961	49.8 (0.23)	1730	47.7 (0.30)	-	-
	$p^{\times}$				<0.0001**		
Region	BC	662	50.0 (0.49)[ab]	397	47.4 [ab] (0.63)	1059	49.0 (0.39)[a]
	AB	351	50.4 (0.67)[ab]	222	47.3 (0.84) [ab]	573	49.2(0.53)[ab]
	MB	452	47.6 (0.59)[c]	229	45.4 [b] (0.83)	681	46.9 (0.48)[c]
	ON	856	51.4 (0.43) [a]	531	50.0 (0.54) [a]	1387	50.9 (0.34)[b]
	AT	640	48.8 (0.50) [bc]	351	46.4 (0.67) [b]	991	47.9 (0.4) [ac]
	$p^{\times}$		<0.0001**		<0.0001**		<0.0001**
Age group	19-30	551	46.3(0.53) [a]	328	45.2 (0.68)[a]	879	45.9 (0.42) [a]
	31-50	1421	49.3 (0.33) [b]	764	46.1 (0.45) [a]	2185	48.2 (0.27)[b]
	51-70	814	52.3 (0.43)[c]	533	51.2 (0.53) [b]	1347	51.8 (0.34)[c]
	71+	159	54.3 (0.98)[c]	96	51.2 (1.26) [b]	255	53.2 (0.78)[c]
	$p^{\times}$		<0.0001**		<0.0001**		<0.0001**
Social Assistance	Yes	805	47.5 (0.46)	500	45.7 (0.56)	1305	46.8 (0.36)
	No	2156	50.7 (0.27)	1230	48.5 (0.36)	3386	49.9 (0.21)
	$p^{\times}$		<0,0001**		<0,0001**		<0.0001**
Employment[3]	FT or PT[4]	1934	49.9 (0.28)	1075	47.8 (0.38)	3009	49.1 (0.23)
	Other	1018	49.7 (0.41)	646	47.5 (0.50)	1664	48.8 (0.32)
	$p^{\times}$		0,6968		0,5931		0.4191
Food security status	Food Secure	1806	50.6 (0.30)	1098	48.2 (0.38)	2904	49.7 (0.24)
	Food Insecure	1056	48.7 (0.38)	556	46.9 (0.53)	1612	48.1 (0.31)
	$p^{\times}$		<0,0001**		0,0554		<0.0001**
HH TF activity[5]	Yes	1876	50.2 (0.29)	1229	48.1 (0.35)	3105	49.4 (0.22)
	No	1085	49.1 (0.39)	501	46.7 (0.59)	1586	48.4 (0.33)
	$p^{\times}$		0,0266		0,0302		0.0089
TF Consumption[6]	Yes	533	53.6(0.51)	372	52.8 (0.59)	905	53.3 (0.39)
	No	2428	49.0 (0.26)	1358	46.3 (0.34)	3786	48.0 (0.21)
	$p^{\times}$		<0,0001**		<0,0001**		<0,0001**
Education level	High (≥11 yrs)	1739	49.9 (0.31)	883	48.0 (0.44)	2622	49.2 (0.25)

		Female		Male		Total	
		N	HEI mean1(SE2)	N	HEI mean(SE)	N	HEI mean(SE)
	Low (<11 yrs)	1222	49.8(0.35)	710	47.5 (0.42)	2069	48.8 (0.27)
	$p^{\times}$		0.8674		0.4170		0.2975
Household size	Small	966	51.2 (0.42)	836	48.0 (0.43)	1802	49.7 (0.30)
	Large	1995	49.2 (0.28)	894	47.5 (0.43)	2889	48.6 (0.23)
	$p^{\times}$		<0.0001**		0.4345		0.0069
Children in the HH[7]	Yes	1674	49.1 (0.31)	667	47.0 (0.48)	2341	48.5 (0.26)
	No	1286	50.7 (0.35)	1063	48.1 (0.39)	2349	49.6 (0.26)
	$p^{\times}$		0.0006**		0.0785		0.0055

[1]Marginal means (Least Squares Means);[2] SE= standard error; [3]Whether any member of the household was employed at the time of the study; [4]Any member of the household had full-time (FT) or part-time(PT) work; [5] Household traditional food activity; [6]Any traditional food reported on 24-hr recall; [7]The presence of any children (>15 years old) in the household; $p^{\times}$ Student's *t*-test for social assistance, household TF activity, employment, food security status, TF consumption, education level, household size, and presence of children in the household and ANOVA analysis for differences of each group for region and age group; **Bonferonni correction: ($p \leq 0.05/10 = p \leq 0.005$ for differences within same gender group. Superscripts[abc] show post-hoc (Tukey-Kramer) significant differences ($\alpha \leq 0.05$) between groups in each row, where LS means with the same letter are not significantly different.

Regression analysis results showed that food security remained a significant predictor of diet quality (HEI mean score), even when other socio-demographic variables were considered (p=0.0029). However, results from independent associations of the mean HEI score with socio-demographic correlates (Table X) show that sex and age have an even greater impact on HEI scores, where scores were higher for women and older people. Traditional food consumption appeared to have a greater impact on diet quality than food security (β=4.78). Moreover, households not receiving social assistance, participants with a higher level of education, and those who lived in a household where somebody from the household engaged in traditional food activities had higher HEI scores.

Table XI - Independent associations of mean HEI score with socio-demographic covariates

Covariate		*β*	SE	ρ
Sex	Female	2.46	0.389	<.0001
	Male	Ref	.	.
Region	BC	-0.40	0.573	0.4798
	AB	0.86	0.665	0.1966
	MN	-1.24	0.648	0.0549
	ON	2.00	0.522	0.0001
	AT	Ref	.	.
Age group	19-30	-5.67	0.992	<.0001
	31-50	-3.89	0.922	<.0001

Covariate		β	SE	ρ
	51-70	-0.39	0.895	0.6623
	71+	Ref	.	.
Social Assistance[3]	No	1.23	0.518	0.0177
	Yes	Ref	.	.
Employment[1]	Ft or PT[2]	-0.27	0.484	0.5833
	Other	Ref	.	.
Food Security Status	Food Secure	1.98	0.666	0.0029
	Moderately Food Insecure	1.25	0.705	0.0754
	Severely Food Insecure	Ref	.	.
HH TF activity[3]	Yes	1.01	0.406	0.0127
	No	Ref	.	.
TF consumption[4]	Yes	4.78	0.492	<.0001
	No	Ref	.	.
Educational level	High (≥11 yrs)	0.97	0.399	0.0146
	Low (<11 yrs)	Ref	.	.
Household size	Small (< 3)	0.75	0.520	0.1516
	Large (≥3)	Ref	.	.
Children in household[5]	Yes	0.89	0.520	0.0858
	No	Ref	.	.

Ref.: reference; β indicates the change in HEI score per unit change of the covariates; SE: Standard Error.
[1]Whether any member of the household was employed at the time of the study; [2]Any member of the household had full-time (FT) or part-time (PT) work; [3]Household traditional food activity; [4]Any traditional food reported on 24-hr recall; [5] The presence of any children (>15 years old) in the household;

3 Food Security Status and Diet Quality

A statistically significant difference (χ^2, 2 (n=4691) = 14.2, p <0.0001) was found between the percentage distribution of index score categories between food secure and food insecure groups (Table XI). People from food insecure households were more likely to have a mean HEI score that fell into the "poor" category then the food secure group. We see that <1% of respondents in both groups fell into the "good" category, which is allotted to a score of 80 or higher.

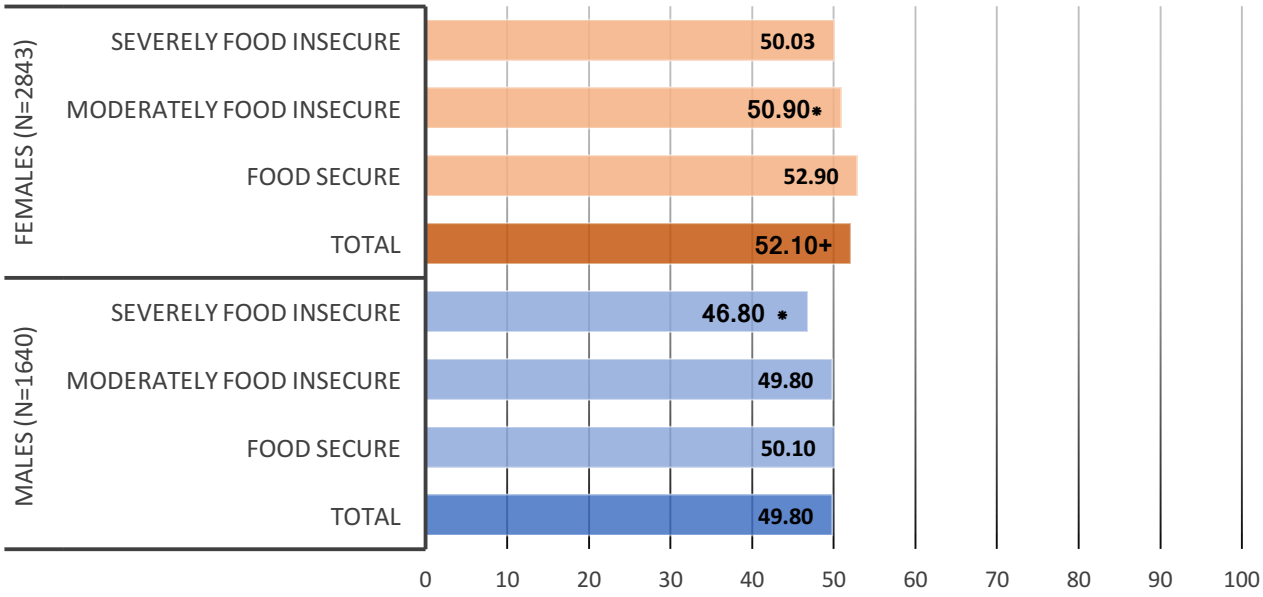
Table XII - Percentage distribution of HEI index score categories between food security levels

HEI Category	Food secure N (%)	Food Insecure N (%)
Good (> 80)	26 (0.90)	4 (0.22)*
Needs improvement (50-80)	1381 (47.56)	788 (44.10)
Poor (<50)	1497 (51.55)	995 (55.68)

Chi-Square test of independence using Ficher`s exact test. *p<0.0001. (N=4691)

Additional comparisons of HEI mean scores across food security levels for women and men show that there is a trend of decreasing mean HEI scores with increased severity of food insecurity. However, this is only statistically different between moderate FI and severe FI levels for men, and between food secure and both moderate and severe FI levels for women.

Figure 7. Mean HEI score by food security status for women and men



*Significantly different for estimate of same sex for previous food security group ($p<0.05$)
+significantly different for estimate between men and women ($p<0.001$)

A comparison of the mean HEI total and component scores between individuals from food secure and food insecure households is presented in table XII. Food secure adults had higher total HEI scores than those in food insecure households, even after adjustments were made for sociodemographic characteristics. However, after applying the Bonferonni correction for multiplicity of tests ($p\leq0.05/12= p\leq0.004$), significance was lost for many of the associations. In the unadjusted model, there were statistical differences for the total HEI score (49.7 vs. 48.09) and 4 of the HEI component scores, where FS scored higher for total vegetables and fruits (3.94

vs. 3.38), dark green and orange vegetables (0.69 vs. 0.53), whole fruits (0.95 vs. 0.72), and milk and alternatives (3.56 vs. 3.23). Significance remained after adjusting for age group, gender and region. However, after adjusting for age group, gender, region, years of education, household size, income, household TF activity, and TF intake, statistical differences only remained for the total vegetables and fruits component (p=0.0002).

Table XIII - Mean scores of Canadian Healthy Eating Index (HEI) and its components and other dietary characteristics for First Nations adults by food security status

Component (score weight)	Mean[1] HEI Scores (SE[2]) Unadjusted[3]		Mean[1] HEI Scores (SE[2]) model b[4]		Mean[1] HEI Scores (SE[2]) model c[5]	
	Food Secure	Food insecure[6]	Food secure	Food insecure	Food secure	Food insecure
HEI total score (100)	49.70 (0.235)	48.09** (0.315)	49.64 (0.294)	48.45 * (0.369)	51.34 (1.504)	50.25 * (1.515)
Total vegetables and fruits (10)	3.94 (0.060)	3.38** (0.080)	3.90 (0.076)	3.40 ** (0.095)	3.98 (0.391)	3.59 ** (0.394)
Dark green/orange vegetables (5)	0.69 (0.025)	0.53** (0.034)	0.63 (0.032)	0.50** (0.041)	0.83 (0.167)	0.75 (0.168)
Whole fruits (5)	0.95 (0.031)	0.72** (0.042)	0.91 (0.707)	0.71** (0.05)	1.01 (0.203)	0.89 * (0.205)
Total grains (5)	3.20 (0.030)	3.23 (0.040)	3.21 (0.038)	3.26 (0.047)	3.34 (0.196)	3.37 (0.197)
Whole grains (5)	1.16 (0.033)	1.05 (0.045)	1.21 (0.042)	1.184 (0.053)	1.50 (0.216)	1.50 (0.217)
Milk and alternatives (10)	3.56 (0.065)	3.23** (0.088)	3.38 (0.082)	2.97 ** (0.103)	4.02 (0.423)	3.74 * (0.426)
Meat and alternatives (10)	7.96 (0.056)	7.96 (0.075)	7.90 (0.072)	7.89 (0.090)	8.66 (0.366)	8.64 (0.369)
Unsaturated fats (10)	8.24 (0.048)	8.10 (0.064)	8.03 (0.060)	7.849 * (0.076)	8.22 (0.312)	8.12 (0.315)
Other foods (20)	8.74 (0.134)	8.33 (0.180)	9.00 (0.169)	8.86 (0.212)	8.90 (0.873)	8.57 (0.880)
Sodium (10)	5.71 (0.070)	5.78 (0.095)	5.76 (0.088)	5.90 (0.111)	5.23 (0.456)	5.32 (0.459)
Saturated fats (10)	5.57 (0.070)	5.78 (0.094)	5.69 (0.089)	5.92 * (0.112)	5.63 (0.457)	5.76 (0.461)

[1]Marginal means (Least-square means); [2] SE=Standard error; [3]n=4515; [4]Adjusted for age group, gender, region (n=4495 after adjustment); [5]Adjusted for age group, gender, region, years education, household size, income, household traditional food activity, traditional food intake (as per 24-hour recall) (n=4386 after adjustment); [6]Food Insecure Households (moderately food insecure + severely food insecure);

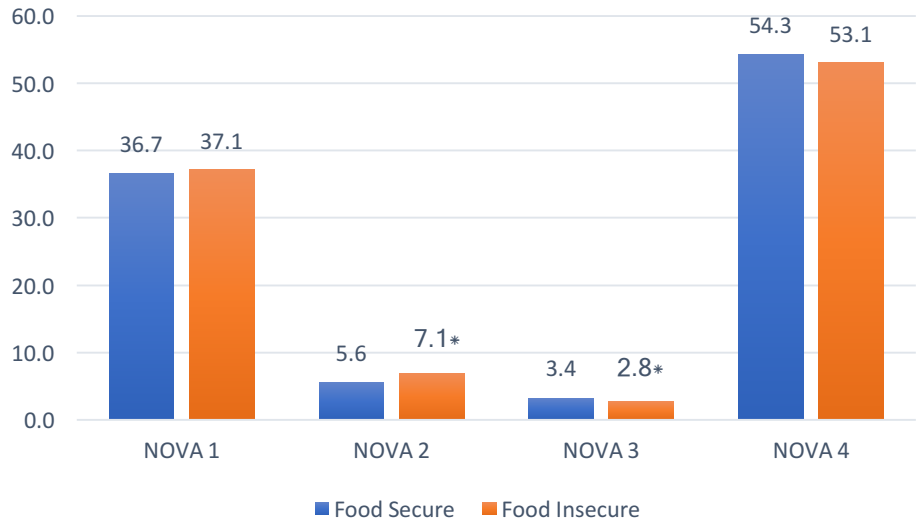
*p≤0.05 for differences between food secure and food insecure (one-way ANOVA)

** Bonferonni correction: p≤0.05/12= p≤0.004)

3.1 NOVA and food insecurity

Overall the mean caloric contribution (% kcal) of each NOVA group for the sample was as follows: 35.0 ± 23.43% from fresh or minimally processed foods (NOVA 1), 6± 8.37% from processed culinary ingredients (NOVA 2), 3.3 ± 7.31% from processed foods (NOVA 3), and 55.7 ±24.79% from ultra-processed foods (NOVA 4). Figure 8 presents the estimated mean caloric contribution of each NOVA group between from FS and FI households, adjusting for age group, sex, and region. A one-way ANOVA was conducted and revealed that those in FI households received a significantly greater proportion of calories from NOVA 2 and less from NOVA 3.

Figure 8. Mean caloric contribution of NOVA food groups according to household food security status for First Nations in Canada



*P<0.05 (One-way ANOVA), adjusting for age group, sex, and region.

The proportion of calories received from each NOVA group and subgroup was compared between FI and FS groups (Table XIII). A comprehensive list of foods that are included in each subgroup can be found in APPENDIX VI. After applying the Bonferonni correction for multiple tests, individuals from food insecure households were found to consume significantly more calories from traditional meats, eggs, sugar, and plant oils. However, they received less energy

from homemade dishes, and sweet milks. They also consumed less fast food. We also saw a difference for fruits, with people from food secure households consuming more raw fruits and raw fruit juices, but those from food insecure households consuming more fruit juices and drinks. After adjustments (model c), significant differences were only observed for homemade dishes, sugars, and plant oils. People from FI households consumed a greater proportion of their calories from processed culinary ingredients (7.1% vs. 5.6%), sugar (3.59% vs. 2.34%) and plant oils (1.40% vs. 1.03%), and less from homemade dishes (1.73% vs. 2.77%).

Table XIV - Mean caloric contribution of NOVA groups and subgroups in First Nations adults by food security status

NOVA subgroups		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Unadjusted[3]		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Model A[4]		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Model B[5]	
		Food secure	Food insecure[6]	Food secure	Food insecure[6]	Food secure	Food insecure[6]
NOVA 1 - TOTAL		**35.02 (0.434)**	**34.74 (0.582)**	**36.69 (0.538)**	**37.08 (0.675)**	**44.21 (2.717)**	**43.50 (2.737)**
1	Grains and flours-market	3.80 (0.158)	4.26 (0.213)	4.40 (0.199)	5.0* (0.249)	5.49 (1.009)	5.96 (1.17)
2	Grain products - traditional	1.37 (0.111)	1.73 (0.149)	1.91 (0.141)	2.29 (0.176)	4.15 (0.721)	4.27 (0.726)
3	Pulses	0.10 (0.033)	0.14 (0.045)	0.12 (0.043)	0.18 (0.054)	0.24 (0.214)	0.34 (0.215)
4	Meat and poultry-market	10.00 (0.258)	9.16 (0.346)	10.03 (0.330)	9.15* (0.414)	7.69 (1.690)	7.09 (1.702)
5	Meat- traditional	2.01 (0.149)	2.83** (0.200)	2.54 (0.188)	3.36** (0.236)	6.63 (0.740)	6.74 (0.746)
6	Milk and plain yogurt	2.15 (0.081)	1.84 (0.108)	2.36 (0.103)	2.20 (0.129)	1.94 (0.536)	1.82 (0.540)
7	Fruits + raw fruit juice - market	1.80 (0.079)	1.35** (0.106)	1.65 (0.101)	1.25* (0.127)	1.34 (0.526)	1.11 (0.530)
8	Fruits + raw fruit juice - traditional	0.07 (0.010)	0.05 (0.013)	0.09 (0.013)	0.07 (0.016)	0.15 (0.066)	0.13 (0.067)
9	Vegetables-market	1.04 (0.043)	0.81* (0.058)	1.02 (0.055)	0.82* (0.069)	0.92 (0.288)	0.77 (0.290)
10	Roots and tubers	2.92 (0.115)	2.83 (0.155)	3.27 (0.147)	3.35 (0.184)	3.66 (0.764)	3.53 (0.770)
11	Eggs	2.99 (0.114)	3.68** (0.154)	3.04 (0.147)	3.78** (0.184)	3.32 (0.749)	3.71 (0.754)

NOVA subgroups		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Unadjusted[3]		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Model A[4]		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Model B[5]	
		Food secure	Food insecure[6]	Food secure	Food insecure[6]	Food secure	Food insecure[6]
12	Eggs- traditional	0.01 (0.008)	0.01 (0.011)	0.01 (0.011)	0.00 (0.013)	0.03 (0.056)	0.02 (0.57)
13	Fish - market	0.19 (0.041)	0.10 (0.054)	0.18 (0.052)	0.11 (0.065)	0.17 (0.272)	0.12 (0.274)
14	Fish-traditional	0.61 (0.077)	0.85(0.103)	0.68 (0.098)	0.98* (0.123)	1.66 (0.488)	1.87 (0.491)
15	Nuts and seeds	0.29 (0.046)	0.21 (0.062)	0.28 (0.959)	0.21 (0.075)	0.17 (0.312)	0.15 (0.314)
16	Pasta	2.51 (0.143)	2.71 (0.192)	2.21 (0.184)	2.39 (0.230)	1.93 (0.950)	2.04 (0.957)
17	Homemade dishes	2.77 (0.146)	1.73** (0.196)	2.50 (0.187)	1.45** (0.234)	2.48 (0.968)	1.61** (0.974)
18	Other	0.37 (0.051)	0.43 (0.068)	0.39 (0.065)	0.45 (0.082)	2.24 (0.324)	2.22 (0.327)
NOVA 2- TOTAL		**5.53 (0.154)**	**6.96** ** **(0.208)**	**5.61 (0.198)**	**7.08** ** **(0.248)**	**6.03 (1.028)**	**7.23** ** **(1.035)**
19	Sugar	2.34 (0.099)	3.59** (0.133)	2.35 (0.127)	3.59** (0.159)	1.73 (0.654)	2.74** (0.659)
20	Plant oils	1.03 (0.067)	1.40** (0.090)	1.14 (0.085)	1.53** (0.107)	1.43 (0.442)	1.78** (0.445)
21	Animal fats - market	2.15 (0.089)	1.90 (0.120)	2.10 (0.114)	1.89 (0.143)	2.79 (0.598)	2.58 (0.602)
22	Animal fats - traditional	0.01 (0.021)	0.07 (0.028)	0.01 (0.027)	0.07 (0.034)	0.06 (0.138)	0.10 (0.139)
23	Salt	0.00	0.00	0	0	0	0
24	Other ingredients	0.01 (0.002)	0.00 (0.002)	0.00 (0.002)	0.00 (0.00)	0.03 (0.012)	0.03 (0.012)
NOVA 3 - TOTAL		**3.53 (0.135)**	**2.88* (0.181)**	**3.36 (0.173)**	**2.754* (0.216)**	**3.62 (0.894)**	**3.15 (0.901)**
25	Cheese	0.96 (0.064)	0.68 (0.086)	0.75 (0.082)	0.48 (0.103)	0.71 (0.431)	0.53 (0.434)
26	Preserved fruits, vegetables and pulses	0.89 (0.060)	0.79 (0.081)	0.90 (0.077)	0.83 (0.097)	0.90 (0.402)	0.83 (0.405)
27	Preserved meat and fish - market	0.87 (0.063)	0.76 (0.084)	0.90 (0.080)	0.83 (0.101)	1.29 (0.404)	1.25 (0.406)
28	Preserved meat and fish - traditional	0.20 (0.040)	0.21 (0.054)	0.23 (0.051)	0.25 (0.064)	0.46 (0.265)	0.46 (0.266)
29	Other processed foods	0.61 (0.067)	0.45 (0.090)	0.57 (0.086)	0.36 (0.108)	0.26 (0.451)	0.078 (0.454)
NOVA 4 - TOTAL		**55.92 (0.460)**	**55.41(0.617)**	**54.34 (0.566)**	**53.08 (0.710)**	**46.14 (2.849)**	**46.13 (2.869)**

NOVA subgroups		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Unadjusted[3]		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Model A[4]		Mean[1] Caloric Contribution (% Kcal) (SE[2]) Model B[5]	
		Food secure	Food insecure[6]	Food secure	Food insecure[6]	Food secure	Food insecure[6]
30	Industrial breads	9.85 (0.197)	9.38 (0.264)	9.86 (0.247)	9.84 (0.309)	7.46 (1.275)	7.34 (1.284)
31	Reconstituted meats	4.29 (0.160)	4.84* (0.214)	4.27 (0.205)	4.81* (0.257)	3.47 (1.064)	3.96 (1.072)
32	Carbonated, sports and energy drinks	4.17 (0.156)	4.28 (0.210)	3.95 (0.196)	3.71 (0.246)	1.98 (1.021)	1.98 (1.028)
33	Fruit juices and drinks	3.40 (0.156)	4.18* (0.210)	3.19 (0.194)	3.69* (0.243)	2.09 (0.999)	2.56 (1.006)
34	Chocolate, candies and other sweets	2.02 (0.102)	2.18 (0.138)	1.82 (0.132)	1.95 (0.165)	1.68 (0.690)	1.98 (0.695)
35	Sweet milks	1.12 (0.081)	0.65** (0.108)	1.07 (0.104)	0.63* (0.130)	1.38 (0.543)	1.05* (0.546)
36	Cookies, cakes and baked goods	2.93 (0.139)	2.59 (0.187)	3.02 (0.178)	2.78 (0.223)	3.62 (0.907)	3.52 (0.913)
37	Chips, crackers and other salty snacks	3.51 (0.161)	3.78 (0.216)	3.32 (0.203)	0.32 (0.255)	2.63 (1.052)	2.67 (1.059)
38	Sauces & spreads	2.34 (0.089)	2.07 (0.119)	1.95 (0.113)	1.72 (0.141)	1.24 (0.584)	1.11 (0.588)
39	Margarine	2.05 (0.090)	2.05 (0.120)	2.12 (0.115)	2.22 (0.144)	1.54 (0.600)	1.55 (0.605)
40	Breakfast cereals	2.17 (0.114)	1.84 (0.153)	2.46 (0.146)	2.19 (0.183)	2.38 (0.756)	2.23 (0.761)
41	Fast food	5.90 (0.244)	4.03** (0.327)	5.41 (0.308)	3.47** (0.386)	5.29 (1.592)	3.99* (1.603)
42	Other ultra-processed products	12.18 (0.317)	13.57 (0.425)	11.90 (0.402)	12.76 (0.504)	11.37 (2.066)	12.18 (2.081)

[1]Marginal means (Least-square means); [2]SE=Standard error; [3]unadjusted (n=4516); [4]Adjusted for age group, gender, region (n=4495 after adjustment); [5]Adjusted for age group, gender, region, years education, household size, income, household traditional food activity, traditional food intake (as per 24-hr) (n=4386 after adjustment); [6]Food Insecure Households (moderately food insecure + severely food insecure);

*p≤0.05 for differences between food secure and food insecure (one-way ANOVA):

** Bonferonni correction: p≤0.05/46= p≤0.001)

† soups, salads, sauces, baked goods, stews and other dishes made from fresh or minimally processed foods.

‡ White and brown sugar, icing sugar, molasses, honey and maple syrup.

‖ Vinegar, leavening agents, unsweetened cocoa powder, corn starch.

⌡ Salted, sweetened or oil-roasted nuts or seeds, plain tortillas and potato chips, tofu, soya sauce, condensed milk, peanut butter, French and pita breads, bannock and dumplings

⊧ Cheese products, fish and seafood imitations, meal replacements, sweeteners, supplements and coffee whitener, ready-to-eat dishes (commercial pies, canned or dehydrated soups; frozen and prepared French fries and onion rings and frozen meals)(Batal et al., 2017)

Chapter VI: Discussion

The first objective of the study was to assess the food security situation of First Nations living on-reserve, as well as identify its socio-demographic correlates. This study highlighted three interesting findings in this regard: 1) Food security remains a serious problem for First Nations living on-reserve, with 35.7% classified as either moderately or severely food insecure; 2) Socio-demographic factors, similar to those previously reported in the literature, were associated with food insecurity, including: being female, being younger, having a low level of education, having an income source other than wages or salary, and any household engagement in traditional food; 3) Food insecurity is mostly an issue of income, with those receiving social assistance having the highest risk of being food insecure.

The second objective was to describe the quality of the diet, as well as related underlying socio-demographic factors, of First Nations living on-reserve using two diet quality indicators: a Canadian adaptation of the HEI-2005 and the NOVA classification system. Mean total HEI scores of 49.0±2.65 were lower than those of the general Canadian population (58.8) assessed using 2004 CCHS data. Scores were higher for women, older adults, and those with a higher level of education, while they were lower for social assistance recipients compared to any other income source. Household TF activity and TF consumption were predictive of higher HEI scores. However, only a small proportion of our sample (19.3%) reported consuming TF in their recall. FNFNES data also revealed many barriers that prevent people from using more traditional foods, including: a lack of equipment and transportation, a hunter in the family, and time to harvest and prepare TF. These findings reveal potential targets for interventions addressing food insecurity for Aboriginal peoples.

The final objective was to examine the relationship between household food security status and diet quality. Small, yet significant, differences in HEI scores and component scores between food secure and food insecure households were found. However, only one component score remained significantly different after adjusting for socio-demographic variables and using the Bonferonni correction for multiplicity of tests: food secure individuals had a higher mean score

for the vegetable and fruit category. Although such differences were small, they could be in part related to the high cost of fresh produce on many reserves.

Ultra-processed food intake was found to be high in the diet of FN living on-reserve, making up 55.7 ±24.79% of calories consumed. Decreasing UPF intake could improve diet quality, specifically increasing protein and potassium intakes, while decreasing sodium, free sugar, and overall energy intake. However, no significant differences were found in UPF intake between the FS and FI groups. A few interesting results were found in NOVA subgroups, however, where food secure individuals were found to consume more culinary processed ingredients, including sugar and plant oils, as well as fewer homemade dishes. This could indicate a potential compensation mechanism of food insecure people, also reported in previous literature, who may opt for inexpensive but highly caloric food items and ingredients to stave off hunger.

1. Food Insecurity Remains a Burden

Results from this study show that household food insecurity is extremely high amongst First Nations living on-reserve in Canada, with 35.7% of households classified as food insecure, approximately four times the most recent national prevalence, estimated at 8.2% in 2014 (Tarasuk et al., 2016). Rates of severe food insecurity in our sample (9.2%) even exceeded all food insecurity categories combined for the rest of Canada. These findings echo those of previous studies that have revealed significant discrepancies in food insecurity rates for Aboriginal peoples living both on and off reserves compared to the rest of the Canadian population (Council of Canadian Academies, 2014; Guo et al., 2015; Power, 2008; Tarasuk et al., 2016). For instance, an important and unique First Nations-run health survey, the First Nations Regional Health Survey (FNRHS) found that between 2008 and 2010, 54.2% of households were classified as either moderately of severely-food insecure, with 14.4% considered to be severely food insecure (n=10.371). As discussed in chapter II (section 5.3.5) FNRSH used a different household food security questionnaire made up of 9 questions (Council of Canadian Academies, 2014; FNIGC, 2012). However, it must be kept in mind that this questionnaire is less precise than the 18-item HFSSM survey. Although food insecurity rates have been found to differ drastically between FN communities, what is consistent is that they are highest in northern and remote communities (Council of Canadian Academies, 2014). In

Northern Manitoba, for instance, FNRHS (2008-2010) rates of food insecurity varied from 47% in Nelson House to 100% in South Indian Lake First Nation (FNIGC, 2012).

Our findings concerning household and individual characteristics associated with food insecurity also support findings from previous research in Canada (Che & Chen, 2001; Li et al., 2016; Tarasuk et al., 2016; Vozoris & Tarasuk, 2003). Results from regression analysis revealed higher odds of food insecurity for being female; being younger (19-30, 31-50); receiving social assistance, workers' compensation, or "other sources"[6] of income (compared to earning wages); the presence of a household member engaging in TF activity; the presence of children under 15 years old in the household; and having a lower level of education (<11 years). These characteristics will be further discussed below.

1.1 Demographics

As is commonly observed, females were more likely than males to report household food insecurity. One explanation is that women may sacrifice their intake and use protective strategies to prevent other household members, notably children, from going hungry (Domingo, 2016; Martin & Lippert, 2012; McIntyre et al., 2003; Power, 2007; Power, 2005). However, some have suggested that a reporting bias may be to blame for higher rates of food insecurity reported amongst women (Matheson & McIntyre, 2014).

Food insecurity was also studied across age groups. Our results show that when compared with respondents who were older than 71, age groups under 50 years old were found to have higher rates of food insecurity. This could be explained by several factors. For one, older adults may be more likely to live on their own, which confounds with the fact that smaller households have lower rates of FI (data not shown). Furthermore, studies have found that food insecurity risk drops when people are able to receive old-age pension, a guaranteed annual income (Li et al., 2016). Another hypothesis of this occurrence is that elders on reserves are more likely to receive social support from the community-at-large through food-sharing programs, such as community

[6] Other income category includes: None, savings/trust fund, support from parent or spouse, training/school allowance

freezers, or may be provided with food by family members (Willows, 2005). Community members who hunt or fish may provide TF to elders who tend to appreciate the taste of TF more than any other demographic. As found in the present study (data not shown), researchers have also found older age to be associated with increased intake of TF, which have been shown to improve diet quality (Willows, 2005). Better budgeting skills have also been suggested as a possible explanation for lower rates of food insecurity among the elderly (Guo et al., 2015).

1.2 Regional differences

Regional differences were found, although they did not appear to follow any geographical trend. Amongst the five regions included in the sample, the highest rates of food insecurity were in Alberta (40.7%) and Manitoba (40.5%), followed by British Columbia (37.2%), the Atlantic Provinces (32.9%) and Ontario (32.3%). Regional discrepancies may be explained in part by variations in welfare and other existing social support policies, as well as the number of remote communities in the region – as they will bring up the FI averages for the entire region (Domingo, 2016; Tarasuk, 2017). These will be interesting avenues to explore deeper when FNFNES data from all provinces is available.

Another factor that was not included in this analysis but that could act as a determinant of food insecurity is remoteness. Using FNFNES data from British Columbia, Manitoba, Alberta, and Ontario, Domingo (2016) found food insecurity to be related to road access, with fly-in communities (OR 2.51, 95% CI: 1.77-3.57) and those that only had winter roads access (OR 2.81, 95% CI: 2.15-3.69) having higher odds of household food insecurity than communities with year-round road access ($p<0.001$) (Domingo, 2016). Northern and remote First Nations communities are unique in that they face significant barriers to accessing affordable, safe and nutritious market and traditional foods (FNIGC, 2012; Willows, 2005). Some First Nations who lack a road infrastructure, rely on a short window of time in which winter roads are open to receive shipments (Fieldhouse & Thompson, 2012). Other communities depend on shipments by plane, resulting in inflated prices due to the cost of transport, in addition to limited food variety because of weight restrictions on flights, and a low quality of perishable healthy foods (Fieldhouse & Thompson, 2012). Exacerbating factors include the high cost of fuel and warehouse storage and the presence of a single retailer in many communities that is able to

monopolize the market in an environment where the local population has very low purchasing power (Veeraraghavan et al., 2016). As previously discussed, availability and accessibility of healthy food supplies are the baseline necessities for ensuring food security, and so it understandable how remoteness can be related to food insecurity. Data was not available to study remoteness in this present study.

1.3 Household characteristics

The average household size in the sample was (3,6± 2,2), which is greater than the Canadian average of 2.5 residents per house, but slightly less than the average observed in the RHS (2008/10), which reported an average household size of 4.2 residents in First Nations communities (FNIGC, 2012). As expected, households with a greater number of members than the median (M=3) had a higher prevalence of food insecurity, suggesting that having more HH members puts pressure on available resources and thus, results in higher rates of food insecurity.

The presence of children in the household was also associated with FI status, as is the case across the country in the non-Aboriginal population (Council of Canadian Academies, 2014; Tarasuk et al., 2016). Data from the provinces and territories included in food security analysis in the 2014 CCHS[7] revealed that households with children under 18 years old were more at risk of food insecurity (33.5%) than those without (15.7%) (Tarasuk et al., 2016). Moreover, the presence of children (<15 years old) and household size were also found to be associated with one another (data not shown). Similarly, the Nunavut Inuit Child Health Survey (2001/08) found that households with children who were food insecure had more members compared to other food secure households with children (Council of Canadian Academies, 2014; Domingo, 2016).

Another household correlate of food insecurity discussed in the literature, which was not assessed in this present study is household crowding. Crowded households are defined by Statistics Canada as having more than one person per room, including bedrooms, kitchens, and other finished rooms (Statistics Canada, 2013b). Huet et al. (2012) found crowding to be

[7] The following provinces agreed to include the HFSSM in the 2014 CCHS: PEI, Nova Scotia, New Brunswick, Quebec, Ontario, Saskatchewan, Alberta, North-West Territories, and Nunavut

associated with food insecurity, predictably, since having more people in a household is a way of reducing living expenses and a sign of socio-economic disadvantage (Ruiz-Castell et al., 2015). The NRHS found that about a quarter of FN adults live in crowded households, compared to 7% of the Canadian adults (FNIGC, 2012). FNFNES did not gather data about number of rooms in a house and so this could not be assessed in our sample.

1.4 Income

Income source was found to be an important predictor of food insecurity. In regression analysis, social assistance recipients, and those receiving worker's compensation or employment insurance were much more likely to be food insecure than those receiving wages. (Tarasuk et al., 2016). Social assistance has been shown to increase the odds of food insecurity in numerous population surveys (Che & Chen, 2001; McIntyre, 2003; McIntyre, Bartoo, & Emery, 2014; Power, 2016; Tarasuk, 2017; Tarasuk et al., 2016; Vozoris & Tarasuk, 2003). For example, in 2012, the prevalence of food insecurity amongst social assistance recipients in Canada was 69.5%, though it varied from as high as 75% in western Canada, Nunavut and the Yukon, to 46.2% in Newfoundland and Labrador, in relation to social programs offered in the province or territory (Power, 2016; Tarasuk et al., 2016).

As previously discussed in Chapter II, the most important social determinant of health is economic status, which has been found to affect life expectancy and risk of illness even when controlling for variables such as sex, age, and race (Public Health Agency of Canada). Using information on income categories from 2014 CCHS data, Tarasuk et al. (2016) demonstrated a strong relationship between income levels and food security, where the likelihood of food insecurity increases with decreasing household income. Although the association was not quite linear since at high-income levels, the risk of being severely food insecure is basically non-existent, while below an income level of $30,000, the risk increased dramatically (Tarasuk, 2017; Tarasuk et al., 2016). Income data was not gathered by FNFNES, however it is known that Aboriginal peoples are more likely to be of low-income compared to the rest of Canadians (Socha, Zahaf, Chambers, Abraham, & Fiddler, 2012). The poverty rate for Aboriginal peoples has been found to be twice the Canadian average (Power, 2007). The First National Regional Health Study (2008/10) found that approximately a third (30.7%) of FN adults earned less than

$20,000 per year, compared to 6.4% of the Canadian population (FNIGC, 2012). In 2000, Statistics Canada reported the median total income of Aboriginal peoples living on-reserve at $13,932, compared to $16,949 for those living off-reserve and $30,023 for non-aboriginal Canadians (Palmater, 2011). Low-income affects not only one's ability to procure store-bought foods, but also makes it difficult to hunt or fish due to the associated costs of equipment and fuel (Lawn & Harvey, 2003; Power, 2007; Reading & Wien, 2009; Tarasuk et al., 2016). People without a reliable source of income also lack savings, assets, and access to credit to buffer any unexpected expenses, explaining their increased vulnerability to food insecurity (Li et al., 2016; Power, 2016). For this same reason, people who rent rather than own their homes are at greater risk of food insecurity (Council of Canadian Academies, 2014; Fafard St-Germain & Tarasuk, 2017; Tarasuk et al., 2016). Although data on housing ownership was not gathered by FNFNES, it is another factor to keep in mind, as it is another measure of socio-economic disadvantage and lack of resilience to unexpected threats, especially considering that FN on reserves rarely own their own homes and they cannot build equity because the land cannot be mortgaged (FNIGC, 2012). Furthermore, those on social assistance have to balance the distribution of financial resources between food and other household essentials (Domingo, 2016). The First Nations Information Governance Centre (2012) explains this situation clearly: "For many low-income families, the unfortunate reality is that the grocery budget is flexible, whereas other bills, such as hydro, are not."(FNIGC, 2012).

Food security advocates argue that social assistance is not enough and that reform must be made to social support programs to truly see a reduction in food insecurity rates. Evidence that supports this has been gathered in recent years, as examples emerge where changes to welfare programs in some provinces have fortuitously managed to reduce food insecurity levels. One such successful initiative was the Poverty Reduction Strategy conducted in Newfoundland and Labrador in 2006. The provincial government aimed to reduce poverty by improving social assistance program such as income support payments, tax exemptions, changing the low-income tax threshold, and offering health benefits and special diet allowances for those receiving social assistance (Tarasuk, 2017). These measures focused on poverty but as a result, food insecurity levels nearly halved among people receiving social assistance: from 59.9% in 2007 to 33.5% in 2012 (Li et al., 2016; Tarasuk, 2017). Another success story occurred in British Columbia,

where a small but significant reduction in household food insecurity was observed after the Universal Child Care Benefit program was put into place, in which a one-time increase to social assistance was provided to families with children (Li et al., 2016). Although the reduction in food insecurity prevalence was not sustained, experts rationalise that this was likely a result of failing to account for inflation in subsequent years of the intervention (Tarasuk, 2017). These examples show that by simply augmenting income for the most vulnerable, food security can be improved (Tarasuk, 2017). The reduced rates of FI among the elderly who rely on seniors' pension is another example that illustrates how social benefits can address food insecurity (Tarasuk, 2017; Tarasuk et al., 2016). Seniors receive a guaranteed source of income from the government, in addition to other benefits such as Old Age Security and Pharmacare, and experience the lowest rates of food insecurity, as also observed in this study (Power, 2016).

1.5 Employment is not protective

When looking at the food insecure households' main sources of income in this study (Chapter V, figure 6), we see that a significant percentage (43%) rely on social assistance, and an equally high percentage (39%) earn wages or are self-employed. This finding is consistent with results from other FI studies in Canada, where the greatest proportion of people living in FI HHs are employed. For instance, 58.9% of food insecure households in Ontario actually received wages and salaries (Tarasuk, 2017; Tarasuk et al., 2016). This can be explained by the fact that people who earn wages and salaries represent the overwhelming majority of Canadian households, but also by the fact that incomes from wages are often too low to cover people's basic needs (McIntyre et al., 2014; Power, 2016; Tarasuk, 2017). Power (2016) emphasizes this point: "If incomes from wages and salaries were sufficient for all households relying on employment income, the number of food insecure households in Canada might be reduced by almost two thirds". Household crowding, as previously discussed, may also put pressure on the income or wages of one or two working household members (Tarasuk, 2017). Moreover, in a study exploring food insecurity amongst Canadian households participating in the labour force, McIntyre and colleagues (2014) reported that there was an over-representation of Aboriginal peoples among the working food insecure, arguing that racialization within the labour force may be an issue. They also found that workers who were food insecure were more likely to earn less and hold multiple jobs, engage in seasonal and shift work, work irregular hours, and not be a

part of a union. These factors could result in volatile earnings, a source of vulnerability to food insecurity, despite being employed (McIntyre et al., 2014).

Furthermore, in addition to low-wages, FN adults in remote communities are burdened by high food prices that may counteract any protective effect offered by employment (Fieldhouse & Thompson, 2012; FNIGC, 2012; Lawn & Harvey, 2003). In their review of food costs in 3 communities in Northern Ontario (Fort Albany, Attawapiskat, and Moose Factory) in 2015, Food Secure Canada (FSC) calculated that the average cost of the Revised Northern Food Basket (RNFB)[8] for a family of four over the period of a month was $1,793.40, much higher than the National Nutritious Food Basket (NNFB) in southern cities in Ontario in the same year ($874.90 in Thunder bay and $847.16 in Toronto) (Veeraraghavan et al., 2016). Moreover, using conservative averages of monthly household income, researchers calculated that it would take over 50% of a monthly income to purchase all of the RNFB items in Fort Albany, compared to 15% and 10.6% in Thunder Bay and Toronto, respectively (Veeraraghavan et al., 2016). This is simply one example of the prohibitively high cost of food in many First Nations communities across Canada, despite Nutrition North, a federal subsidy program in place to offset the increased cost of shipping foods to northern remote communities (Government of Canada, 2017). All combined, the factors listed previously can perhaps explain why this study did not find employment to be protective against food insecurity for First Nations living on-reserve in Canada.

1.6 Household traditional food activity

In regression analysis, the odds of being food insecure were higher for those who reported any household TF activity (OR 1.127; 95% CI: 1.09-1.45; p=0.0003). This goes against conventional wisdom that engaging with TF harvesting and preparation would foster food security (Council of Canadian Academies, 2014). One explanation for this inverse relationship could be that having a hunter in the house is a sign of vulnerability, as people with fewer resources to buy

[8] The RNFB, which was created by Indigenous and Northern Affairs Canada and updated in 2008, is a list of 67 standardized food items that represent a basic nutritious diet for a family of four. It is a tool that researchers use to monitor and compare the cost of food between communities in northern Canada. It differs only slightly from the National Nutritious Food Basket (NNFB) used by Health Canada to calculate the cost of food in Canadian cities (Veeraraghavan et al., 2016).

market foods may rely increasingly on hunting and fishing to meet their needs. However, it is worth noting here that one limitation of the cross-sectional design of this study is an inability to draw inference on causality or directionally of associations. This limits our ability to full understand this situation.

Exploring FNFNES data from BC, AB, MN and ON, Domingo (2016) reported that about half of households in which a member participated in traditional food activities worried about their TF running out before they could get more. Moreover, FNFNES found that 91% of respondents in British Columbia (n=1,103) , 73% in Ontario (n=1421), 78% in Alberta (n=609), and 66% in Manitoba (n=701) reported wanting to harvest more traditional food in the past year (Chan et al., 2016a; Chan et al., 2014; Chan, Receveur, Sharp, Schwartz, et al., 2012; Chan et al., 2011). The main barriers, reported by participants, to using more TF included: a lack of equipment and transportation, a lack of a hunter in the family, and a lack of time to harvest and prepare TF. Other barriers reported to a lesser extent were issues related to diminished availability of TF, loss of traditional knowledge, government policies and climate change. And so, the inverse relationship found between household TF activity and food security may also be a sign that those who rely on hunting or fishing, are not able to meet their needs through these practices (Domingo, 2016). It appears that there needs to be certain conditions in place for people to be able to use and rely on TF. For example, in Nunavik, the households who reported the highest intake of traditional foods were two-parent households, in which only the mother was employed. This created a situation where there was money for purchasing equipment and fuel for hunting, in addition to a father who had time to hunt and prepare TF (Duhaime, Marcelle, & Gaudreault, 2002; Power, 2007). Although the overall cost of TF may be cheaper than market foods, if people lack income to purchase fuel and equipment for hunting and fishing, the time, or even just the know-how, they will not be able to engage in such activities (Halseth, 2015; Haman et al., 2010; Power, 2007).

Moreover, in this study, only 19.3 % of respondents reported consuming traditional foods in their 24-hour recall, and in bivariate analysis, this group was more likely to be classified as food insecure (p=0.0054). In their study of determinants of FS in Iqaluit, Nunavut (n=532), Guo et al. (2015) did not find a relationship between the consumption of TF and food security, and

argue that this relates to the nutrition transition experienced in many FN communities, where people have started to rely almost exclusively on the market-food system, and so access to TF is no longer an important buffer to food insecurity. As descibed in Chapter II (section 3), the shift away from TF towards MF has been the result of many factors that are political, societal, socio-economic, and environmental (Willows, 2005). Nevertheless, a few studies have shown that the absence of a hunter is associated with an increased risk of food insecurity (Guo et al., 2015). For instance, the IPY Inuit Health Survey found that low-income and the absence of a hunter in the households were important predictors of food insecurity for the Inuit (Chan et al., 2006). Furthermore, a study conducted by Huet (2012), which looked at dietary correlates of food insecurity in the Canadian Arctic found that food insecure homes were less likely to have an active hunter. In these cases, having an active hunter in the household appears to reduce anxiety about food resources. However, the examples listed here all come from Inuit communities. Due to geographic and cultural differences, caution must be applied before comparing their reality with that of FN living on-reserve below the 60th parallel.

2 Diet Quality

Applying the same Canadian adaptation of the HEI to 2004 CCHS 2.2 data, Garriguet (2009) found the average HEI score for the general population (>2 years old) to be 58.8, 10 points higher than the mean score in the present study (49.0). The vast majority (82.9%) of Canadians had scores that fell into the "needs improvement" category, while 16.6% had scored less than 50 points and only 0.5% had scores above 80. This shows that throughout the country, Canadians, both Aboriginal and non-aboriginal, are not eating well, but that First Nations living on-reserve appear to have poorer diet quality.

However, some differences between the HEI index used in the present study and the original one published by Garriguet (2009) must be noted. For one, more conservative criteria were used in this study to classify "other foods" (refer to Chapter IV, section 6.3.1). Additionally, Garriguet included scores from a sample of Canadians over 2 years old, whereas our sample only included adults above the age of 19 years old, making it difficult to compare the results. However, it must be noted that in general, HEI scores improve with age, so the fact that the CCHS sample includes both children and adults should not explain why our results had a lower

mean score. Overall, the gap between our results and Canada-wide data remains consistent with previous findings that have shown poorer diet quality amongst First Nations living in Canada.

Overall, caloric intake of ultra-processed food was high at 55.7 ± 24.79% entire sample. This is similar to the rates reported in other studies of non-indigenous populations: 57.9% in the USA, 53% in the UK, 47% in Quebec, and 54% in the non-Aboriginal Canadian population (Batal et al., 2017; Moubarac & Batal, 2016). As previously discussed in chapter II, ultra-processed foods have been found to be inversely related to diet quality. Batal et al. (2017) used FNFNES data to study the relationship of caloric contribution of UPF to the diet and overall diet quality. The researchers divided the sample into quintiles of energy intake form UPF and found that as calories from UPF increased, the proportion of protein in the diet decreased, while that of free sugar increased. Furthermore, potassium intake decreased, while sodium increased with higher intake levels of UPF. The Na:K has been related to hypertension, with higher amounts of K having a protective effect. And so, by using both the Canadian HEI and NOVA, this study reveals the extent to which diet quality is poor for First Nations adults living on-reserve in Canada.

2.1 Determinants of diet quality

Many factors have been found to influence diet, including environmental (e.g. availability of healthy and safe food and climate change); economic (e.g. high cost of foods and hunting equipment); and individual ones (e.g. education, unemployment, food skills, decreased transfer of knowledge and taste preferences) (Blanchet & Rochette, 2008; Guo et al., 2015; Mead, Gittelsohn, Roache, & Sharma, 2010). Although, not all of these levels were explored in the present study, the following factors were found to be associated with diet quality, as measured by the HEI in multivariate regression analysis: age group, sex, social assistance, educational level, food security status, household traditional food activity, and traditional food consumption.

2.2 Education and employment

Significant differences were observed in mean HEI scores between levels of education, for both women and men. Interestingly, there was no difference in mean HEI scores for women or men based on whether they were employed or not. One suggestion is that people who are employed

on reserves may be more likely to travel outside of the community and eat out at fast-food restaurants, whereas those who are unemployed may simply limit their dietary variety to cut costs– and so both groups end up with poor diet quality (Ho et al., 2008). Another explanation is that people with disposable income from employment may be more likely to spend it on ready-made foods. Since the availability of healthy ready-to-eat foods is minimal on-reserves (e.g. pre-washed fruits and vegetables, ready-made salads), they may be driving to consume more ultra-processed foods as a result. Since employment in First-Nations communities does not appear to promote better diet quality, just as it didn't show an association with food security status, it indicates that employment opportunities for FN living on-reserve may simply be inadequate and employment may not be an important heath indicator for this population.

2.3 Traditional food

In this study, any household traditional food activity, as well as traditional food consumption, were found to be predictive of better diet quality. Respondents who reported consuming traditional food in their 24-hour recall had significantly higher HEI mean scores ($p<0.0001$). For women, there was a difference of 5 points and for men a difference of 7 points on the HEI scale between TF consumers and non-consumers. This study found that people over 71 years old were more likely to have consumed TF on the previous day (33.7%), compared to younger adults (18.5%), reflecting previous research, which has found TF intake to increase with age. For example, children in Arctic Aboriginal communities have been found to consume as little as 0.4-15% of their energy intake from TF, while adults may consume between 17 and 28% (Chard, 2010; Kuhnlein & Receveur, 2007a). Elders consume the most and have more of a taste and appreciation for TF, having grown up on it, contrary to younger generations that may not have as strong of a connection or know-how related to TF (Willows, 2005). This could be an indication as to why older age was also positively associated with higher mean HEI scores,

TF are generally high in animal protein, low in fat and carbohydrates and rich in micronutrients, notably iron, calcium, vitamins A and C (National Collaborating Center for Aboriginal Health, 2012; Willows, 2005). Studies among indigenous peoples in the Arctic have shown that even as little as one traditional food item in the diet increased dietary intakes of protein, iron, zinc, copper, magnesium, manganese, potassium, selenium, vitamin D, vitamin E, riboflavin and

pyridoxine" (Kuhnlein et al., 2008). FNFNES data showed that any TF in the diet was inversely related to energy-intake from ultra-processed foods, meaning that TF can not only improve nutritional value of the diet but improve overall dietary patterns (Batal et al., 2017).

Although TF consumption was not assessed across NOVA groups, Batal et al. (2017) used FNFNES data to compare the dietary share of ultra-processed foods between TF consumers and non-consumers. They found that those who reported TF on their recall had higher intakes of the first 3 NOVA categories (fresh and minimally processed foods, processed culinary ingredients, and processed foods), and lower intakes of UPF. This revealed that TF consumption is not only associated with higher HEI scores, but is inversely related to caloric contribution of UPF in the diet for First Nations (Batal et al., 2017).

It is important not to discount the contribution of TF in the diets of Aboriginal peoples, given that an increased consumption of traditional food has been associated with higher diet quality (Donaldson et al., 2010; Erber, Beck, et al., 2010; Kuhnlein & Receveur, 2007b). Despite the fact that traditional food consumption is said to have decreased dramatically, in terms of amounts and use, it still contributes significantly to the diets of Aboriginal peoples in certain parts of the country, notably Arctic communities (Halseth, 2015). Furthermore, recorded benefits of traditional food activities extend beyond their potential impact on improving diet quality. Despite the fact that the energy expenditure associated with such activities has decreased with modernization of hunting techniques and the use of automated transportation to access land, traditional food harvesting and hunting continues to provide a benefit to health by increasing levels of fitness (Haman et al., 2010). Traditional food harvesting has also been credited with increased social wellbeing, cultural identity, and economic development for a community – all factors that act as social determinants of health (Mirindi, 2013; National Collaborating Center for Aboriginal Health, 2012) Often, the concept of healthy eating in intrinsincally tied to the consumption of traditional food within many Aboriginal communities and TF consumption is said to be "an important indicator of cultural expression, an anchor to culture and personal well-being, an essential agent to promote holistic health and culture, and the direct link between the environment and human health."(Willows, 2005). Aboriginal food culture does not only concern the food itself, but also extends to the means of procuring

traditional foods, including interactions and sharing between members of the community (Willows, 2005).

3 The Relationship Between Food Insecurity and Diet Quality

The main objective of this research was to study the relationship between food insecurity and the quality of the diet for First Nations adults living on-reserve in 5 Canadian regions. The findings of this study showed some small but significant differences in diet quality indicators across food security categories. For one, the total HEI scores were slightly higher in the FS group than in the combined moderately food insecure and severely food insecure group, though this difference was only significant for women. This relationship remained significant, even after correcting for confounding variables (age group, gender, region, years education, household size, income, household traditional food activity, traditional food intake) ($p=0.0074$). However, not after applying the Bonferonni correction for multiplicity of tests.

Looking more closely at other individual HEI components (after adjusting for age group, gender, region, years of education, household size, income, household TF activity, and TF intake), statistical differences only remained for the total vegetables and fruits component of the HEI, where individuals from FS households scored 3.94 points, while those from FI HH 3.38 points. This may be partially the result of their high-cost, poor quality and availability in many remote First Nation communities (Huet et al., 2012). Although a statistical significance has been found, it is important to translate the difference in terms of quantity of food of any group. The difference in the mean score for the total vegetables and fruits component is 0.56, which represents less than half a serving of difference. Though this may appear insignificant, over the course of a year, it is possible that the higher fruit and vegetable intake could result in notable health gains. It is also interesting to note that people from food insecure households were more likely to consume fruit juices. This means that food insecurity could be responsible for replacing fresh fruit and vegetable intake with juice consumption.

3.1 Diet quality: a possible pathway between food insecurity and obesity

One hypothesized pathway in which food insecurity is associated with obesity is through poor diet quality. This study aimed to build on the previous work to help understand if this was

occurring with First Nations living on-reserve in Canada. In the five regions included in our study, 33.2% of respondents were classified as overweight and 46.6% as obese (Ho et al., 2008). Using FNFNES data, Domingo (2016) found that there was a non-linear relationship between household food insecurity and obesity. When compared to their food secure counterparts, marginally food insecure women and men had significantly higher odds of obesity, while severely food insecure men only had lower odds (Domingo, 2016). In this way, FNFNES data was consistent with previous studies that found low and intermediate levels of food insecurity to be associated with higher levels of overweight and obesity (Adams et al., 2003; Domingo, 2016; Hanson et al., 2007; Townsend et al., 2001b; Wilde & Peterman, 2006). However, for the most part, associations between obesity and food insecurity have been well document among women, but there have been less consistent findings among men (Drewnowski & Specter, 2004).

In his well-cited article "Obesity and the Food Environment Dietary Energy Density and Diet Costs", Drewnowski (2004) argues that obesity is more common amongst the poorest and least educated segment of the American population. One hypothesis is that this is due to the inverse relationship between food cost and energy-density (Drewnowski, 2004). In his assessment on energy cost ($/MJ), Drewnowski found that oil, shortening, margarine, sugar, and pasta had the lowest cost per energy density. This is quite interesting when applying this to our findings from NOVA analysis, since adults from food insecure households were found to consume a significantly greater caloric proportion from these low-cost processed culinary ingredients, notably sugar and plant oils. FI individuals may be relying more on such cheap calories to meet their caloric requirements on a budget. Purchasing processed and energy-dense foods when resources are scarce has been documented, even in research with Aboriginal peoples in Canada (Mead, Gittelsohn, Kratzmann, Roache, & Sharma, 2010). However, no differences were observed in terms of processed or ultra-processed food intake, after controlling for socio-demographic variables and applying the Bonferonni correction. The only other difference than remained significant after adjusting for socio-demographic variables in NOVA analysis was that FS individuals consumed more home-cooked dishes (2.77% kcal vs. 1.73 % kcal). Our results paint an interesting picture in which food insecure individuals are less likely to prepare food at home, while being more likely to fill up on inexpensive processed culinary ingredients. It must be noted that in general, very small differences (±1%) in proportion of energy from NOVA

groups and subgroups were found between food security categories. However, the findings do suggest that small effects on diet quality might be risk factors for obesity, diabetes, and cardiovascular disease. This research highlights the complexity of the relationships between food insecurity, diet quality and obesity, and the need to gather stronger evidence to better understand the pathways in these relationships. The limitation of this research is in its observational nature, which fails to make any conclusions on causation and directionality. Furthermore, obesity was assessed only as a control variable, rather than an outcome variable. Moving forward, it would be interesting to conduct a mediation analysis on the pathway between food insecurity, diet quality and obesity.

4 Recommendations: Improving diet quality by increasing income and promoting food sovereignty

The present study showed that an important variable relating to food insecurity and poor diet quality is income. Notably, household's reliant on social assistance had lower global diet quality scores and were more likely to be food insecure. However, to date the approach to mitigating food insecurity and improve nutrition has been fixated on implementing educational interventions focused on nutrition knowledge and food skills, rather than on improving income. In fact, nutrition education strategies have been suggested as early as the 1930s in Aboriginal communities, when non-aboriginal nutrition experts began trying to persuade Aboriginal peoples to consume more nutritious market foods and even encouraged greater intake of traditional foods, as a result of shifting dietary patterns stemming from the adoption of non-Aboriginal food systems (Mosby, 2013). Another example was the implementation of Family Allowances in the 1950s in the Canadian subarctic. These were given to households with children in form of monthly payments that could be used towards purchasing foods. However, allowances were restricted to certain foods of "high nutritive value", such as: canned tomatoes, rolled oats, luncheon meat, dried prunes, cheese, and canned butter (Mosby, 2013). Some reports show that families were prohibited from purchasing flour in some cases, which was problematic during long hunting trips, as there was not enough flour to last the season (Mosby, 2013).

Though intentions may have been (and continue to be) good, these examples of the implication of the state in all aspects of Aboriginal life, reveal a perpetuated paternalistic, and at times racist, approach where Aboriginal peoples are viewed as incapable of exerting self-governance or autonomy and thus lack self-determination to make decisions about food. It is true that most people, Aboriginal and non-aboriginal alike, can benefit from increased nutrition knowledge, however, a focus on behavioural change puts the emphasis on the failure of the individual to manage their resources efficiently (Tarasuk, 2001a). Interestingly, studies have illustrated that food insecure individuals already tend to stretch their food dollars in a way to maximize household food purchases. Drewnowsk clearly elucidates:

> *"If higher food costs represent both a real and perceived barrier to dietary change, especially for lower-income families, then the ability to adopt healthier diets may have less to do with psychosocial factors, self-efficacy, or readiness to change than with household economic resources and the food environment. Continuing to recommend costly diets to low-income families as a public health measure can only generate frustration and culpability among the poor and less-well educated. Obesity in America is, to a large extent, an economic issue." (Drewnowski, 2004).*

Moreover, well-intentioned initiatives, such as community kitchens, have also been suggested to perpetuate the problem, since they also take the responsibility away from overarching systems and governments and place it on charitable organizations efficiently (Power, 2005; Tarasuk, 2001a). There remains progress to be made in empowering individuals and communities to advocate for food security. Though the real work remains in working on levelling the playing field at the root of the problem and beginning by eliminating poverty and ensuring adequate access to food for all. As previously discussed, one issue that is often emphasized by experts advocating for food security is that social assistance is not enough to cover essential needs in Canada. Over the years, researchers have shown that it is not possible to afford a healthy diet when relying on social assistance alone (Riches, 1997). This point was evidenced by provincial social reforms that have consequently, though unintentionally, reduced rates of food insecurity.

Such interventions have been found to improve the situation of people to a much greater extent than many of the commonly used food security interventions described above.

Using this rationale, The Northern Policy Institute in Ontario is proposing a basic income guarantee (B.I.G) as an effective policy solution to help reduce food insecurity. B.I.G. is currently being explored and evaluated to see whether it would have positive economic and social impacts in the province. As mentioned in Chapter VI (section 1.4), other forms of social reform have been shown to improve food security in Canada, however the benefit of B.I.G is that it is inclusive. Tarasuk (2017) explains: "Having the adequacy of one's income be the sole criterion for the receipt of a B.I.G. optimizes the potential for this intervention to reach those most vulnerable to food insecurity" (Tarasuk, 2017). It does not simply target households with children, those who earn wages, or those receiving social assistance. However, researchers have also questioned whether this approach would benefit First Nations communities, as a different cultural approach is currently used in welfare administration on reserves. In order to avoid potential negative consequences, they suggest piloting such an approach in First Nations communities prior to widespread implementation.

Moving towards inclusive and more systemic approaches: a case for food sovereignty

The results of the present study showed that household traditional food activity and traditional food consumption were predictive of better diet quality. Though the relationship was less clear with food security, it is well understood that ensuring Indigenous peoples' right to food goes beyond physical and economic access. Social and cultural practices involved in traditional food procurement, preparation, and sharing are vital for food security among Aboriginal peoples. In order to meet all of these added layers of food security, appropriate governance structures are required to allow for self-determination to build food systems that meet the preferences of the people (Council of Canadian Academies, 2014; Loring & Gerlach, 2015). One concept that has emerged is that of food sovereignty. Food sovereignty is defined as:

> […]*"the peoples' right to define their own policies and strategies for the sustainable production, distribution and consumption of food that guarantee the right to food for the entire population, on the basis of small and medium-sized production, respecting their own cultures and the diversity of peasant, fishing and indigenous forms of agricultural production, marketing and management of rural areas, in which women play a fundamental role"(WFFS, 2001).*

Food sovereignty is an important lens through which Aboriginal food issues must be viewed, in line with the Indigenous eco-philosophy that stems from a belief that humans cannot manage land, but rather only the way they interact with it (Morrison, 2011; Working group on Inidgenous Food Sovereignty). The Expert Panel on the State of Knowledge of Food Security in Northern Canada has highlighted the importance of talking about food sovereignty when discussing Indigenous food systems by emphasizing the right for Indigenous peoples to achieve control over the food systems they rely on (Council of Canadian Academies, 2014). The goal is to be able to ensure sustainability of traditional food practices, such as hunting, fishing, gathering, and farming, which have relied on the biological and cultural diversity for thousands of years (Domingo, 2016; Morrison, 2011).

To achieve food sovereignty, the focus must move towards community-level research and planning (Council of Canadian Academies, 2014). And yet, despite this local focus, there is a movement to use this concept to help reshape the global food system in such a way that gives power back to the people and relies on principles of sustainability, ecology, and human rights (Morrison, 2011). It is an approach based on relationships between all interacting elements in a food system – plants, animals, land, and humans (Morrison, 2011).

Moreover, in order to constructively move forward from past systemic failures that have harmed traditional food systems and the health and wellbeing of Aboriginals people, an inclusive approach is needed. One strategy, promoted by Food Secure Canada (FSC), is the development of a national food policy. The guiding principles and priorities of such a policy include building a food system that is inclusive, sustainable, efficient and nutritious. To do so, a collaborative effort that integrates health policy, income support programs and nutrition guidelines at the

policy level is being advocated for (Food Secure Canada, 2017). Embedded in this framework is the importance of building nation-to nation relationships with Indigenous peoples and working towards food sovereignty.

5 Strengths and Limitations

FNFNES is a cross-sectional study, which limits the ability to draw any real conclusions about causality. Moreover, one limitation to conducting a secondary analysis is a lack of control over the variables included in the study. Based on the relevant literature on food security and diet quality, it would have been interesting to explore the following additional variables: household crowding, household income, marital status, the number of children under the age of 18 in the household, and community remoteness. One strength of the FNFNES study is that data collection occurred during the fall of every year, and so 24-h recalls reflect only foods consumed during the months of September to December. This was done to control for seasonal fluctuations of dietary patterns, the period in which Aboriginal peoples have been found to consume the highest concentrations of TF, as most foods are harvested late-summer and during the fall months. However, one drawback to this is that conducting all 24-hour recalls during the same season fails to consider such seasonal variations and may not accurately provide a portrait of the diet of First Nations throughout the year. At the time of analysis, results were only available from British Columbia, Manitoba, Ontario, Alberta and the Atlantic provinces. The final reports from the missing provinces, Saskatchewan and Quebec, will be completed by 2018, presenting the opportunity to gain a representative portrait of the situation for all FN living on-reserve in Canadian provinces below the 60^{th} parallel, as well as the ability to compare the relationship of food insecurity and diet quality between provinces and eco-zones.

Although FNFNES was designed to be representative of First Nations communities in Canada, an unweighted sample was used in analysis, meaning that food security and diet quality statistics calculated only reflect the situation in the 69 communities included in this analysis. However, the large sample (n=4691) was a strength of this study, as it allowed trends to be observed, which may not have been picked up in a study with fewer respondents.

Another limitation was missing data, largely due to refusals, for food security (n=175), years of education (n=87), and BMI (n=390). The highest degree obtained was not included in analysis due to the high amount of missing data (n=299), since this question was not included in the first year of the survey in British Columbia. This would have been an interesting variable to include,

allowing us to observe the distinct correlation between various levels of education (high school, post-secondary, vocational studies, etc.) and the outcome variables.

The Health Eating Index used in this study presents a few limitations. For one, HEI scores were calculated using a single 24-hour recall, with no adjustments made to account for individual daily variation. The Canadian HEI is an index used to evaluate the quality of the diet of Canadians based on how well it conforms to the current nutritional recommendations, including the 2007 Eating Well with Canada's Food Guide. Since national nutrition recommendations are made to be met over an extended period, the HEI is generally used to calculate an individual's usual intake (mean intake over a set period) (Freedman, Guenther, Krebs-Smith, & Kott, 2008a; Freedman, Guenther, Krebs-Smith, & Kott, 2008b). However, in observational studies, such as FNFNES, often only a single day of food intake data is often available. Freedman and colleagues (2008) explain that although one 24-hr recall can be used to calculate scores, that they may be biased as they do not provide an accurate portrait of usual intake. This is especially the case for foods that are episodically consumed, that is foods unlikely to be consumed every day by everyone or fresh foods, but less for non-perishable foods that store for a long time. This is problematic since scores are not allotted linearly, but are truncated, with imposed minimum and maximum scores for each component (0, 5, 10, 20). For example, an individual may not eat fruit or vegetables on the day of the 24-hr recall, giving that person a score of 0 for the fruit and vegetable component score. Many scores of 0 will be allotted if only one-day intake is used, which does not accurately reflect their average usual intake, and thus biases the population average. And so, including only one 24-hr recall can have an impact on underestimating certain HEI sub-scores (e.g. Fruits and vegetables), but not impacting other sub-groups (e.g. Oils). Freeman and colleagues recommend calculating a population ratio when only one 24-hr recall is available to calculate the population's mean usual intake. This consists of taking a ratio between the population's total intake of each component (food group or nutrient) and the total energy intake of the population. The total HEI score becomes the sum of all the component ratio scores. However, it would not have served us in this study, as we would not have been able to compare mean HEI scores between subgroups in the sample (e.g. food secure vs. food insecure). Furthermore, other studies have supported the use of a single day dietary recall to measure usual intakes of a population (Zizza et al., 2008).

Another limitation of applying the HEI in the Aboriginal context is that it does not consider the added nutritional benefit of consuming traditional food. Traditional meats are simply included in the meat and alternative component (Huet et al., 2012). However, results from this study showed that First Nations living on-reserve consumed a very small proportion of their energy intake from traditional food, and so HEI remains an appropriate diet quality metric to use for this population. Furthermore, a TF category was included as a NOVA subgroup, allowing any differences in caloric contribution of TF foods between FS levels to be observed.

The Household Food Security Module is the food security measurement tool most commonly used in North America and has been included in the Canadian Community Health Survey since 2004 (Health Canada, 2007). However, since food insecurity is a complex situation, it is difficult for any single metric to capture all of its dimensions. For one, it does not assess whether coping mechanisms were used to access foods or whether other factors that might affect household food insecurity, such as illness or disability, are present. It also does not assess the food supply, which may be of particular concern in First Nations communities. Respondents also answer questions relating to the previous 12 months, which fails to indicate whether the situation is acute or chronic. This is also a limitation when it is compared with diet quality data collected on a single day. An individual may be food secure at the time of the 24-hour recall, but considered food insecure over the course of the year, which may introduce confusion to the results (Bickel et al., 2000). Furthermore, not all individuals within a given household may experience food insecurity the same way and over the same period. However, evidence does suggest that at severe levels of food insecurity, most, if not all, adults will likely experience hunger in a similar way, while the situation of children is quite different and has been accounted for in the survey (Bickel et al., 2000).

One considerable limitation is that the HFSSM may not adequately depict the reality of food security for First Nations in Canada. There is no inclusion in existing metrics of how traditional food systems may contribute to food security within First Nations communities. For this reason, there has been a call for the development of a culturally-appropriate food security metric for First Nations peoples (FNIGC, 2012). Power (2007) suggests introducing “cultural food

security", which measures access to "sufficient and safe traditional/country food". The metric would evaluate the transfer of traditional knowledge, access to lands and food systems for traditional food harvesting, and availability of safe food free of contamination (Power, 2007).

Chapter VIII - Conclusion

Aboriginal peoples in Canada are disproportionally burdened by obesity and chronic disease, compared to the rest of the Canadian population. Distal determinants of health, such as colonialism and social exclusion, mediated by more proximal determinants, such as low levels of employment and income, poor education, and high rates of food insecurity, have been identified as root causes of such population health inequities. The particular relationship between food insecurity and health outcomes has been widely explored in the last 20 years. This study aimed to contribute to existing literature by assessing the relationship between food insecurity and diet quality as a factor associated with the high rates of obesity and chronic disease observed in First Nations communities today. The main goal was to better understand the risk factors of food insecurity, poor diet quality, as well as their relationship, in hopes of better targeting public health interventions in the future.

Though overall differences in HEI components, dietary characteristics, and caloric contribution of various NOVA subgroups were small between foods security levels, they could potentially indicate that even small effects on diet quality might be risk factors for obesity, diabetes, and cardiovascular disease. These findings also suggest that to address food insecurity, it is not enough to increase access to foods currently available, but it will also be necessary to improve the food environment and ensure that high-quality healthy and culturally appropriate foods are readily available.

In summary, the results of this study add to previous findings showing that diet quality is poor and household food insecurity is widespread for First Nations living on-reserve in Canada. The present study offers a novel approach of using two diet quality indicators, a Canadian HEI and NOVA, to study the relationship between food insecurity and diet quality for First Nations living on-reserve, a population previously excluded from national nutrition and food security surveys in Canada. To help redress this disturbing food security and diet quality situation among FN living on-reserve, a series of recommendations were reviewed. Strategies favouring a systems approach are to be encouraged if this injustice were to be corrected.

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APPENDIX I – Components and scoring of a Canadian Healthy Eating Index

Components	Maximum points	Criteria for maximum score, by sex and age				Criteria for minimum score
Adequacy	**60**	Female 19-50	Male 19-50	Female 51+	Male 51+	
Total fruits and vegetables	10	7	8	7	7	0 servings
Whole fruits	5	1.5	2	1.5	1.5	0 servings
Dark green and orange vegetables	5	1.5	2	1.5	1.5	0 servings
Total grain products	5	6	8	6	7	0 servings
Whole grains	5	3	4	3	3.5	0 servings
Milk and alternatives	10	2	3	2	3	0 servings
Meat and alternatives	10	2	3	2	3	0 servings
Unsaturated fats	10	30 g	45g	30 g	45 g	0 grams
Moderation	**40**					
Saturated fats	10	7% of kcal				≥ 15% of kcal
Sodium	10	≤1500 mg				≥ 4600 mg
Other foods	20	≤5% of kcal				≥ 40% of kcal

APPENDIX II – Social, Health and Lifestyle Questionnaire

Participant ID: __ __ / __ / __ __ __

IV. SOCIAL, HEALTH AND LIFESTYLE QUESTIONNAIRE

This questionnaire is short and addresses questions about your household and the role and use of traditional food in your household. Remember, traditional food is food that is coming from the local land and environment, such as fish, birds, land animals and plants. Can I start with the first question?

1. How many persons, including yourself, live in your household now? (i.e., this month) Include children and adults, but not visitors. To live in your household, this means that they have meals and sleep there at least 3 nights per week.
   a. How many are less than 15 yrs of age _____
   b. How many are between 15 and 65 _____
   c. How many are over 65 _____

2. How many persons, including yourself, living in your household are either self-employed or an employee now? (i.e., this month)
   a. Full-time (≥ 35 hours/week) _____
   b. Part-time (< 35 hours/week) _____

3. What is your main source of income? *(circle one)*
   a. Wages/salary/self-employment
   b. Pension/seniors benefits
   c. Social assistance
   d. Worker's compensation/employment insurance
   e. Other, please specify_____

4a. How many years of school have you completed? Please don't count partial years, kindergarten or grades repeated _____ years

4b. Have you obtained the following diplomas, certificates, or degrees?:

a. High school diploma	YES □	NO □	
b. GED (high school equivalency)	YES □	NO □	Not applicable □
c. Vocational training certificate	YES □	NO □	
d. College diploma	YES □	NO □	
e. Bachelor's degree	YES □	NO □	
f. Master's degree	YES □	NO □	
g. Doctorate degree	YES □	NO □	

Participant ID: __ __ / __ / __ __ __

5. During the past year, did <u>you</u> personally:
   a. Hunt or set snares for food? YES □ NO □
   b. Fish? YES □ NO □
   c. Collect wild plant food? YES □ NO □
   d. Collect seafood? YES □ NO □
   e. Plant a garden? YES □ NO □

6. During the past year, did <u>anyone else</u> in your household:
   a. Hunt or set snares for food? YES □ NO □
   b. Fish? YES □ NO □
   c. Collect wild plant food? YES □ NO □
   d. Collect seafood? YES □ NO □
   e. Plant a garden? YES □ NO □
   □ NOT APPLICABLE (participant lives alone)

7. a) What do you think are the most important benefits of traditional food? Please state as many as you wish.

_____
_____
_____
_____
_____
_____

b) What do you think are the most important benefits of market food? Please state as many as you wish.

_____
_____
_____
_____
_____
_____

8a. Would your household like to have more traditional food?

YES □ NO □ (if NO, go to Q. 8c)

8b. Can you tell me what prevents your household from using more traditional food?

_____
_____
_____
_____
_____
_____

Participant ID: __ __ / __ / __ __ __

8c. Some families might say, **"We worried whether our traditional food would run out before we could get more."** In the last 12 months, did that happen often, sometimes, or never for your household?

a. Often □
b. Sometimes □
c. Never □
d. Don't know or refused □

8d. Some families might say, **"The traditional food that we got just didn't last, and we couldn't get any more."** In the last 12 months, did that happen often, sometimes, or never for your household?

a. Often □
b. Sometimes □
c. Never □
d. Don't know or refused □

9a. Have you noticed any significant climate change in your traditional territory in the last 10 years?

YES □ NO □ DON'T KNOW □ (if NO or DON'T KNOW, go to Q. 10)

9b. Can you tell me one way how this has affected traditional food availability in your household?

_____
_____
_____
_____
_____
_____

10. Do any of the following affect (or limit) where you can hunt, fish or collect berries?

a. Mining	YES □	NO □	DO NOT KNOW □
b. Forestry	YES □	NO □	DO NOT KNOW □
c. Oil and gas	YES □	NO □	DO NOT KNOW □
d. Hydro	YES □	NO □	DO NOT KNOW □
e. Farming	YES □	NO □	DO NOT KNOW □
f. Sports Outfitters/Lodges	YES □	NO □	DO NOT KNOW □
g. Recreation boaters/fishers	YES □	NO □	DO NOT KNOW □
h. Snowmobiles/ATV's	YES □	NO □	DO NOT KNOW □
i. Roadways	YES □	NO □	DO NOT KNOW □
j. Government restrictions	YES □	NO □	DO NOT KNOW □
k. Other	YES □	NO □	DO NOT KNOW □

if yes, please specify: _____

11. In general, compared to other people of your age, would you say your health is:
    a. Excellent
    b. Very good
    c. Good
    d. Fair
    e. Poor

12. Which of the following statements best describes your activities for most days when you are in the community?
    a. I am usually sitting and do not walk around very much.
    b. I stand or walk around quite a lot, but I do not have to carry or lift things very often.
    c. I usually lift or carry light loads or I have to climb stairs or walk up hills often.
    d. I do heavy work or carry heavy loads.

13. In general, compared to other people of your age, are you physically:
    a. More active
    b. Less active
    c. About average
    d. Don't know

14a. Did you smoke cigarettes yesterday? YES ☐ NO ☐

14b. ***[IF YES ABOVE, ASK]*** How many? _____

15. Have you ever been told by a health care provider that you have:

    a. diabetes YES ☐ NO ☐
    b. If yes to 15a, how long ago were you diagnosed? _____# years
       _____ don't know

    c. If yes to 15a, circle type if known: Type 1 Type 2 Unknown

Participant ID: __ __ / __ / __ __ __

V. FOOD SECURITY QUESTIONNAIRE

Food security has been defined as: "…. when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996).

This last section asks questions about being able to afford food for your household. Some of the questions are very personal and may be difficult for you to answer. Like the rest of the questionnaire, this information is strictly confidential and no names will be released to the community or government.

I'm going to read several statements that may be used to describe the food situation of a household.

Please tell me if the statement was true **often, sometimes or never** for your household in the last 12 months. ***[INTERVIEWER, CHECK ONE BOX ONLY]***

Were the following statements often true, sometimes true or never true in the last 12 months:	Often true	Sometimes true	Never true	*Don't know or refused*
Q1.You and other household (HH) members couldn't afford to eat balanced meals.				
Q2. You and other HH members worried food would run out before you got money to buy more				
Q3. Food that you and other HH members bought didn't last and there wasn't any money to get more				

Q3b. Are there children living in the house who are under 18 years of age?

Yes ☐ ***If 'Yes', GO TO Q4 AND Q5***

No ☐ **1)** ***If ANY of Q1, Q2 OR Q3 WAS ANSWERED "often or sometimes" GO TO Q7***

2) IF ALL of Q1, Q2 and Q3 WERE ANSWERED "never true" GO TO ADDITIONAL COMMENTS, PAGE 31

Participant ID: __ __ / __ / __ __ __

IF CHILDREN UNDER 18 IN HOUSEHOLD, ASK QUESTIONS 4 and 5				
Were the following statements <u>often</u> true, <u>sometimes</u> true or <u>never</u> true in the last 12 months:	Often true	Sometimes true	Never true	*Don't know or refused*
Q4. You or other adults in your HH relied on less expensive foods to feed the children because you were running out of money to buy food				
Q5. You or other adults in your HH couldn't afford to feed children a balanced meal				

IF PARTICIPANT ANSWERS "<u>OFTEN</u>" OR "<u>SOMETIMES</u>" TO ANY ONE OF QUESTIONS 1 TO 5, THEN CONTINUE TO Question 6; OTHERWISE, GO TO ADDITIONAL COMMENTS, PAGE 31

Was the following statement <u>often</u> true, <u>sometimes</u> true or <u>never</u> true in the last 12 months:	Often true	Sometimes true	Never true	*Don't know or refused*
Q6. Children were not eating enough because you and other adults in your HH just couldn't afford enough food				

Participant ID: __ __ / __ / __ __ __

STAGE 2 QUESTIONS	Yes	No	*Don't know or refused*
Q7. Since October last year, did you or other adults in your HH ever cut the size of your meals or skipped meals because there wasn't enough money for food?			
IF Yes to Question 7, go to Question 8 ***IF No, go to Question 9*** **Q8**. How often did this happen… almost every month, some months but not every month, or in only 1 or 2 months? a. Almost every month □ b. Some months but not every month □ c. Only 1 or 2 months □ d. Don't know or refused □			
Question	Yes	No	*Don't know or refused*
Q9. In the last 12 months, did <u>you</u> ever eat less than you felt you should because there wasn't enough money to buy food?			
Q10. In the last 12 months, were <u>you</u> ever hungry but did not eat because you couldn't afford enough food?			
Q11. In the last 12 months, did <u>you</u> lose weight because you didn't have enough money for food?			

IF PARTICIPANT ANSWERED "<u>Often</u>" or "<u>Sometimes</u>" to Question 6, or "YES" TO ANY ONE OF QUESTIONS 7 TO 11, THEN CONTINUE TO Question 12; OTHERWISE, GO TO ADDITIONAL COMMENTS, PAGE 31

Participant ID: __ __ / __ / __ __ __

STAGE 3 QUESTIONS	Yes	No	*Don't know or refused*
Q12. In the last 12 months, did you or other adults in your HH ever not eat for a whole day because there wasn't enough money for food?			

IF Yes to Question 12, go to Question 13
IF No and have children in the HH <18, go to Question 14
IF No and don't have children, go to Additional Comments, Page 31

Q13. How often did this happen… almost every month, some months but not every month, or in only 1 or 2 months?

a. Almost every month □
b. Some months but not every month □
c. Only 1 or 2 months □
d. Don't know or refused □

IF CHILDREN UNDER 18 IN HOUSEHOLD, ASK QUESTIONS 14 to 17; OTHERWISE, GO TO ADDITIONAL COMMENTS, PAGE 31

Question	Yes	No	*Don't know or refused*
Q14. In the last 12 months, did you or other adults in your HH ever cut the size of any of the children's meals because there wasn't enough money for food?			
Q15. In the last 12 months, did any of the children ever skip meals because there wasn't enough money for food?			

IF <u>Yes</u> to Question 15, go to Question 16
IF <u>No</u> go to Question 17

Q16. How often did this happen… almost every month, some months but not every month, or in only 1 or 2 months?

a. Almost every month □
b. Some months but not every month □
c. Only 1 or 2 months □
d. Don't know or refused □

Question	Yes	No	*Don't know or refused*
Q17. In the last 12 months, were the children ever hungry but you just couldn't afford more food?			
Q18. In the last 12 months, did any your children ever not eat for a whole day because there wasn't enough money for food?			

APPENDIX III – Summary of the literature on the association between food insecurity and diet quality

An overview of studies assessing the relationship between food insecurity and diet quality in the United States

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
(Bhattacharya et al., 2004)	➢ NHANES III 1988-1994: Representative sample of USA population (≥2 years) ➢ N=34,000	**Food security:** ➢ NHANES food insufficiency questionnaire **Diet Quality:** - One 24-hour recall +30 d intake : - HEI and its components **Controls:** ➢ age, gender, race, urban residence, census region	<u>18-64 years</u> ➢ HEI score (-) ➢ Obesity (+) <u>65+ years</u> ➢ HEI (-) ➢ Low BMI (+) ➢ Obesity (≠)
(Basiotis & Lino, 2002)	➢ NHANES III 1988-1994 ➢ Women (19-55 years) who do not live alone ➢ N=4,804, food sufficient HH ➢ N=437, food insufficient HH	**Food security**: ➢ NHANES household food sufficiency questionnaire **Diet quality:** ➢ One 24-hour recall: ➢ HEI and components **Controls :** ➢ none mentioned	➢ Total energy (≠) ➢ HEI (-) ➢ HEI-vegetables (-) ➢ HEI- fruits (-) ➢ HEI – milk (-) ➢ HEI- cholesterol (-) ➢ HEI- variety (-)
(Berkowitz et al., 2014)	➢ Prospective longitudinal cohort study/ Baseline: 2004-2009 ➢ Puerto Rican adults (45-75 years)	**Food security:** ➢ HFSSM **Diet quality:** ➢ Semi-quantitative FFQ (12-months): ➢ HEI-2005 **Controls:**	➢ HEI-2005 (-) ➢ HEI- total vegetables (-) ➢ HEI- dark green and orange vegetables and legumes (-)

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
	➢ N=584	➢ age, sex, education, income-to-poverty ratio, BMI, glucse-lowering medications, physical activity, smoking, and alcohol use	
(Dixon et al., 2001)	➢ NHANES III 1988-1994 ➢ N=6475: adults (20-59 years old) ➢ N=3690: elderly ≥60 years)	**Food security:** ➢ NHANES Food insufficiency questionnaire **Diet Quality** - One 24-hour recall + a 1-mo qualitative 60-item food frequency questionnaire (FFQ): - Nutrient intakes - Serum nutrients **Controls**: - gender, age, race/ethnicity, family income and region	<u>Adults (20-59 years)</u> ➢ Calcium (-) ➢ Vitamin E (-) ➢ Serum total cholesterol (-) ➢ Vitamin A (-) ➢ Carotenoids (-) ➢ Milk products (-) ➢ Fruit/fruit juices (-) ➢ Dark green leafy vegetables (-) ➢ Salty snacks (-) ➢ Desserts and sweets (-) <u>Adults (≥ 60 years)</u> ➢ Energy intake (-) ➢ Vitamin B-6 (-) ➢ Mg (-) ➢ Fe (-) ➢ Zn (-) ➢ Serum concentrations of high-density lipoprotein cholesterol (-) ➢ Albumin (-) ➢ Vitam A (-) ➢ B-cryptoxanthin (-) ➢ Vitamin E (-) ➢ Cereals (-)

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
			➢ Salty snacks (-) ➢ Non-alcoholic beverages (-)
(Champagne et al., 2007)	➢ Delta Nutrition Intervention Research Initiative ("Delta NIRI") ➢ Adults ≥18 years living in 36 countines in the Lower Delta region of Arkansas, Louisiana, and MIssissipi ➢ N=1607	**Food security** ➢ 18-item HFSSM **Diet quality:** ➢ One 24-hour dietary recall + questions regarding usual intake: ➢ HEI ➢ Nutrient intakes: ➢ Estimated Aerage Requirements (EAR) ➢ Adequate Intake (AI) **Controls :** - age group, household income, race, sex, education, household size.	- HEI (-) but not significant) - HEI-vegetable (-) - EAR vitamin A (-) - EAR selenium (-) - AI Ca (-) - Energy density (+)
(Kendall, Olson, & Frongillo Jr, 1996)	➢ Health census in rural New York State county ➢ Women (15-40 years) with children from all had < 16 years education ➢ N=193	**Food security:** ➢ Radimer/Cornell measures of food insecurity (10-item) **Diet quality:** ➢ 2 x 24-hour recalls ➢ inventory of household food supplies ➢ frequency of fruit and vegetable consumption - Eating Disorder questionnaire - Nutrient intakes (RDA) **controls :** - not mentioned	➢ Frequency of consumption (times/week): ➢ Fuits (-) ➢ Salad(-) ➢ Carrots (-) ➢ Vegetables (-) ➢ Household food inventory scores (-) ➢ Eating Disorder score (+) ➢ Potassium (-) ➢ Fibre (-) ➢ Fruit food group intake (-) ➢ Vitamin C (-) ➢ Servings of fruits and

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
			vegetables (-)
(Gamba, Leung, Guendelman, Lahiff, & Laraia, 2016).	➢ NHANES (1999-2008) ➢ Pregnant women with household incomes (≤300% Federal Poverty Level) ➢ N=668	**Food security:** ➢ 18-item FSSM **Diet quality:** - 1 to 2 24-hour recalls: - AHEI-Pregnancy - Nutrient intakes **Controls :** - age, education, race/ethnicity, income, marital status, and nativity	➢ Calcium (+) ➢ AHEI-P (≠)
(Leung et al., 2014)	➢ NHANES 1999-2008 ➢ low-income adults (≤300% poverty level) ➢ N=8,129	**Food security:** ➢ 18-item HFSSM **Diet quality:** ➢ 2 x 24-hour recalls: - Health Eating Index-2005 (HEI-2005) - Alternate Health Eating Index-2010 (AHEI -2010) **Controls :** - age, sex, survey year, total energy intake, race/ethnicity, education level, marital status, household size, poverty income ratio, smoking status	➢ High-fat dairy products (+) ➢ Salty snacks (+) ➢ Sugar-sweetened beverages (+) ➢ Red/processed meat (+) ➢ Nuts, seeds, legumes (+) ➢ Vegetables (-) ➢ Sweets/bakery desserts (-) ➢ HEI-2005 (-) ➢ AHEI-2010 (-) ➢ Total energy (≠) ➢ Macronutrients (≠) ➢ Carotenoids (-) ➢ Vitamin E (-) ➢ EPA and DAH (-) ➢ Sodium (-)
(Lee & Frongillo, 2001)	➢ NHANES III (1988-1994):	**Food security:** ➢ NHANES Food insufficiency	➢ Energy (-) ➢ Protein (-)

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
	N=6596 ➢ Nutrition Survey of the Elderly in New York State (NSENY)(1994) : N=447 ➢ Older adults (60-90 years old)	questionnaire **Diet quality:** ➢ One 24-hour recall + ➢ vitamin/supplement use: ➢ Nutrient intakes **Controls :** ➢ age, gender, race, Poverty Index Ratio, education, living arrangement, food program participation, disease, functional impairments, dietary change due to health problems, vitamin/mineral supplement and medication use	➢ Carbohydrate(-) ➢ Saturated fat (-) ➢ Niacin (-) ➢ Riboflavin (-) ➢ Vitamins B-6 (-) ➢ B-12 (-) ➢ Magnesium (-) ➢ Iron (-) ➢ Zinc (-)
(Robaina & Martin, 2013)	➢ food pantry clients in Hartford, CT (2010-2011) ➢ N=212	**Food Security:** ➢ 18-item HFSSM **Diet quality:** ➢ 100-item Block Food Frequency Screener: usual intake of fruit, vegetable and fibre intake (scores ranged from 0-50. Portion sizes not assessed **Controls** : ➢ age, sex, education, income	➢ Fruit intake (-) ➢ Vegetable intake (-) ➢ Fibre intake (-)
(Rose & Oliveira, 1997)	➢ CSFII 1989-1991 ➢ Women (19-50): (n=3774) ➢ Elderly (≥65 y):	**Food security:** ➢ USDA Household Food insufficiency questionnaire	<u>Women (19-50):</u> ➢ Energy intake (-) ➢ Calcium (-) ➢ Protein (-) ➢ Vitamin A (-)

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
	(n=2215)	**Diet quality:** ➢ One 24-hour recall: - nutrient intakes **Controls :** ➢ Age, sex, race/ethnicity, pregnancy/lactation status, current smoking status, income, size and structure of the household, location and ownership of the home, participation in food assistance programs, schooling of the household head, observation day, quarter, and year	➢ Vitamin E (-) ➢ Vitamin C (-) ➢ Vitamin B6 (-) ➢ Phosphorous (-) ➢ Magnesium (-) ➢ Riboflavin (-) ➢ Niacin (-) <u>Elderly (≥65 y):</u> ➢ Energy intake (-) ➢ Calcium (-) ➢ Vitamin A (-) ➢ Vitamin E (-) ➢ Vitamin B6 (-) ➢ Folate (-) ➢ Zinc (-) ➢ Riboflavin (-) ➢ Niacin (-)
(Zizza et al., 2008)	NHANES 1999-2002 Adults (18-60 y): ➢ Women (n=2707) ➢ Men (n=2933)	**Food security:** ➢ 18-item FSSM **Diet quality:** ➢ one 24-hour recall ➢ Number of meals and snacks ➢ Energy contribution and energy density and frood groups sources from snacks and meals **Controls :** ➢ age, ethnicity/race, education, income	<u>Women:</u> ➢ Protein (+): MFS$^{\bullet}$ ➢ Total fat (+): FIWH$^{\oplus}$ ➢ Saturated fat (+): FIWH ➢ Total meals (-) FIWOH$^{\varnothing}$/ FIWH ➢ Energy per snack (+): FIWH <u>Men:</u> ➢ Protein (-): FIWH ➢ Total meals (-): FIWOH ➢ Total snacking (-) : FIWOH

Study	Sample Characteristics	Methods	Significant Associations with Food Insecurity (association)
			➢ Total energy from snacking (+): FIWOH ➢ Energy density (-): FIWH ➢ Snack kcal density(-):FIWOH

(+) Intakes of Food insecure are significantly higher than food secure
(-) Intakes of Food Insecure are significantly lower than food secure
(≠) No significant difference between levels of food security
•MFS: Marginally food secure; ∅FIWOH: food insecure without hunger; ⊕FIWH: food insecure with hunger

APPENDIX III (Continued)

An overview of studies assessing the relationship between food insecurity and diet quality in Canada

Study	Sample Characteristics	Methods	Results: Associations with Food Insecurity (association)
(Decelles, 2014)	➢ FNFNES (2010) results from Manito ➢ First Nations adults (≥19 years living on-rserve ➢ N=550	**Food security:** ➢ 18-item HFSSM **Diet Quality:** ➢ 24-hour recall ➢ nutrient intakes **controls** : ➢ eco-zone, energy intake	<u>Women 31-70:</u> ➢ Vitamin B6 (-)
(Eid, 2011)	➢ FNFNES (2010) results from British Columbia ➢ First Nations adults (≥19 years living on-rserve ➢ N=493	**Food security:** ➢ 18-item HFSSM **Diet Quality:** ➢ 24-hour dietary recall ➢ nutrient intakes **Controls :** ➢ age, eco-zone, energy intake	Women (≥19 years) in severe food insecurity: ➢ saturated fat (-) ➢ unsaturated fat (-) ➢ sodium (-)
(Egeland, Williamson-Bathory, Johnson-Down, & Sobol, 2011)	➢ Inuit Adults (≥18 years) from 36 arctic communities (2007-2008) ➢ n=1901	**Food security:** ➢ 18-iten HFSSM **Diet quality:** ➢ One 24-hour recall ➢ nutrient intakes ➢ Past-day TF consumption **Controls:** ➢ age	<u>Men:</u> ➢ Energy intake (-) ➢ Energy-adjusted fibre (-) ➢ Vitamin C (-) ➢ Iron (-) ➢ Zinc (-) ➢ Magnesium (-) <u>Women:</u> ➢ Carbohydrates (+) ➢ Fibre (-) ➢ Dietary folate

Study	Sample Characteristics	Methods	Results: Associations with Food Insecurity (association)
			equivalent (-) ➢ Vitamin C (-) ➢ Iron (-) ➢ Magnesium (-) ➢ Calcium (-) ➢ Vitamin D (-)
(Tarasuk & Beaton, 1999)	➢ women (19-49 years old) with at least one child (<15 y) of families receiving food assistance in Toronto, Canada ➢ N=153	**Food security**: ➢ 30 day scale items from the USDA Food Security Model **Diet quality**: ➢ 3 x 24-hour recall ➢ Nutrient intakes **Controls:** ➢ Disposablle income, employment income in the household, presence of a parner in the HH, woman's lvl of education, smoking status, ethnoracial identity	➢ Energy intake (-) ➢ Protein (-) ➢ Carbohydrates (-) ➢ Total fats (-) ➢ Vitamin A (-) ➢ Folate (-) ➢ Fe (-) ➢ Mg (-) ➢ Zn (-)
(Kirkpatrick & Tarasuk, 2008)	➢ 2004 CCHS (2.2) ➢ Representative sample of canadian population (1-70 years old) ➢ n=35,107,	**Food security:** ➢ 18-item HFSSM **Diet quality**: ➢ 24-hour recalls, 2nd 24-h recall for 10,786 respondents ➢ nutrient intakes ➢ Canada's Food Guide servings **Controls :** ➢ income, education, immigrant status, smoking, household	➢ Energy intake (-):M[3] ➢ Energy density (-):F[1] ➢ Protein (-):M[2], M[3], F[3] ➢ Fibre (-):F[1], F[2] ➢ Vitamin A (-):M[3] ➢ Vitamin D (-): M[3] ➢ Vitamin C (-): M[1] ➢ Thiamin (-): M[3] ➢ Riboflavin (-): M[3]

Study	Sample Characteristics	Methods	Results: Associations with Food Insecurity (association)
		size	➢ Niacin (-): M^2 ➢ Vitamin B (-):M^3 ➢ Folate (-):F^3 ➢ Vitamin B-12(-):M^1, M^2, M^3 ➢ Calcium (-): M^3 ➢ Fe (-): M^3 ➢ Mg (-):F^2, M^3 ➢ Phosphorous (-): M^3 ➢ Zn (-): M^2, M^3 ➢ Na (-):F^2, M^3 ➢ Fruits and vegetables (-):M^1, F^1, F^2 ➢ Milk products (-):M^1, M^3, F^3 ➢ Meat and alternatives (-): M^2 ➢ Grain products (-): M^3
Huet et al. (2012)	➢ Inuit Health Survey (2007-2008): 36 communities in Inuvialuit, Nunavut and Nunatsiavut ➢ N=1901 adults	**Food security** ➢ 18-tiem HFSSM **Diet quality:** ➢ 24-hour dietary recall ➢ Canadian adaptation of HEI **Controls :** age, sex, region	➢ HEI (-) ➢ Vegetables and fruit (-) ➢ Grains (-) ➢ Dairy products (-) ➢ Energy from high-sugar foods (+)

(+) Intakes of Food insecure are significantly higher than food secure
(-) Intakes of Food Insecure are significantly lower than food secure
(≠) No significant difference between levels of food security
M^1: Males 19-30;M^2: Males:31-50;M^3: Males: 51-70; F^1: Females:19-30 ;F2 :Females:31-50;F^3: Females51-70

APPENDIX IV – Serving sizes of mixed dishes, by weight

Mixed Foods	Food Code	Grain Products	Vegetable & Fruits	Milk Products	Meat & Alternatives	Serving Size	Examples of mixed foods
junk	0	-	-	-	-	-	-
simple food	1	-	-	-	-	-	-
Grains and Meat	2	1			1	100g	Rice fried with meat, bannock with eggs, hamburger sandwich
Grains and Milk Products	3	1		0.5		150g	Cheese pizza, cheese tortellini, macaroni and cheese
Grains and Vegetables	4	2	1			150g	Bread raisin, potato gnocci, granola bar with blueberries
Grains, Vegetables and Meat	5	1	1		0.5	150g	Egg roll with meat, cabbage rolls, Chimichanga without cheese
Grains, Vegetables and Milk Products	6	1	1	0.5		200g	Meatless lasagna, cheese pizza with vegetables, Cannelloni with cheese and spinach,
Grains, Meat and Milk Products	7	1		0.5	0.5	200g	French toast, Quiche Lorraine, croissant with egg, cheese and sausage (fast food)
Vegetables and Meat	8		1		1	150g	Succotash, Chili con carne, meat and vegetable stew
Vegetables and Milk Products	9		1	1		150g	Tzaziki, poutine, scalloped potatoes au gratin
Grains, Vegetables, Meat and Milk Products	10	1	0.25	0.5	0.5	200g	Spinach quiche, all dressed pizza, lasagna with meat, Burrito
Meat and milk products	11			1	1	150g	Eggnog, Sausage cheesefurter, chicken parmesan
Vegetables, meat and milk products	12		0.5	1	0.5	200	Clam chowder, Mixed dishes, (chicken, broccoli, cheese), Salad with egg, cheese, vegetables

APPENDIX V – SAS program for calculating the HEI score

```
data heicoding; set sumsvg;
*VEG AND FRUIT;
if gender=1 and agegroup in ("19-30" "31-50") then FVHEI=(nbsvgfl/7)*10;
if gender=2 and agegroup in ("19-30" "31-50") then FVHEI=(nbsvgfl/8)*10;
if agegroup in ("51-70" "71+") then FVHEI=(nbsvgfl/7)*10;
if FVHEI>10 then FVHEI=10;

*WHOLE FRUITS;
if gender=1 then WFHEI=(nbsvgwfrt/1.5)*5;
if gender=2 and agegroup in ("19-30" "31-50") then WFHEI= (nbsvgwfrt/2)*5;
if gender=2 and agegroup in ("51-70" "71+") then WFHEI= (nbsvgwfrt/1.5)*5;
if WFHEI>5 then WFHEI =5;

*DARK GREEN AND ORANGE VEG;
if gender=1 then DGOHEI=(nbsvgdgror/1.5)*5;
if gender=2 and agegroup in ("19-30" "31-50") then DGOHEI =(nbsvgdgror
/2)*5;
if gender=2 and agegroup in ("51-70" "71+") then DGOHEI =(nbsvgdgror/1.5)*5;
if DGOHEI >5 then DGOHEI =5;

*TOTAL GRAIN;
if gender=1 then GRAINHEI= (nbsvgbrd/6)*5;
if gender=2 and agegroup in ("19-30" "31-50") then GRAINHEI= (nbsvgbrd/8)*5;
if gender=2 and agegroup in ("51-70" "71+") then GRAINHEI= (nbsvgbrd/7)*5;
if GRAINHEI>5 then GRAINHEI=5;

*WHOLE GRAIN;
if gender=1 then WGRAINHEI= (nbsvgwgrn/3)*5;
if gender=2 and agegroup in ("19-30" "31-50") then WGRAINHEI=
(nbsvgwgrn/4)*5;
if gender=2 and agegroup in ("51-70" "71+") then WGRAINHEI=
(nbsvgwgrn/3.5)*5;
if WGRAINHEI>5 then WGRAINHEI=5;

*Milk and alternative;
if agegroup in ("19-30" "31-50") then DAIRYHEI= (nbsvgdry /2)*10;
if agegroup in ("51-70" "71+") then DAIRYHEI= (nbsvgdry /3)*10;
if DAIRYHEI >10 then DAIRYHEI=10;

*Meat and alternative;
if gender=1 then MEATHEI = (nbsvgmet /2)*10;
if gender=2 then MEATHEI = (nbsvgmet /3)*10;
if MEATHEI >10 then MEATHEI=10;

*sodium;
If sodium >= 4600 then NAHEI=0;
Else if sodium <= 1500 then NAHEI =10;
Else if sodium >= 2300 then
      NAHEI = 8-(8* (sodium-2300)/2300);
Else NAHEI= 10-(2* (sodium-1500)/800);
```

```
*Unsaturated fat (15 ml = 1 srvg);
Unsat=sumpufa + summufa;
IF gender=1 then UNSATHEI=10*(unsat/30);
IF gender=2 then UNSATHEI=10*(unsat/45);
if UNSATHEI> 10 THEN UNSATHEI=10;


/*Saturated fat
Standard for maximum score is <=7% total kcal, Maximum score is 10
 10% total kcal, score is 8, >=15% total kcal, minimum score is zero; */

IF sumKCAL > 0 THEN PCTSFAT=100*(sumSFAT*9)/sumKCAL; /*Calculate percent of
calories from Saturated fat*/
if pctsfat >= 15 then SATFATHEI=0;
  else if pctsfat <= 7 then SATFATHEI =10;
  else if pctsfat > 10 then
      SATFATHEI = 8-( 8 * (pctsfat-10)/5 );
  ELSE SATFATHEI = 10-(2 * (PCTSFAT-7)/3 );

* Other food (% total energy) ;
Pctkcalother=(sumkcalother/sumkcal)*100;
IF pctkcalother >= 40 then OTHERHEI=0;
      Else if pctkcalother <= 5 then OTHERHEI=20;
      Else OTHERHEI=20-(20*(pctkcalother-5)/35);

Array ArrHEI(11) FVHEI WFHEI  DGOHEI  GRAINHEI  WGRAINHEI  DAIRYHEI  MEATHEI
UNSATHEI   NAHEI  SATFATHEI  OTHERHEI;
      do i=1 to 11;
            if ArrHEI(i)=. then ArrHEI(i)=0;
      end;

/*Total score*/
TotalHEI =FVHEI+WFHEI+ DGOHEI+ GRAINHEI+ WGRAINHEI+ DAIRYHEI+ MEATHEI+
UNSATHEI + NAHEI+ SATFATHEI +OTHERHEI;
    run;
```

APPENDIX VI – Description of NOVA subgroups

NOVA Subgroups		CANDAT descriptors
UNPROCESSED OR MINIMALLY PROCESSED		
1	GRAINS AND FLOURS-MARKET	Raw/crude, pearled, cooked, boiled, drained, dried, sprouted, toasted, decorticaded, de-germed, parboiled, enriched, hot cereals, rice with salt added
2	GRAIN PRODUCTS - TRADITIONAL	-
3	PULSES	Raw, boiled, frozen, dried, roasted, drained, stir-fried, dehydrated, home prepared, beans with salt added,
4	MEAT AND POULTRY-market	Raw, aged, cooked, boiled, roasted, stewed, breaded, fried, braised, simmered, baked, broiled, flour coated, batter dipped, ground, water chill,
5	MEAT- traditional	-
6	MILK AND PLAIN YOGURT	Whole, pasteurized, homogenized, evaporated, dried, reduced fat, partly skimmed, powdered, plain yogurt
7	FRUITS + RAW FRUIT JUICE - MARKET	Raw, frozen and unsweetened, dried, cooked/uncooked, sliced, microwaved, dried, cooked and added sugar, guava or apple sauce, pruneau purée,
8	FRUITS + RAW FRUIT JUICE - TRADITIONAL	-
9	VEGETABLES-MARKET	Raw, frozen, boiled, drained, unprepared, freeze dried, cooked, chopped, steamed, baked, dried, boiled, drained and salt added, sun-dried, mashed
10	ROOTS AND TUBERS	Raw, frozen and unprepared, cooked, boiled, baked, drained, dehydrated, home prepared with whole milk, microwaved, dry mix (unprepared), mashed, hashed brown
11	EGGS	Raw/fresh, frozen, fried, dried, boiled, spray dried (powder), scrambled, poached, omelet
12	EGGS- TRADITIONAL	-
13	FISH - MARKET	Raw, dried, broiled, poache,d baked, home prepared
14	FISH-TRADIATIONAL	-
15	NUTS AND SEEDS	Raw, boiled, dried, dried roasted, blanched/unblanched, coconut meat or water raw/unsweetened
16	PASTA	Raw, dry cooked, enriched, home prepared, couscous, breaded and fried
17	HOMEMADE DISHES	Soups, biscuit, cakes, cookies, stews, etc.
18	OTHER UNPROCESSED OR MINIMALLY PROCESSED FOODS	Spices (fresh, dried, powder, ground), water, coffee, tea sweetened or unsweetened (brewed, instant powder, decaffeinated, powder, coffee substitutes prepare with water), yeast
PROCESSED CULINARY INGREDIENTS		
19	SUGAR	White and brown sugar, molasses, powder ice, corn syrup, honey, maple syrup, fructose (dextrose), other syrups (grenadine, cane)
20	PLANT OILS	All vegetable oils, salad dressing made from recipes, fish oils
21	ANIMAL FATS - MAKRETS	Cream (table, whipping, sour), butter (unsalted and salted), butter milk, animal fats
22	ANIMAL FATS - TRADITIONAL	-
23	SALT	Table salt

24	OTHER INGREDIENTS	Vinegar, cornstarch, leavening agents, unsweetened cocoa powder
PROCESSED FOODS		
25	CHEESE	All cheese except if processed or creamed with flavours
26	PRESERVED FRUITS, VEGETABLES AND PULSES	Fruits frozen or dried and sweetened, canned fruits/vegetables/pulses, fruits (sulphured), vegetables (pickled), popcorn (air-popped), vegetables packed in oil, tomatoe ripened (canned), coconut meat or cream (sweetened or canned), hummus (commercial), candied fruits
27	PRESERVED MEAT AND FISH - MARKET	Ham/pork/beef (sliced, cured, minced or pickled), fish/seafood (canned, smoked, salted, pickled), chicken/turken breast (smoked, honey glazed),
28	PRESERVED MEAT AND FISH - TRADITIONAL	-
29	OTHER PROCESSED FOODS	Salted, sweetened or oil roasted nuts and seeds; almond paste; tofu (with magnesium chloride and/or calcium sulphate), milk condensed (sweetened and canned), soya fermented products (tempeh), artisanal breads (breads homemade recipe, pita, bannock), peanut butter (regular), dumpling
ULTRA-PROCESSED FOODS		
30	INDUSTRIAL BREADS	All types of bread (not homemade or pita), tortilla and tacos, bagel, croissant (regular), roll, English muffin, French toast (frozen),
31	RECONSTITUTED MEATS	All sausages and chorizos, luncheon meats (bologna, peperoni, salami, mortadella, pastrami), ham/chicken spread, corned beef, bacon, pate (canned), fish sticks, beef jerky, simulated meats, pork and gravy (canned), based meat snacks,
32	CARBONATED, SPORTS AND ENERGY DRINKS	Regular and diet carbonated drinks, sports drinks, energy drinks
33	FRUIT JUICES AND DRINKS	All juices (canned, bottled or frozen concentrate), coffee or tea with flavours, frozen popsicles, tomato juices
34	CHOCOLATE, CANDIES AND OTHER SWEETS	All candies, chocolate syrup or flavoured beverage mix or powder, pie fillings, coffee whitener, whipped cream, dessert toppings, strawberry mix powder, fruit leathers, puddings, table blend syrups, chocolate spreads, gelatins, sweets, jams, preserves, and jellies
35	SWEET MILKS	Ice cream, egg nog mix, chocolate milk (from powder or syrup + milk), malted milk, flavoured or sweetened yogurt, milkshakes, minigo, petit danone, Ensure products
36	COOKIES, CAKES AND BAKED GOODS	All cakes, cookies or biscuits (except homemade), flavoured croissant and Danish pastries, doughnuts, muffins, ice cream cones, pancakes (dry mix), sweet roll, toaster pastry, granola bar
37	CHIPS, CRACKERS AND OTHER SALTY SNACKS	Potato chips, pretzels, banana chips, rice cakes, tortilla chips, all crackers, bread sticks
38	SAUCES & SPREADS	All salad dressing (commercial), canned or dehydrated sauces and gravy, relish, ketchup, tomato sauces (canned), peanut butter (salt and sugar added)
39	MARGARINE	Margarines and shortening
40	BREAKFAST CEREALS	All cereals (ready-to-eat), hot cereals with flavour added and creamed
41	FAST FOOD	Includes all food items consumed at fast food outlet
42	OTHER ULTRA-PROCESSED PRODUCTS	Egg substitutes, sweeteners, protein shales, meal replacements, fish or seafood imitations, veggie deli slices and veggie sausages, frozen and prepared French fries, beans and wieners (canned), onion rings (frozen),

		macaroni and cheese (canned), baby products, soups (dehydrated, dry mix, canned, condensed, ready-to-serve, instant cup),

Université de Montréal

Comité d'éthique de la recherche en santé

15 February 2016

Objet: Approbation éthique – « Pulling together for health: Food security in first nations communities »

M. Malek Batal & Mme Lara Steinhouse,

Le Comité d'éthique de la recherche en santé (CERES) a étudié le projet de recherche susmentionné et a délivré le certificat d'éthique demandé suite à la satisfaction des exigences précédemment émises. Vous trouverez ci-joint une copie numérisée de votre certificat; copie également envoyée au Bureau Recherche-Développement-Valorisation.

Notez qu'il y apparaît une mention relative à un suivi annuel et que le certificat comporte une date de fin de validité. En effet, afin de répondre aux exigences éthiques en vigueur au Canada et à l'Université de Montréal, nous devons exercer un suivi annuel auprès des chercheurs et étudiants-chercheurs.

De manière à rendre ce processus le plus simple possible et afin d'en tirer pour tous le plus grand profit, nous avons élaboré un court questionnaire qui vous permettra à la fois de satisfaire aux exigences du suivi et de nous faire part de vos commentaires et de vos besoins en matière d'éthique en cours de recherche. Ce questionnaire de suivi devra être rempli annuellement jusqu'à la fin du projet et pourra nous être retourné par courriel. La validité de l'approbation éthique est conditionnelle à ce suivi. Sur réception du dernier rapport de suivi en fin de projet, votre dossier sera clos.

Il est entendu que cela ne modifie en rien l'obligation pour le chercheur, tel qu'indiqué sur le certificat d'éthique, de signaler au CERES tout incident grave dès qu'il survient ou de lui faire part de tout changement anticipé au protocole de recherche.

Nous vous prions d'agréer, Madame, Monsieur, l'expression de nos sentiments les meilleurs,

Dominique Langelier, présidente
Comité d'éthique de la recherche en santé (CERES)
Université de Montréal

DL/GP/gp
c.c. Gestion des certificats, BRDV
p.j. Certificat #16-011-CERES-D

adresse postale
C.P. 6128, succ. Centre-ville
Montréal QC H3C 3J7

3744 Jean-Brillant
4e étage, bur. 430-11
Montréal QC H3T 1P1

Téléphone : 514-343-6111 poste 2604
ceres@umontreal.ca
www.ceres.umontreal.ca

Université de Montréal

Comité d'éthique de la recherche en santé

20 juin 2017

Objet: Certificat d'approbation éthique - 1er renouvellement – « Pulling together for health: Food security in first nations communities »

M. Malek Batal, M. Jean-Claude Moubarac & Mme Lara Steinhouse,

Le Comité d'éthique de la recherche en santé (CERES) a étudié votre demande de renouvellement pour le projet de recherche susmentionné et a délivré le certificat d'éthique demandé suite à la satisfaction des exigences qui prévalent. Vous trouverez ci-joint une copie numérisée de votre certificat; copie également envoyée au Bureau Recherche-Développement-Valorisation.

Notez qu'il y apparaît une mention relative à un suivi annuel et que le certificat comporte une date de fin de validité. En effet, afin de répondre aux exigences éthiques en vigueur au Canada et à l'Université de Montréal, nous devons exercer un suivi annuel auprès des chercheurs et étudiants-chercheurs.

De manière à rendre ce processus le plus simple possible et afin d'en tirer pour tous le plus grand profit, nous avons élaboré un court questionnaire qui vous permettra à la fois de satisfaire aux exigences du suivi et de nous faire part de vos commentaires et de vos besoins en matière d'éthique en cours de recherche. Ce questionnaire de suivi devra être rempli annuellement jusqu'à la fin du projet et pourra nous être retourné par courriel. La validité de l'approbation éthique est conditionnelle à ce suivi. Sur réception du dernier rapport de suivi en fin de projet, votre dossier sera clos.

Il est entendu que cela ne modifie en rien l'obligation pour le chercheur, tel qu'indiqué sur le certificat d'éthique, de signaler au CERES tout incident grave dès qu'il survient ou de lui faire part de tout changement anticipé au protocole de recherche.

Nous vous prions d'agréer, Madame, Messieurs, l'expression de nos sentiments les meilleurs,

Guillaume Paré
Conseiller en éthique de la recherche.
Comité d'éthique de la recherche en santé (CERES)
Université de Montréal

c.c. Gestion des certificats, BRDV
p.j. Certificat #16-011-CERES-D(1)

adresse postale
C.P. 6128, succ. Centre-ville
Montréal QC H3C 3J7

3744 Jean-Brillant
4e étage, bur. 430-11
Montréal QC H3T 1P1

Téléphone : 514-343-6111 poste 2604
ceres@umontreal.ca
www.ceres.umontreal.ca

Université de Montréal

Comité d'éthique de la recherche en santé

N^O de certificat
16-011-CERES-D(1)

CERTIFICAT D'APPROBATION ÉTHIQUE
- 1er renouvellement -

Le Comité d'éthique de la recherche en santé (CERES), selon les procédures en vigueur et en vertu des documents relatifs au suivi qui lui a été fournis conclu qu'il respecte les règles d'éthique énoncées dans la Politique sur la recherche avec des êtres humains *de l'Université de Montréal*

Projet	
Titre du projet	**Pulling together for health: Food security in first nations communities**
Chercheurs requérants	**Malek Batal** (10000960), Professeur agrégé, Faculté de médecine - Département de nutrition **Lara Steinhouse** (ND), Candidate à la M. Sc. en nutrition, Faculté de médecine - Département de nutrition **Jean-Claude Moubarac** (ND), Professeur adjoint, Faculté de médecine - Département de nutrition

Financement	
Organisme	IRSC
Programme	Bridge funding
Titre de l'octroi si différent	
Numéro d'octroi	
Chercheur principal	
No de compte	

MODALITÉS D'APPLICATION

Tout changement anticipé au protocole de recherche doit être communiqué au CERES qui en évaluera l'impact au chapitre de l'éthique. Toute interruption prématurée du projet ou tout incident grave doit être immédiatement signalé au CERES.

Selon les règles universitaires en vigueur, un suivi annuel est minimalement exigé pour maintenir la validité de la présente approbation éthique, et ce, jusqu'à la fin du projet. Le questionnaire de suivi est disponible sur la page web du CERES.

[redacted]

Conseiller en éthique de la recherche.
Comité d'éthique de la recherche en santé
Université de Montréal

20 juin 2017
Date de délivrance du renouvellement ou de la réémission*

1er juillet 2018
Date du prochain suivi

15 février 2016
Date du certificat initial

1er juillet 2018
Date de fin de validité

*Le présent renouvellement est en continuité avec le précédent certificat

adresse postale
C.P. 6128, succ. Centre-ville
Montréal QC H3C 3J7

3744 Jean-Brillant
4e étage, bur. 430-11
Montréal QC H3T 1P1

Téléphone : 514-343-6111 poste 2604
ceres@umontreal.ca
www.ceres.umontreal.ca

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Nº de certificat
16-011-CERES-D

Comité d'éthique de la recherche en santé

CERTIFICAT D'APPROBATION ÉTHIQUE

Le Comité d'éthique de la recherche en santé (CERES), selon les procédures en vigueur, en vertu des documents qui lui ont été fournis, a examiné le projet de recherche suivant et conclu qu'il respecte les règles d'éthique énoncées dans la Politique sur la recherche avec des êtres humains *de l'Université de Montréal.*

Projet	
Titre du projet	**Pulling together for health: Food security in first nations communities**
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	Coordination du projet: Jean-Claude Moubaracx

Financement	
Organisme	IRSC
Programme	Bridge funding
Titre de l'octroi si différent	
Numéro d'octroi	
Chercheur principal	
No de compte	

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[redacted]

Dominique Langelier, présidente
Comité d'éthique de la recherche en santé
Université de Montréal

15 février 2016
Date de délivrance

1er mars 2017
Date de fin de validité

adresse postale
C.P. 6128, succ. Centre-ville
Montréal QC H3C 3J7

3744 Jean-Brillant
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Montréal QC H3T 1P1

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ceres@umontreal.ca
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