Obesity prevention in the Canadian Arctic

OBESITY PREVENTION IN THE CANADIAN ARCTIC

Exploring the Determinants of Energy Balance-Related Behaviors and Opportunities for Action

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Chapter 1

General introduction

Background

Canadian Inuit have been undergoing rapid dietary transition in the last five decades which reflects both a disruption to, and shift away from, their traditional ways of life (1). The shift is largely due to the adoption of Western values and acculturation into the Euro-Canadian system, all of which have subjected the population to developing energy balance-related health problems (2,3). An increasing body of evidence suggests that unhealthy behaviors such as the consumption of poor diets and less physical activity in the past few decades have resulted to significant weight gain, and are major drivers of the rising rates of diet-sensitive chronic diseases (4,5,6,7). The prevalence rates for Diabetes Type II (1.51%) and hypertension (10.83%) in 2004/2005 have increased to 3.31% and 16.02%, respectively, by 2012/2013 (8). These rates are not too surprising considering the prevalence of obesity in the population and the role of obesity as a critical risk factor of Diabetes Type II.

In comparison to other jurisdictions in Canada, Nunavut has the second highest age-adjusted obesity rate at 25.6% and the highest youth obesity rate at 45.4% (9). Additionally, a nutrition-related anthropometric study of 388 three to five-year old Inuit children in Nunavut showed that the prevalence of overweight and obesity in the territory is significantly higher than initially thought, with 57.1% of boys and 45.2% of girls classified as overweight (10). These rates have implications for adult health outcomes. There is therefore a growing concern among health professionals about the rising rates of obesity, Diabetes Type II, cardiovascular diseases, and some cancers in the population, with increasing calls for more focused health promotion interventions to address energy balance-related health issues in the population (11,12,13,14,15).

The aim of this PhD dissertation is to provide an overview of the determinants of energy balance-related behaviors among Canadian Inuit adults and identify specific factors that are critical for the development and implementation of an effective obesity prevention interventions in the population.

The Inuit Population in Nunavut

The Inuit are one of the three Indigenous Peoples of Canada, occupying more than one third of Canada's land mass and spread across three regions: Inuvialuit, Nunavik, and Nunavut (1). Nunavut is the largest of the four Inuit regions, becoming a territory in 1999 with approximately 49% of the national Inuit population (1). The territory is located in the Arctic Region of Canada (Figure 1) and covers an extensive area of 2,093,190 km^2, accounting for 21% of Canada's land and freshwater area (16). Nunavut is unique compared to other jurisdictions in Canada owing to the remoteness of its 25 communities in the Arctic, the dispersion of the small population of approximately 38,243 people, 84.2% Inuit and 15.8% non-Inuit (17). The Inuit in Nunavut have the highest population growth rate and are the youngest demographic group in Canada with a median age of 22, compared to 40, nationally (1).

In the 1960s, many Inuit families were relocated to resource-limited environments in the Arctic North by the federal government to protect the Canadian interest in the region. The families were dislocated from their familiar environments creating livelihood challenges. Moreover, the relocation to unfamiliar and resource-limited environments limited their traditional food gathering and other cultural activities. Traditional food (TF), consisting mainly of land and marine animals, is a marker of traditional and social practices which are embedded in the Inuit's cultural identity (18). Food gathering was necessary for subsistence, and historically a diet selection process through which healthy TFs were harvested by Inuit on the one hand, and excess energy was lost to food-gathering process on the other hand. Harvesting (hunting, trapping, fishing) and processing of foods were physically demanding and required some degree of fitness and active living (19,20).

Accessibility and availability of healthy foods and medical supplies from the Southern part of Canada are hampered by a unique transportation problem in Nunavut. There are no roads or railways connecting Nunavut to Southern provinces, or between any two Nunavut communities; air travel is the only means of travelling between communities and out of the territory (21), except during summer when sealift activities take place. This results in high living costs, prohibitive expenditures on airfares, medical facilities, food supplies, as well as on health

programs and services (21). In Nunavut, there is heavy reliance of households on store-bought processed foods from Southern Canada (22) since less local food gathering activities take place among Inuit. As well, many Inuit have adopted the Western lifestyles and become sedentary nowadays with access to the television, internet, gaming computers and dependence on a wage-based economy. While an average Canadian household spends $609 per month on food supplies, Nunavut households expend about $1992 monthly on the average (23), despite having the lowest household income amongst all provinces and territories in Canada (24), and unemployment rate of 13.5% versus 6.8% nationally (25). The Government of Nunavut provides income assistance to individuals and families as a last resort and to defray the high costs of living in the territory. Approximately 45% of Nunavut Inuit receive income assistance (25) to meet their basic needs, particularly food supplies. Food insecurity and general household poverty are further aggravated by the fact that income-earning Inuit support more dependents than anywhere else in Canada at 82.1% compared to a national average of 59.2%.

The Nunavut Arctic Communities

The Inuit inhabit *Nunaat*, *Inuktitut* language expression for the traditional Inuit homeland, which spans across the Canadian Arctic and occupies more than one-third of Canada's land mass. *Nunaat* spreads across four discrete geographic regions—Inuvialuit, Nunavik, Nunatsiavut, and Nunavut (26). Nunavut is the largest of the four regions, becoming a territory in 1999. The area has a population of 37,082 (84.2% Inuit and 15.8% non-Inuit) and is divided into three regions: Qikiqtaaluk - North and South subregions, each with six communities); Kivalliq – eight communities; and Kitikmeot - five communities.

Seven communities were initially contacted and provided with information on the purpose of the study, including potential benefits to the participating communities and Nunavut in general. Four communities were selected based on the letters of support that were received from community leaders/administrators, the population size, and geographic spread across the three regions. This research work took place in + (South Qikiqtaaluk subregion), Resolute Bay (North Qikiqtaaluk subregion), Baker Lake (Kivalliq Region), and Cambridge Bay (Kitikmeot

region). In 1999, Iqaluit was designated the capital of Nunavut after the then Northwest Territory was split into two territories – Nunavut and Northwest territories. Nunavut then became an independent territory.

Iqaluit has a population of 7740 people and relies heavily on expensive air-freighted supplies such as foods, medical, and other household essentials. The city, like the rest of Nunavut, has no road or rail connections to other communities or the rest of Canada. Resolute Bay is Canada's second northernmost community, has a population of approximately 200, and is one of the coldest inhabited places in the world with an average yearly temperature of −15.7 °C. Baker Lake is located 320 km inland from Hudson Bay, it is near the nation's geographical centre, and is notable for being the Canadian Arctic's sole inland community with a population of 2069. Cambridge Bay was a traditional hunting and fishing location in the Kitikmeot region for caribou, muskox, Arctic char, lake trout, and ringed seal. These species remain important food sources today. The community has a modest population of 1766. Nunavut Inuit were traditionally nomadic hunter-gatherers who have survived on subsistence diets that are predominantly protein-based foods harvested locally, including caribou, Arctic hare, seal, fish, ptarmigan, goose, berries (27,28). Traditional foods are symbolic of Inuit cultural identity. An essential part of this is the food sharing systems and practices that reinforce the identity, promote communal living and social support and cohesion within the community (27,28).

Social-Ecological Changes in Nunavut Communities

The sociocultural and environmental changes in Inuit communities appear to largely contribute to the transitions from healthy traditional diets to less nutrient energy-dense store-bought foods on the one hand, and from active hunter-gatherer ways of life to increasingly more sedentary lifestyles, on the other hand, both resulting to weight gain. The social and cultural changes that swept across Inuit communities since the first contact with European immigrants have profoundly impacted virtually all spheres of Inuit life, which historically was rooted in Indigenous traditions. Many aspects of Inuit traditional life have been eroded, particularly the

hunter-gatherer identity and traditional food sharing practices. Food gathering is a critical traditional activity and is symbolic of Inuit cultural identity (29).

However, Euro-Canadian lifestyles and its domineering influence continue to subjugate Inuit traditions and influence their energy balance-related behaviors. Apart from increasingly becoming a less active population in contrast to pre-contact era, there is also a growing interest in less nutrient energy-dense store-bought Euro-Canadian diets among the younger generation of Inuit. This has in the last three decades resulted to significant weight gains, with increasing concerns about obesity trends in the population particularly amongst children. Additionally, a large proportion of Inuit are of lower socioeconomic status (SES), measured by education, employment, and income, which further aggravates the problem. A lower SES and pervasive household food inadequacy substantially reduce a household's ability to access healthy foods and engage in healthy dietary behaviors in the face of limited affordable and accessible choices.

Adequate daily physical activity is also essential to maintaining energy balance. A rapidly growing body of empirical evidence supports the influence of environmental factors on physical activity participation across populations, suggesting that the built environment is underpinned by attributes that influence physical activity behaviors (30,31,32). It is logical to state that modifications to the built environment can promote physical activity participation or foster sedentary behaviors and the consequential effects on health and general wellbeing. In Nunavut, changes to the built environment are an integral part of the social, cultural, and environmental shifts that the Canadian Arctic has experienced over the past five decades. For example, global industrialization and modernization that resulted in community planning and development have altered the traditional built environment and reduced hunting activities. Increasing dependence on wage-based economy and factory-processed foods instead of subsistence food gathering and manual processing, and transportation by automobiles have all eroded an active living lifestyle. These changes have taken place without the provision of adequate infrastructure and cultural resources in Nunavut communities to support active living and can be correlated with decreased physical activity participation according to research evidence (33). Particularly, subsistence activities that were associated with walking behavior, such as hunting, fishing, traditional food processing, etc., have remarkably decreased over time and replaced with modern modes of

transportation, including snow mobile and standard utility vehicles (34). Moreover, a body of research evidence supports a positive relationship between community walkability and residents' walking behavior (32,33,35).

Gaps in Knowledge

Peer-reviewed studies that examined dietary and physical activity-related behaviors of Inuit, including direct and indirect factors influencing these behaviors are scarce. Where studies are available, they have produced inconsistent results, or they are largely focused on metrics; quantifying the prevalence rates of illnesses, the extent of deplorability of social conditions (social determinants of health), and the associated public health problems. There is also a dearth of research that explored the perspectives of Inuit on factors influencing their dietary choices. Published studies (36,37,38,39,10) have mainly quantified the levels of food insecurity, identified obesity as a growing problem from epidemiological standpoint. Extensive literature search produced few studies that examined social and cultural factors as well as the lived experiences of Inuit, in relation to their dietary and physical activity-related behaviors, including interrelationship between factors mediating these behaviors.

Published articles that reported on determinants of physical (in)activity in Canadian Inuit population are equally scarce. It is clear from the longitudinal studies published about three decades ago (40,41) that a change from hunting-related subsistence ways of life to wage-based economy, mechanized and sedentary living due to Euro-Canadian cultural influences, are contributory to lower rates of participation in physical activity and corresponding fitness levels. Findings from more recent studies (42,43) on physical activities are inconsistent and perhaps unreliable because, despite claims that the self-report measures have been validated in Nunavut, the instruments appear to be questionable measures for determining physical activity levels in Inuit population. These instruments do not appear to fully account for physical activity of Inuit who engage in traditional and often seasonal "on-the-land activities". Moreover, articles by Hopping et al. 2010a, 2010b (42,43) reported a co-existence of overweight/obesity and high levels of physical activity in both Nunavut and Inuvialuit. This perhaps suggests that the use of

International Physical Activity Questionnaires (IPAQ) instrument was not appropriate for Inuit. The inconsistencies observed in the findings suggest that more research is needed to determine reliable age-specific physical activity levels in the population. A more objective measure of physical activity, such as accelerometry, might produce better results for the population as was the case for Greenland Inuit (44,45). Accelerometry in combination with heart rate measurement produced more accurate assessments of physical activity amongst Greenland Inuit, and when contrasted with IPAQ, generated more reliable results (44). Physical activity determination by accelerometry is an actual real-time objective measurement by an electronic sensor that measures acceleration. The device possesses a timing mechanism and a memory capacity that records movement parameters over a determined range of time. This approach removes recall bias and subjectivity associated with self-report instruments such as IPAQ.

Access to reliable data on the physical activity levels and consumption patterns is a necessary first step. As well, the cultural uniqueness and experiences of the Canadian Inuit in the Arctic call for a deeper understanding of the needs of the population. A few studies that explored the perspectives of Indigenous peoples suggest that an in-depth look at their lived experiences is necessary, given that diet selection and physical activity behaviors are embedded in Indigenous peoples' social and cultural practices (46,47,48). Given the strategic and regulatory role of the government in providing resources, understanding the extent to which the Government of Nunavut is committed to "fight" obesity as a "wicked problem" (49) could assist in identifying gaps for potential interventions. The political environment influences an organization's priorities, policies, and programs. The political environment is an upstream factor that controls the food environment, the built environment, and the healthcare systems in general terms. Research evidence has shown that organizational readiness for change particularly within the healthcare setting is a critical factor for successful and sustained implementation of change initiatives (50,51,52). It is thus expedient to examine the Government of Nunavut Department of Health's (NDH) readiness to implement changes to policies and programs to steer the population in the direction of healthy choices, and diminish obesity rate in the territory. Taken together, a deeper understanding of the level of NDH's readiness and the perspectives of Inuit who are directly impacted by policies and programs being implemented by NDH, may assist in identifying

appropriate elements that are required for the development and implementation of effective and sustainable obesity intervention programs in Nunavut.

Theoretical Framework

The studies reported in this thesis were conducted to address some of the gaps described above, and advance our understanding on the determinants of dietary behavior and physical activity among Nunavut Inuit in the Arctic. Our research was guided by the Social Ecological Model - SEM (53) and the Environmental Research framework for weight-Gain prevention -EnRG (54). The SEM contextualizes individuals' behaviors using dimensions that include intrapersonal (e.g. knowledge, attitudes, behavior), interpersonal (social networks, social support), community (e.g. relationships among organizations/ institutions, infrastructural development), and public policy (e.g. local, state, national policies, regulations) to provide a framework for describing the interactions between these levels, and the impacts they have on individuals' health behaviors (55). The SEM is based on the notion that environmental settings have physical, social and cultural dimensions, which may act as a stressor to, or an enabler of, health of an individual (53). The theoretical approach aims to uncover the interrelationship and influence of the cultural, economic, environmental and social factors at community, intercultural, interpersonal, and institutional levels (56).

The EnRG is a conceptual framework that is grounded in the social (psychological) ecological theories. The framework is underpinned by the notion that environmental factors influence energy balance-related behaviors (EBRB) both indirectly and directly. This influence is described as a dual process. The indirect (conscious) process is demonstrated by behavior-specific cognitions that mediate the influence of the environment on that particular behavior (e.g., riding bicycle to work instead of driving based on the knowledge that physical activity is good for me). This bicycle-riding behavior is cognitively mediated by the knowledge/belief that riding a bicycle increases physical activity because it improves my health and wellbeing. The direct influence reflects the automatic and often unconscious influence of the environment on behavior (e.g., the environmental prompts/cues by the sign that says "use stairs" automatically

activates the travel mode "stairs" and results in increased physical activity). This is an automatic environment – behavior process, that is, automatically activated goal-directed behavior. Both SEM and EnRG are congruent with Indigenous cultures, particularly within social, cultural and environmental settings that are undergoing rapid transitions as found in the Canadian Arctic. The EnRG framework then provides a theoretical basis for understanding larger environmental interrelated influences mediated by behavior-specific beliefs on individual's health behavior (54).

The SEM and the EnRG framework will be complemented by the Self-Determination Theory (SDT), which is used to predict self-regulated behaviors (57) such as diet and physical activity. The SDT focuses on the extent to which behaviors are autonomous or self-determined, and is particularly relevant to Indigenous population due to their past history of cultural suppression and assimilation into Euro-Canadian system. The theory proposes that motivated behavior aims to satisfy the three basic needs of competence, autonomy, and relatedness (57).

Moreover, the SDT describes a situation in which the quality of an individual's motivation influences whether the individual will engage in, and sustain, the health behavior. This theory distinguishes six cognitive regulations that reside along a continuum from amotivation, via controlled motivation (i.e., external and introjected regulation), to autonomous motivation (i.e., identified regulation, integrated regulation and-the optimal form-intrinsic motivation). Controlled motivation is characterized by feelings of pressure and lack of choice, either emanating from factors situated outside the person (e.g., punishment, deadlines: external regulation), or from inside factors (e.g., guilt, shame: introjected regulation). Autonomous motivation, as opposed to controlled motivation, is characterized by experiencing a sense of freedom in one's choices and is driven by feelings of personal relevance (e.g., exercise is important to me because it is good for my health: identified regulation), personal identity (e.g., I am a sporty type: integrated regulation) or enjoyment (intrinsic motivation) (57). Previous studies have demonstrated that autonomous motivation is associated with more favourable outcomes (e.g., greater well-being, greater participation in physical activity in a variety of contexts and greater perseverance; (58,59). Thus, a higher environmental walkability may increase an individual's motivation for exercise, for example easier walking opportunities may

lead to increased perceived behavioral control, which in turn increases motivation; an example of the indirect influence of the environment on physical activity behavior (54).

Outline of the Thesis

This dissertation describes the determinants of dietary behavior and physical activity amongst Nunavut Inuit in the Canadian Arctic, and reports on some preparatory studies to inform obesity prevention approaches in the population. **The second Chapter** presents the findings of a systematic review that examined the factors influencing the dietary behavior and physical activity participation amongst Canadian Inuit. **Chapter 3** reports on the objectively measured physical activity levels among Nunavut Inuit adults, and explores the socio-cognitive and environmental factors influencing the number of steps taken per day. The study presented in **Chapters 4** describes the barriers to, and enablers of, healthy dietary choices and physical activity participation from the perspectives of Nunavut Inuit who shared their lived experiences with us. In **Chapter 5**, we provided findings from a study that was conducted with policy makers and program officers who hold the responsibility and authority to develop and deliver obesity prevention policies and programs in the territory. Here, we explored the Nunavut public health system's commitment to implement obesity prevention policies and programs to reduce the burden of obesity-related diseases. Finally, **Chapter 6** discusses the most salient findings from the preceding chapters, and the methodical, theoretical, and practical implications of the studies.

Figure 1: The map of Nunavut relative to other provinces and territories in Canada

Figure 2: The BUILT ENVIRONMENT – Adequate community resources and infrastructure such as sidewalks, indoor sports facilities, etc. may increase participation in physical activity.

Figure 3: THE FOOD ENVIRONMENT – Cost, Affordability & Accessibility are Critical Factors.

Chapter 2

Determinants of dietary behavior and physical activity among Canadian Inuit: a systematic review

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Abstract

Background

Increased dependence on Western diets and low physical activity have largely contributed to weight gain and associated chronic diseases in the Canadian Inuit population. The purpose of this study was to systematically review factors influencing dietary and physical activity behaviors to guide health promotion interventions and provide recommendations for future studies.

Methods

We conducted a systematic literature review to identify relevant articles. Searches were conducted between May 2014 and July 2014, and inclusive of articles published up until July 2014. Articles were searched using four databases: PubMed, PsycINFO, SocINDEX, and Psychology and Behavioral Sciences Collection. Eligible studies focused on diet and/or physical activity or determinants of diet and/or physical activity in Canadian Inuit population, and were published in English.

Results

A total of 45 articles were included in the analysis. A detailed appraisal of the articles suggested that many Inuit have disconnected from the traditional ways of life, including harvesting and processing of traditional food species and the associated physical activity. In the last two decades there has been a significant shift from consumption of healthy traditional foods to energy-dense store-bought foods particularly among younger Inuit (<50 years of age). Additionally, low socioeconomic status (SES) and high transportation cost affect food accessibility and contribute to poor dietary choices in the population. However, a few articles that described the mediating role of psychosocial factors reported that higher SES, increased

healthful food knowledge, and self-efficacy towards healthy dietary behavior, were associated with greater intentions to make healthier food choices and participate in physical activity.

Conclusion

It is evident that the rapid social, cultural, and environmental changes in the Arctic have altered dietary and physical activity behaviors of Canadian Inuit. However, our understanding is limited on how these behaviors might be influenced in the face of these changes. Prospective studies are needed to advance our knowledge of cognitive and environmental determinants of Inuit energy balance-related behaviors. These studies can inform the development of health promotion interventions in the population.

Background

Over the past 50 years Canadian Inuit have been undergoing rapid dietary transition, which reflects a shift away from the traditional ways of living (1). This shift is largely due to the adoption of Western values and acculturation into Euro-Canadian system. As a result, the population is nowadays developing the so-called 'energy balance-related' health problems, such as diabetes and cardiovascular diseases (2,3). The rates of overweight and obesity in the population are particularly alarming. According to the 2007–2008 Inuit Health Survey (18), 29 % of Inuit men and 41.6 % of Inuit women are obese. The prevalence of abdominal obesity, measured by waist circumference, is 27.9 % among men and 59.8 % among women, compared to 29.1 % and 40 %, respectively, nationally. An increasing body of evidence suggests that unhealthy behaviors such as the consumption of energy dense food and sedentary lifestyle have resulted in significant weight gain, and are major drivers of the rising rates of diet-sensitive chronic diseases (19,20,21,23). For example, the prevalence of Diabetes Type II was about 1 % in 2002 and had increased to 4.4 % by 2008/2009 (60). As a result, there is a growing concern among health professionals about the rising rates of obesity, Diabetes Type II, cardiovascular diseases, and certain cancers among Inuit. This has led to increasing calls for more focused health promotion interventions to address the energy balance-related health issues in the population (10,4,5,6).

The Inuit are one of the three Indigenous Peoples of Canada and occupy more than one-third of Canada's total land mass. Canadian Inuit are spread across four regions: Inuvialuit, Nunatsiavut, Nunavik, and Nunavut (7). "Inuit" in this review includes the Inuvialuit from the Northwest Territories. Nunavut is the largest of the four Inuit regions with approximately 49 % of national Inuit population (7). The Inuit have the highest population growth rate and are the youngest demographic group in Canada with a median age of 22, compared to 40, nationally (7). In the 1960s, many Inuit families were relocated to resource-limited environments in the Arctic North by the federal government to protect Canadian interest in the region. As expected, relocation to unfamiliar environment created livelihood challenges for relocated Inuit. For example, the relocation restricted the traditional food [TF] gathering and other cultural activities. Today, Inuit like other Aboriginal groups live and gather foods within spaces which are fractions of the original land mass, and this limits traditional hunting and other food gathering activities (61). Food gathering was necessary for subsistence, and historically a diet selection process. Healthy TFs were harvested by Inuit on the one hand, and excess energy was lost to food-gathering process on the other hand. Harvesting (hunting, trapping, and fishing) and processing of foods were physically demanding and required some degree of fitness and active living (28,22).

At present, less local food gathering activities take place among Inuit. There is heavy reliance of households on store-bought processed foods from Southern Canada (62). Accessibility and availability of healthy foods from the Southern part of Canada are hampered by unique transportation problems. While there are limited road connections among communities in the other Inuit regions and to some southern cities, there are no roads or railways connecting Nunavut to Southern provinces, or between any two Nunavut communities. Air travel is the only means of movement between communities and traveling out of the territory (63), except during summer when sealift activities take place. This results in high living costs, high expenditures on airfares, medical facilities, food supplies, as well as on health programs and services (63). Although Inuit household income in Nunavut is significantly lower than that of Canadians in other jurisdictions, an average Inuit household in Nunavut however spends twice the Canadian average on food supplies on a monthly basis (64).

Since globalization and its attendant social and environmental changes in the Arctic North cannot be reversed or stopped it is important to explore health promotion interventions for the growing energy balance-related problems among Canadian Inuit. To guide intervention development, it is important to identify factors influencing the dietary and physical activity behaviors that have the strongest impact on the energy balance among Canadian Inuit, i.e., the so-called 'energy balance-related behaviors' (54). It is therefore pertinent to identify and systematically analyze behavioral studies that describe dietary and physical activity patterns of Canadian Inuit. Because systematic reviews on this topic are lacking, our objective was to systematically review the literature regarding the socioeconomic, psychological, cultural and environmental determinants of energy balance-related behaviors among Canadian Inuit. Additionally, we systematically assessed the body of literature on intervention studies to determine the strength of evidence and promising practices for the design of effective health promotion intervention programs. This information is of strategic importance to diet- and physical activity-related chronic disease prevention in Inuit population. We aimed to identify gaps in knowledge and propose priority areas for future research.

Methods

Search strategy and eligibility criteria

We conducted a systematic review of literature according to the standards described by the Institute of Medicine (65). The team of reviewers had expertise in systematic reviews. The reviewers conducted the literature searches between May 2014 and July 2014. The team designed a protocol and analytical framework for the entire review process as previously described (65). Briefly, the topic of interest was formulated and research questions were determined. The search strategy, screening, data extraction process and selection criteria were established. Articles were included up until July 2014. We searched for articles using the key words in two search term strings (Appendix A) in four databases: PubMed, PsycINFO, SocINDEX, and Psychology and Behavioral Sciences Collection. Environmental scan was also conducted to identify relevant grey literatures.

Inclusion/exclusion criteria

Articles were included only if: research subjects were Canadian Inuit, or articles reported disaggregated subset data of Canadian Inuit in case of multi-jurisdictional studies; if articles examined diet and/or physical activity or other behaviors (e.g., smoking or drinking) in relation to diet and/or physical activity; if articles included determinants of diet and/or physical activity; or examined health promotion interventions to improve diet and/or physical activity. Articles were also included irrespective of year of publication, gender, age, methodology, study design, and if published in English.

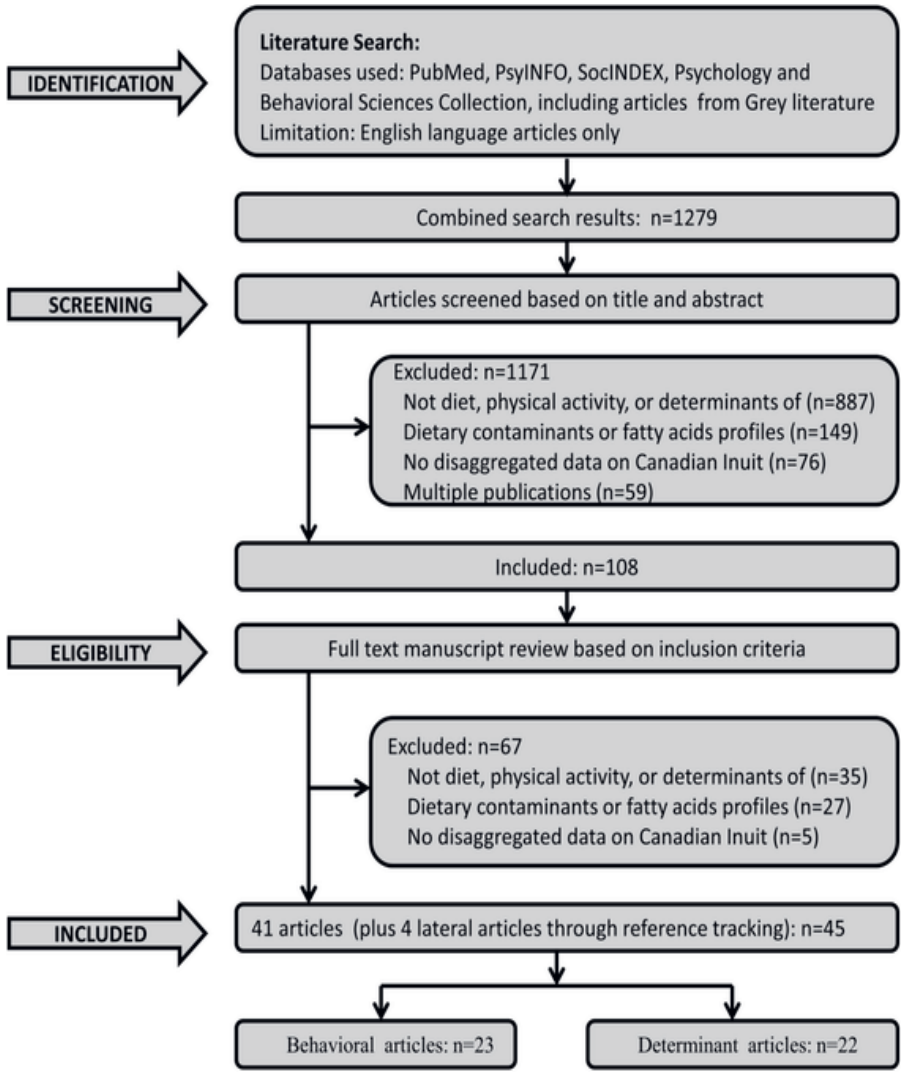
Articles were excluded if they: did not report disaggregated data of Canadian Inuit, were multi-jurisdictional; focus was on dietary contaminants or fatty acid profiles; did not report health promotion intervention on diet and/or physical activity. Two authors (V.A. and A.M.H.) independently screened all titles and abstracts of articles that were identified in the literature search for inclusion in the systematic review. Disagreement on manuscript inclusion was resolved by discussion. When in doubt the third author (S.K.) was consulted.

The review process

The systematic review process (Fig. 1) was divided into four major steps (identification, screening, eligibility, and included) according to the PRISMA scheme; a four-phase reporting procedure for systematic reviews (11). We started the process with an initial key words search, which produced 1279 records during the identification phase. These records were screened based on title and abstract yielding 108 potential articles for further evaluation to determine their eligibility for inclusion in the study. At the level of title and abstract reviews, a total of 1171 records were excluded from the initial 1279 records. Of these, 887 records were not on diet and/or physical activity, or determinants of either dietary behavior and/or physical activity; 149 articles focused on dietary contaminants and fatty acids profiles; 76 articles did not provide disaggregated data on Canadian Inuit. Additionally, 59 records were eliminated because they were duplicate publications. Full text manuscripts were retrieved for the remaining 108 articles and evaluated to determine their eligibility based on the inclusion/exclusion criteria. Following

evaluation, 41 articles were selected for full text review, and a total of 67 publications were discarded. Of these, 35 articles did not focus on diet and/or physical activity, or the determinants of diet and/or physical activity, 27 articles reported on dietary contaminants or fatty acids profiles; and five articles reported no disaggregated data on Canadian Inuit, and were excluded. In addition, lateral article searches using reference tracking produced four additional articles leading to a total of 45 articles for full text review.

Fig. 1 Flowchart of the Systematic Review Process (adapted from the PRISMA process developed by Liberati et al., (11)



Data extraction and analysis

The 45 articles were thoroughly read. Data were extracted and carefully evaluated using the six phases of thematic analysis described by Braun and Clarke (12). Briefly, phase 1 –

familiarizing ourselves with the data: VA and AM were guided by initial thoughts which were linked to the objectives of the study. We developed search terms (Appendix A) which were used to refine a set of codes for semantic theme analysis. Phase 2 – generating initial codes: VA and AM carefully examined each article for semantic patterns followed by notes taking and coding. The data were then organized into meaningful groupings. The data groups were systematically analyzed for repeated patterns and then coded, and re-coded until linkages were established between groups, and a thematic map emerged. Phase 3 – searching for themes: At this stage, all the relevant coded data extracts were collated systematically and organized into thematic areas. Relationships between codes, between themes, and different levels of themes were established to form overarching themes. Phase 4 – reviewing themes: the identified themes were refined and repeatedly examined for fitness and linkages to associated data. Phase 5 – defining and naming themes: at this stage we defined the identified themes and further refined them, including the scope and contents. We identified two overarching themes at this stage including the corresponding themes. Phase 6 – here we began to write up the results of the thematic analysis, discussion and conclusion.

Results

The 45 articles that met the inclusion criteria were classified (Table 1) according to methodology (qualitative, quantitative, or mixed), study design (cross-sectional, longitudinal or intervention), and the research participants involved in the study (adult, children or both adults and children). A descriptive summary of each article is provided in Table 2. The 45 articles were systematically evaluated and categorized into two overarching thematic areas: *behavioral* (*n* = 23, 51 %) or *determinant* (*n* = 22, 49 %) in relation to energy balance-related behaviors (Table 1). Behavioral articles were further divided into two themes: dietary behavior and physical activity. We found 18 articles on dietary behaviors and 5 on physical activity behaviors (Table 1). Articles on behavioral *determinants* were classified into six themes: socioeconomic factors (*n* = 9), historical and cultural factors (*n* = 3), smoking and drinking (*n* = 4), health promotion intervention (*n* = 2), climatic factors (*n* = 2), and psychosocial factors (*n* = 2) (Table 1).

Table 1 Analysis of 45 included articles based on methodology, study design and emergent themes

Methodology/Design	# of articles (n)	Thematic analysis	# of articles (n)
Research participants		Behavioral articles	23
Adults only (≥ 18 years)	31	Dietary Behavior	18
Children & Adults (≥ 2 years)	9	Physical Activity	5
Children Only (2–17 years)	5	Determinant articles	22
Methodology		Socioeconomic	9
Quantitative	9	Smoking & Drinking	4
Qualitative	6	Historical/Cultural	3
*Mixed	3	Climate Change	2
Study design		Intervention	2
Cross-sectional	40	Psychosocial	2
Longitudinal	3		
Intervention	2		

*refers to a combination of quantitative and qualitative methodologies

Table 2: Descriptive summary of 45 articles that met inclusion criteria of full text review

Study/Authors	Major thematic areas	Sample size	Mean Age ± SD OR age range	Gender male; female	Location	Methodology/Design	Major findings
Beaumier & Ford, 2010 [48]	Determinant-Socioeconomic factors	49 participants; 1 community	≥18	Female: (100%)	Nunavut	Qualitative/Cross-sectional	Education, income, food preferences, climate change, and the absence of full-time hunters in households are barriers to food security
Egeland *et al*., 2010 [33]	Behaviour-Dietary	388 participants; 16 communities	3–5	Male:47%; Female-53%	Nunavut	Quantitative/Cross-sectional	In Nunavut households 70 % of preschoolers were food insecure, 31 % of preschoolers were moderately food insecure, and 25.1 % experienced *severe* food insecurity.
Egeland *et al*., 2011 [53]	Determinant-Socioeconomic factors	388 participants; 16 communities	3–5	Male: 47%; Female: 53%	Nunavut	Quantitative/Cross-sectional	Children from food insecure households were more likely to have consumed more TFs and less milk compared to children from food secure homes. TF consumption was associated with higher protein and lower carbohydrate intakes and decreased iron deficiency, regardless of household food security status.
Egeland et al., 2011 [20]	Behavior-Dietary	2595 participants; 36 communities	41 ± 14.7	Male: 38%; Female: 62%	Nunavut; Inuvialuit; Nunatsiavut	Quantitative/Cross-sectional	The prevalence of food insecurity among adults was 62.6 %. In men, food insecurity was correlated with reduced intake of energy, fibre, Iron, Magnesium, Zinc and vitamin C In women, food insecurity was correlated with higher intake of carbohydrate and lower intake of fibre, folate, vitamins C, and D, Magnesium and Calcium TF consumption was associated with higher intakes of protein, vitamins A and C, lower intakes of carbohydrate, saturated fat, fibre, and Sodium.
Erber *et al*., 2010 [31]	Behaviour-Dietary	64 participants; 1 community	Male: 46 ± 13; Female:45 ± 13	Male: 22%; Female: 78%	Inuvialuit	Quantitative/Cross-sectional	The majority of the participants consumed less than their daily requirements of vitamin A while the intake of vitamin D was below recommendations for majority of women. TFs contributed significantly to protein and Iron intake. Store-bought foods particularly juices contributed primarily to carbohydrate and Calcium consumption
Erber *et al*., 2010 [47]	Determinant-Socioeconomic factors	230 participants; 3 communities	Male: 42 ± 14; Female: 45 ± 14	Male: 24%; Female: 76%	Inuvialuit	Quantitative/Cross-sectional	Intakes of non-nutrient dense foods were seven times higher than TF consumption. Respondents with higher SES were more likely to consume nutrient-dense foods compared to those with lower SES.

Findlay, 2011 [40]	Behaviour-Physical activity	359 participants;	≥ 12	Male: 56.4%; Female: 43.6%	Inuit across Canada	Quantitative/Cross-sectional	There was no significant difference between Inuit and non-Aboriginal respondents who were at least moderately physically active in their leisure time. First Nations respondents who lived off-reserve and Métis were more likely to be physically active than Inuit and non-Aboriginal respondents.
Ford & Beaumier, 2011 [49]	Determinant-Socioeconomic factors	19 participants; 1 community	≥ 18	Not reported	Nunavut	Quantitative/Cross-sectional	Determinants of food insecurity included decreased participation in hunting activities, high cost of traditional harvesting, affordability of store-bought foods, food knowledge and preferences as well as impact of climate change.
Ford *et al*., 2012 [51]	Determinant-Socioeconomic factors	94 participants; I community	≥ 18	Male: 56%: Female: 44%	Nunavut	[a]Mixed/Cross-sectional	Users of the community food programs were likely to belong to the lower SES class, unemployed and on social assistance. They were likely to not have hunters in their households.
Gagne *et al*., 2012 [25]	Behaviour-Dietary	217 participants; 10 communities	2 ± 0.88	Male: 52%; Female: 48%	Nunavik	Quantitative/Cross-sectional	Although the TF intake was generally low, children who consumed TFs had higher intakes of protein and several micronutrients, and less intakes of energy and carbohydrate, compared to those who did not consume TFs.
Gagne et al., 2013 [62]	Determinant-Intervention	217 participants; 10 communities	2 ± 0.88	Male: 52%; Female: 48%	Nunavik	Quantitative/Intervention	Greater proportion of children who participated in the nutrition intervention program met their nutritional requirements of fruits, vegetables, and grains, as well as daily requirements of vitamins, irons, and other micronutrients.
Hopping *et al.*, 2010 [13]	Behaviour-Dietary	75 participants; I community	Male: 42 ± 19; Female: 44 ± 16	Male: 9%; Female; 91%	Nunavut	Quantitative/Cross-sectional	Dietary intakes of fibre and micronutrients including Calcium, Iron, vitamins A, D, E, were below requirements. TFs were the primary source of protein and Iron while store-bought energy-dense foods were the largest source of fat and carbohydrates in diets.
Hopping et al., 2010 [46]	Determinant-Socioeconomic factors	211 participants; 3 communities	Male: 42.1 ± 15: Female: 42.2 ± 13.2	Male: 17%; Female: 83%	Nunavut	Quantitative/Cross-sectional	Respondents who were below 50 years of age consumed non-nutrient dense foods, fruits and vegetables more frequently, and TFs less frequently compared to respondents who were 50 years and over. Respondents with higher education and income were more likely to consume more fruits and vegetables and less TFs.

Hopping *et al.*, 2010 [38]	Behaviour-Physical activity	218 participants; 3 communities	Male: 42.3 ± 13.0; Female: 42.4 ± 14.8	Male: 17%; Female: 83%	Nunavut	Quantitative/Cross-sectional	Although a large proportion (72 %) of participants was either overweight or obese, 89 % of participants reported moderate to high levels of physical activity.
Hopping *et al.*, 2010 [39]	Behaviour-Physical activity	196 participants; 3 communities	Male: 41 ± 14; Female: 45 ± 14.8	Male: 24%; Female: 76%	Inuvialuit	Quantitative/Cross-sectional	Although a large proportion (65 %) of participants was either overweight or obese, 89 % of participants reported moderate to high levels of physical activity.
Huet *et al.*, 2012 [52]	Determinant-Socioeconomic factors	2595 participants; 36 communities	43.3 ± 0.4	Not reported	Inuvialuit, Nunatsiavut & Nunavut	Quantitative/Cross-sectional	Food insecurity was associated with lower healthy eating index score, intakes of lower vegetables, fruits, grains, and dairy products, and greater consumption of energy-dense non-nutrient foods. This was also associated with lower income and housing inadequacy.
Johnson-Down & Egeland, 2010 [30]	Behaviour-Dietary	388 participants; 16 communities	3–5	Male: 47%; Female: 53%	Nunavut	Quantitative/Cross-sectional	Most of the children met their dietary requirements of energy and micro nutrients through consumption of TFs. The findings further showed that energy-dense foods and beverages contributed significantly to their diets and placed the children at increased risk of overweight, obesity, and tooth decay.
Kolahdooz et al., 2013 [59]	Determinant-Smoking	92 participants; 3 communities	19–44	Female: 100%	Inuvialuit	Quantitative/Cross-sectional	No significant differences were observed in nutrients intakes between smokers and non-smokers. Regardless of their smoking status, over 60 % of respondents did not meet their daily recommendations for fibre, vitamins D, E, and Potassium.
Kolahdooz *et al.*, 2013 [60]	Determinant-Drinking	92 participants; 3 communities	19–44	Female: 100%	Inuvialuit	Quantitative/Cross-sectional	Energy consumption was significantly higher among drinkers in comparison to non-drinkers. Although there were no significant differences in most nutrients intakes between drinkers and non-drinkers, drinkers tended to have decreased nutrient density compared to non-drinkers.
Kuhnlein et al., 1996 [29]	Behaviour-Dietary	366 participants; 1 community	≥ 3	Not reported	Nunavut	Quantitative/Cross-sectional	TFs provided significantly higher levels of protein and micro nutrients, and less energy and carbohydrates for most age groups than store-bought foods. There was a significant seasonal variation in the consumption of TFs in contrast to store-bought foods.

Kuhnlein *et al*. 2004 [16]	Behaviour-Dietary	3851 participants: 44 communities	≥ 13	Not reported	Yukon, NWT & Nunavut	Quantitative/Cross-sectional	TF intake was associated with lower fat, carbohydrate, and sugar, greater protein, vitamins and most micronutrients, in the diet. Adults 40 years and over had significantly higher intakes of TFs compared to younger respondents.
Kuhnlein & Receveur, 2007 [28]	Behaviour-Dietary	3851 participants; 44 communities	≥ 13	Not reported	Yukon, NWT, & Nunavut	Quantitative/Cross-sectional	TFs contributed about 6–40 % of energy among adults compared to 0.4–15 % among children. Greater amount of energy was contributed by sugar-sweetened beverages and other energy-dense foods in children diets.
Lambden *et al*., 2006 [50]	Determinant-Socioeconomic factors	1711: 838 Inuit; 511 Dene/Métis; 422 First Nation; participants; 44 communities	≥ 20	Female: 100%	Canadian Arctic	[a]Mixed/Cross-sectional	There were significant regional variations across communities in terms of affordability of foods, ranging from 40 to 70 %. These variations were also reflected on other measures such as accessibility and affordability of hunting/fishing equipment; significant proportion of respondents could not afford hunting/fishing equipment.
Lambden *et al*., 2007 [42]	Determinant-Historical and cultural factors	1711: 838 Inuit; 422 Yukon First Nations; 511 Dene/Métis; 44 communities	≥ 20	Female: 100%	Yukon & NWT	[a]Mixed/Cross-sectional	Although TFs are emblematic of cultural identity, and are socially well received, the quality of many local food species has however deteriorated in the last few decades.
Lardeau *et al*., 2011 [54]	Determinant-Socioeconomic factors	8 participants; 1 community	≥18	37.5% male; 62.5% female	Nunavut	Qualitative/Cross-sectional	Affordability was a major factor influencing food security in Iqaluit. Community members with low SES relied on social support networks to meet their basic dietary needs.
Martin, 2011 [43]	Determinant-Historical and cultural factors	24 participants; 1 community	≥ 16	Male: 46%; Female: 54%	Nunatsiavut	Qualitative/Cross-sectional	Dietary transitions from locally sourced, unstable food environment to contemporary times that presented a choice between healthy and unhealthy store-bought foods posed a challenge to residents. TF gathering activity was identified as an opportunity for physical activity.

Mead *et al.*, 2010 [41]	Determinant-Historical and cultural factors	43 participants; 2 communities	≥19	14% male: 84% female	Nunavut	Qualitative/Cross-sectional	Dietary transition was due to changes from traditional ways of life to Euro-Canadian lifestyles. Although TFs were perceived as healthier than store-bought foods, high cost of hunting materials affected the availability of TFs. Cost was also a major barrier of access to healthy store-bought foods, while transportation and harsh climate hindered access to fruits and vegetables.
Mead *et al.*, 2010 [55]	Determinant-Psychosocial factors	266 participants; 3 communities	41.2 ± 13.6	Not reported	Nunavut	Quantitative/Cross-sectional	Greater knowledge about healthy foods and self-efficacy were associated with intentions toward healthy food consumption. Self-efficacy was associated with decreased acquisition of unhealthy foods and increased acceptance of healthier food preparation methods. Additionally, SES was positively correlated with healthy food knowledge, acquisition, and preparation behaviors.
Mead *et al.*, 2010 [56]	Determinant-Psychosocial factors	231 participants; 3 communities	43.4 ± 13.6	Not reported	Inuvialuit	Quantitative/Cross-sectional	Greater intention toward healthy food consumption was positively correlated with increased frequency of healthy food acquisition and decreased frequency of unhealthy food acquisition. The choice of healthier food preparation methods was associated with knowledge of healthy foods, intentions, and self-efficacy.
Mead *et al.*, 2012 [61]	Determinant-Intervention	379 participants; 6 communities	Male: 42.4 ± 13.1; Female: 42.3 ± 12.8	Male: 18%; Female: 82%	Nunavut & Inuvialuit	Quantitative/Intervention	Respondents from intervention communities demonstrated greater food-related self-efficacy and intentions compared to respondents from control communities. Over-weight, obese, and higher SES respondents demonstrated greater improvements compared to control.
Nancarrow & Chan, 2010 [45]	Determinant-Climatic factors	17 participants; 2 communities	≥ 18	Male: 76%; Female: 24%	Nunavut	Qualitative/Cross-sectional	Climate change had both positive and negative effects on accessibility and availability of TF species.

Rittmueller *et al*., 2012 [57]	Determinant-smoking	218 participants; 3 communities	19–79	21% male; 79% female	Inuvialuit	Quantitative/Cross-sectional	Both male and female smokers reported higher intakes of energy and some other nutrients compared to non-smokers. However, more than 50 % of both male and female smokers had insufficient intakes of fibre, Potassium, and vitamin E. Additionally, TFs contributed about 3–6 % less energy and protein intakes among smokers compared to non-smokers.
Rittmueller *et al*., 2012 [58]	Determinant-Smoking	208 participants; 3 communities	19–79	15% male; 85% female	Nunavut	Quantitative/Cross-sectional	Smokers were likely to consume lower amounts of nutrient-dense TFs but higher energy-dense foods, compared to non-smokers, suggesting increased dietary inadequacies among smokers.
Rode & Sheppard, 1984 [36]	Behaviour-Physical activity	344 participants; 1 community	Male: 9–76	Male: 58.4%; Female: 41.6%	Nunavut	Quantitative/Longitudinal	There was a decreased fitness level in the population determined by a 15 % decrease in predicted maximum oxygen intake, a 2–4 kg rise in BMI, build up of subcutaneous fat, and reduced leg extension strength in all age groups except 9–15 years old, in comparison to the 1970–71 data.
Rode & Sheppard, 1994 [37]	Behaviour-Physical activity	221 participants; 1 community	20–69	Male: 57.5%; Female: 42.5%	Nunavut	Quantitative/Longitudinal	Fitness levels had remarkably deteriorated over a 20-year period (1970–1990). However, community members who actively engaged in regular sports had maintained their fitness at levels observed in the 1970s, based on data comparison.
Rosol *et al*., 2011 [32]	Behaviour-Dietary	2595 participants; 36 communities	≥ 18	Not reported	Inuvialuit; Nunatsiavut & Nunavut	Quantitative/ Cross-sectional	The severity of food insecurity differed across the three regions of study. Nunavut had the highest prevalence at 68.8 %, followed by Nunatsiavut and Inuvialuit regions at 45.7 % and 43.3 %, respectively.
Sharma *et al.*, 2009 [34]	Behaviour-Dietary	101 participants; 2 communities	≥ 19	47.5% male; 52.5% female	Inuvialuit	Quantitative/Cross-sectional	Dietary intakes of fibre and most micronutrients were lower than requirements. Less nutrient-dense, store-bought foods were the most frequently consumed food items. Among these, sugar and sugar-sweetened beverages were the leading contributors to energy intake.

Sharma *et al.*, 2010 [35]	Behaviour-Dietary	87 participants; 2 communities	19–87	47% male; 53% female	Nunavut	Quantitative/Cross-sectional	Dietary intakes of fibre and most micronutrients were significantly below recommendations. Less nutrient-dense store-bought foods were more frequently consumed than nutrient-rich TFs.
Sharma *et al.*, 2013 [1]	Behaviour-Dietary	211 participants; 3 communities	Male: 42.4 ± 13.2; Female: 42.1 ± 15	Male: 17%; Female; 83%	Nunavut	Quantitative/Cross-sectional	Less than 10 % of respondents met their dietary requirements. 22 % of saturated fat, 30 % of energy, and 73 % of sugar came from non-nutrient dense foods, while TFs contributed 49 % of Iron and 56 % of protein intake among women.
Sheehy *et al.*, 2013 [11]	Behaviour-Dietary	211 participants; 3 communities	Male: 42.4 ± 13.2; Female: 42.1 ± 15	Male: 17%; Female; 83%	Nunavut	Quantitative/Cross-sectional	TFs including caribou, muktuk and arctic char were widely consumed. Additionally, sugar-sweetened beverages and other energy-dense foods were consumed in significant amounts as of the time of study compared to the past.
Sheikh *et al.*, 2011 [10]	Behaviour-Dietary	2595 participants; 36 communities	41 ± 14.7	Male: 38%; Female: 62%	Inuvialuit, Nunavut & Nunatsiavut	Quantitative/Longitudinal	Contribution to energy from TFs had significantly decreased over the ten year period, while consumption of store-bought foods rose remarkably. BMI also significantly increased over the period, particularly for women.
Wein & Freeman, 1992 [26]	Behaviour-Dietary	71 participants; 1 community	≥10	Not reported	Inuvialuit & NWT	Quantitative/Cross-sectional	Climate change was associated with lower TF availability and use. This resulted to reduced intakes of nutrients normally sourced from TFs.
Wein *et al.*, 1996 [27]	Behaviour-Dietary	164 participants; 1 community	≥12	Not reported	Nunavut	Quantitative/Cross-sectional	TFs were preferred, rated high, and consumed by majority of adults and young people. However, from a total of 41 foods, adults ranked 25 TFs higher and two store-bought foods lower than young people using a five point hedonic scale.
Wesche & Chan, 2010 [18]	Determinant-Climatic factors	30 communities; ample size not reported	≥15	Not reported	Inuvialuit, Nunavut, Nunavik & Nunatsiavut	Qualitative/Cross-sectional	TF availability was influenced differentially across the communities studied by factors including impact of climate change, harvesting patterns, individual species reliability, availability and access to other food species.
Zotor *et al.*, 2012 [12]	Behaviour-Dietary	230 participants; 3 communities	Male:44 ± 14; Female: 41 ± 13	Male: 24%; Female: 76%	NWT	Quantitative/Cross-sectional	Non-nutrient dense foods were consumed at significantly higher frequencies per day, compared to TFs, fruits, and vegetables.

[a]refers to a combination of quantitative and qualitative methodologies

Study/Authors	Major thematic areas	Sample size	Mean Age ± SD (or age range)	Gender (male; female)	Location	Methodology/Design	Major findings
Beaumier & Ford, 2010 [48]	Determinant-Socioeconomic factors	49 participants; 1 community	≥18	Female: (100%)	Nunavut	Qualitative/Cross-sectional	Education, income, food preferences, climate change, and the absence of full-time hunters in households are barriers to food security
Egeland *et al*., 2010 [33]	Behaviour-Dietary	388 participants; 16 communities	3–5	Male:47%; Female-53%	Nunavut	Quantitative/Cross-sectional	In Nunavut households 70 % of preschoolers were food insecure, 31 % of preschoolers were moderately food insecure, and 25.1 % experienced *severe* food insecurity.
Egeland *et al*., 2011 [53]	Determinant-Socioeconomic factors	388 participants; 16 communities	3–5	Male: 47%; Female: 53%	Nunavut	Quantitative/Cross-sectional	Children from food insecure households were more likely to have consumed more TFs and less milk compared to children from food secure homes. TF consumption was associated with higher protein and lower carbohydrate intakes and decreased iron deficiency, regardless of household food security status.
Egeland et al., 2011 [20]	Behavior-Dietary	2595 participants; 36 communities	41 ± 14.7	Male: 38%; Female: 62%	Nunavut; Inuvialuit; Nunatsiavut	Quantitative/Cross-sectional	The prevalence of food insecurity among adults was 62.6 %. In men, food insecurity was correlated with reduced intake of energy, fibre, Iron, Magnesium, Zinc and vitamin C In women, food insecurity was correlated with higher intake of carbohydrate and lower intake of fibre, folate, vitamins C, and D, Magnesium and Calcium TF consumption was associated with higher intakes of protein, vitamins A and C, lower intakes of carbohydrate, saturated fat, fibre, and Sodium.
Erber *et al*., 2010 [31]	Behaviour-Dietary	64 participants; 1 community	Male: 46 ± 13; Female:45 ± 13	Male: 22%; Female: 78%	Inuvialuit	Quantitative/Cross-sectional	The majority of the participants consumed less than their daily requirements of vitamin A while the intake of vitamin D was below recommendations for majority of women. TFs contributed significantly to protein and Iron intake. Store-bought foods particularly juices contributed primarily to carbohydrate and Calcium consumption

Erber *et al*., 2010 [47]	Determinant-Socioeconomic factors	230 participants; 3 communities	Male: 42 ± 14; Female: 45 ± 14	Male: 24%; Female: 76%	Inuvialuit	Quantitative/Cross-sectional	Intakes of non-nutrient dense foods were seven times higher than TF consumption. Respondents with higher SES were more likely to consume nutrient-dense foods compared to those with lower SES.
Findlay, 2011 [40]	Behaviour-Physical activity	359 participants;	≥ 12	Male: 56.4%; Female: 43.6%	Inuit across Canada	Quantitative/Cross-sectional	There was no significant difference between Inuit and non-Aboriginal respondents who were at least moderately physically active in their leisure time. First Nations respondents who lived off-reserve and Métis were more likely to be physically active than Inuit and non-Aboriginal respondents.
Ford & Beaumier, 2011 [49]	Determinant-Socioeconomic factors	19 participants; 1 community	≥ 18	Not reported	Nunavut	Quantitative/Cross-sectional	Determinants of food insecurity included decreased participation in hunting activities, high cost of traditional harvesting, affordability of store-bought foods, food knowledge and preferences as well as impact of climate change.
Ford *et al*., 2012 [51]	Determinant-Socioeconomic factors	94 participants; I community	≥ 18	Male: 56%: Female: 44%	Nunavut	[a]Mixed/Cross-sectional	Users of the community food programs were likely to belong to the lower SES class, unemployed and on social assistance. They were likely to not have hunters in their households.
Gagne *et al*., 2012 [25]	Behaviour-Dietary	217 participants; 10 communities	2 ± 0.88	Male: 52%; Female: 48%	Nunavik	Quantitative/Cross-sectional	Although the TF intake was generally low, children who consumed TFs had higher intakes of protein and several micronutrients, and less intakes of energy and carbohydrate, compared to those who did not consume TFs.
Gagne et al., 2013 [62]	Determinant-Intervention	217 participants; 10 communities	2 ± 0.88	Male: 52%; Female: 48%	Nunavik	Quantitative/Intervention	Greater proportion of children who participated in the nutrition intervention program met their nutritional requirements of fruits, vegetables, and grains, as well as daily requirements of vitamins, irons, and other micronutrients.

Hopping *et al.*, 2010 [13]	Behaviour-Dietary	75 participants; I community	Male: 42 ± 19; Female: 44 ± 16	Male: 9%; Female; 91%	Nunavut	Quantitative/Cross-sectional	Dietary intakes of fibre and micronutrients including Calcium, Iron, vitamins A, D, E, were below requirements. TFs were the primary source of protein and Iron while store-bought energy-dense foods were the largest source of fat and carbohydrates in diets.
Hopping et al., 2010 [46]	Determinant-Socioeconomic factors	211 participants; 3 communities	Male: 42.1 ± 15: Female: 42.2 ± 13.2	Male: 17%; Female: 83%	Nunavut	Quantitative/Cross-sectional	Respondents who were below 50 years of age consumed non-nutrient dense foods, fruits and vegetables more frequently, and TFs less frequently compared to respondents who were 50 years and over. Respondents with higher education and income were more likely to consume more fruits and vegetables and less TFs.
Hopping *et al.*, 2010 [38]	Behaviour-Physical activity	218 participants; 3 communities	Male: 42.3 ± 13.0; Female: 42.4 ± 14.8	Male: 17%; Female: 83%	Nunavut	Quantitative/Cross-sectional	Although a large proportion (72 %) of participants was either overweight or obese, 89 % of participants reported moderate to high levels of physical activity.
Hopping *et al.*, 2010 [39]	Behaviour-Physical activity	196 participants; 3 communities	Male: 41 ± 14; Female: 45 ± 14.8	Male: 24%; Female: 76%	Inuvialuit	Quantitative/Cross-sectional	Although a large proportion (65 %) of participants was either overweight or obese, 89 % of participants reported moderate to high levels of physical activity.
Huet *et al.*, 2012 [52]	Determinant-Socioeconomic factors	2595 participants; 36 communities	43.3 ± 0.4	Not reported	Inuvialuit, Nunatsiavut & Nunavut	Quantitative/Cross-sectional	Food insecurity was associated with lower healthy eating index score, intakes of lower vegetables, fruits, grains, and dairy products, and greater consumption of energy-dense non-nutrient foods. This was also associated with lower income and housing inadequacy.
Johnson-Down & Egeland, 2010 [30]	Behaviour-Dietary	388 participants; 16 communities	3–5	Male: 47%; Female: 53%	Nunavut	Quantitative/Cross-sectional	Most of the children met their dietary requirements of energy and micro nutrients through consumption of TFs. The findings further showed that energy-dense foods and beverages contributed significantly to their diets and placed the children at increased risk of overweight, obesity, and tooth decay.

Kolahdooz et al., 2013 [59]	Determinant-Smoking	92 participants; 3 communities	19–44	Female: 100%	Inuvialuit	Quantitative/Cross-sectional	No significant differences were observed in nutrients intakes between smokers and non-smokers. Regardless of their smoking status, over 60 % of respondents did not meet their daily recommendations for fibre, vitamins D, E, and Potassium.
Kolahdooz *et al*., 2013 [60]	Determinant-Drinking	92 participants; 3 communities	19–44	Female: 100%	Inuvialuit	Quantitative/Cross-sectional	Energy consumption was significantly higher among drinkers in comparison to non-drinkers. Although there were no significant differences in most nutrients intakes between drinkers and non-drinkers, drinkers tended to have decreased nutrient density compared to non-drinkers.
Kuhnlein et al., 1996 [29]	Behaviour-Dietary	366 participants; 1 community	≥ 3	Not reported	Nunavut	Quantitative/Cross-sectional	TFs provided significantly higher levels of protein and micro nutrients, and less energy and carbohydrates for most age groups than store-bought foods. There was a significant seasonal variation in the consumption of TFs in contrast to store-bought foods.
Kuhnlein *et al*. 2004 [16]	Behaviour-Dietary	3851 participants: 44 communities	≥ 13	Not reported	Yukon, NWT & Nunavut	Quantitative/Cross-sectional	TF intake was associated with lower fat, carbohydrate, and sugar, greater protein, vitamins and most micronutrients, in the diet. Adults 40 years and over had significantly higher intakes of TFs compared to younger respondents.
Kuhnlein & Receveur, 2007 [28]	Behaviour-Dietary	3851 participants; 44 communities	≥ 13	Not reported	Yukon, NWT, & Nunavut	Quantitative/Cross-sectional	TFs contributed about 6–40 % of energy among adults compared to 0.4–15 % among children. Greater amount of energy was contributed by sugar-sweetened beverages and other energy-dense foods in children diets.

Lambden *et al*., 2006 [50]	Determinant-Socioeconomic factors	1711: 838 Inuit; 511 Dene/Métis; 422 First Nation; participants; 44 communities	≥ 20	Female: 100%	Canadian Arctic	[a]Mixed/Cross-sectional	There were significant regional variations across communities in terms of affordability of foods, ranging from 40 to 70 %. These variations were also reflected on other measures such as accessibility and affordability of hunting/fishing equipment; significant proportion of respondents could not afford hunting/fishing equipment.
Lambden *et al*., 2007 [42]	Determinant-Historical and cultural factors	1711: 838 Inuit; 422 Yukon First Nations; 511 Dene/Métis; 44 communities	≥ 20	Female: 100%	Yukon & NWT	[a]Mixed/Cross-sectional	Although TFs are emblematic of cultural identity, and are socially well received, the quality of many local food species has however deteriorated in the last few decades.
Lardeau *et al*., 2011 [54]	Determinant-Socioeconomic factors	8 participants; 1 community	≥18	37.5% male; 62.5% female	Nunavut	Qualitative/Cross-sectional	Affordability was a major factor influencing food security in Iqaluit. Community members with low SES relied on social support networks to meet their basic dietary needs.
Martin, 2011 [43]	Determinant-Historical and cultural factors	24 participants; 1 community	≥ 16	Male: 46%; Female: 54%	Nunatsiavut	Qualitative/Cross-sectional	Dietary transitions from locally sourced, unstable food environment to contemporary times that presented a choice between healthy and unhealthy store-bought foods posed a challenge to residents. TF gathering activity was identified as an opportunity for physical activity.
Mead *et al.*, 2010 [41]	Determinant-Historical and cultural factors	43 participants; 2 communities	≥19	14% male: 84% female	Nunavut	Qualitative/Cross-sectional	Dietary transition was due to changes from traditional ways of life to Euro-Canadian lifestyles. Although TFs were perceived as healthier than store-bought foods, high cost of hunting materials affected the availability of TFs. Cost was also a major barrier of access to healthy store-bought foods, while transportation and harsh climate hindered access to fruits and vegetables.

Mead *et al.*, 2010 [55]	Determinant-Psychosocial factors	266 participants; 3 communities	41.2 ± 13.6	Not reported	Nunavut	Quantitative/Cross-sectional	Greater knowledge about healthy foods and self-efficacy were associated with intentions toward healthy food consumption. Self-efficacy was associated with decreased acquisition of unhealthy foods and increased acceptance of healthier food preparation methods. Additionally, SES was positively correlated with healthy food knowledge, acquisition, and preparation behaviors.
Mead *et al.*, 2010 [56]	Determinant-Psychosocial factors	231 participants; 3 communities	43.4 ± 13.6	Not reported	Inuvialuit	Quantitative/Cross-sectional	Greater intention toward healthy food consumption was positively correlated with increased frequency of healthy food acquisition and decreased frequency of unhealthy food acquisition. The choice of healthier food preparation methods was associated with knowledge of healthy foods, intentions, and self-efficacy.
Mead *et al.*, 2012 [61]	Determinant-Intervention	379 participants; 6 communities	Male: 42.4 ± 13.1; Female: 42.3 ± 12.8	Male: 18%; Female: 82%	Nunavut & Inuvialuit	Quantitative/Intervention	Respondents from intervention communities demonstrated greater food-related self-efficacy and intentions compared to respondents from control communities. Over-weight, obese, and higher SES respondents demonstrated greater improvements compared to control.
Nancarrow & Chan, 2010 [45]	Determinant-Climatic factors	17 participants; 2 communities	≥ 18	Male: 76%; Female: 24%	Nunavut	Qualitative/Cross-sectional	Climate change had both positive and negative effects on accessibility and availability of TF species.
Rittmueller *et al*., 2012 [57]	Determinant-smoking	218 participants; 3 communities	19–79	21% male; 79% female	Inuvialuit	Quantitative/Cross-sectional	Both male and female smokers reported higher intakes of energy and some other nutrients compared to non-smokers. However, more than 50 % of both male and female smokers had insufficient intakes of fibre, Potassium, and vitamin E. Additionally, TFs contributed about 3–6 % less energy and protein intakes among smokers compared to non-smokers.

Rittmueller *et al*., 2012 [58]	Determinant-Smoking	208 participants; 3 communities	19–79	15% male; 85% female	Nunavut	Quantitative/Cross-sectional	Smokers were likely to consume lower amounts of nutrient-dense TFs but higher energy-dense foods, compared to non-smokers, suggesting increased dietary inadequacies among smokers.
Rode & Sheppard, 1984 [36]	Behaviour-Physical activity	344 participants; 1 community	Male: 9–76	Male: 58.4%; Female: 41.6%	Nunavut	Quantitative/Longitudinal	There was a decreased fitness level in the population determined by a 15 % decrease in predicted maximum oxygen intake, a 2–4 kg rise in BMI, build up of subcutaneous fat, and reduced leg extension strength in all age groups except 9–15 years old, in comparison to the 1970–71 data.
Rode & Sheppard, 1994 [37]	Behaviour-Physical activity	221 participants; 1 community	20–69	Male: 57.5%; Female: 42.5%	Nunavut	Quantitative/Longitudinal	Fitness levels had remarkably deteriorated over a 20-year period (1970–1990). However, community members who actively engaged in regular sports had maintained their fitness at levels observed in the 1970s, based on data comparison.
Rosol *et al*., 2011 [32]	Behaviour-Dietary	2595 participants; 36 communities	≥ 18	Not reported	Inuvialuit; Nunatsiavut & Nunavut	Quantitative/ Cross-sectional	The severity of food insecurity differed across the three regions of study. Nunavut had the highest prevalence at 68.8 %, followed by Nunatsiavut and Inuvialuit regions at 45.7 % and 43.3 %, respectively.
Sharma *et al.*, 2009 [34]	Behaviour-Dietary	101 participants; 2 communities	≥ 19	47.5% male; 52.5% female	Inuvialuit	Quantitative/Cross-sectional	Dietary intakes of fibre and most micronutrients were lower than requirements. Less nutrient-dense, store-bought foods were the most frequently consumed food items. Among these, sugar and sugar-sweetened beverages were the leading contributors to energy intake.
Sharma *et al.*, 2010 [35]	Behaviour-Dietary	87 participants; 2 communities	19–87	47% male; 53% female	Nunavut	Quantitative/Cross-sectional	Dietary intakes of fibre and most micronutrients were significantly below recommendations. Less nutrient-dense store-bought foods were more frequently consumed than nutrient-rich TFs.

Sharma *et al*., 2013 [1]	Behaviour-Dietary	211 participants; 3 communities	Male: 42.4 ± 13.2; Female: 42.1 ± 15	Male: 17%; Female; 83%	Nunavut	Quantitative/Cross-sectional	Less than 10 % of respondents met their dietary requirements. 22 % of saturated fat, 30 % of energy, and 73 % of sugar came from non-nutrient dense foods, while TFs contributed 49 % of Iron and 56 % of protein intake among women.
Sheehy *et al*., 2013 [11]	Behaviour-Dietary	211 participants; 3 communities	Male: 42.4 ± 13.2; Female: 42.1 ± 15	Male: 17%; Female; 83%	Nunavut	Quantitative/Cross-sectional	TFs including caribou, muktuk and arctic char were widely consumed. Additionally, sugar-sweetened beverages and other energy-dense foods were consumed in significant amounts as of the time of study compared to the past.
Sheikh *et al*., 2011 [10]	Behaviour-Dietary	2595 participants; 36 communities	41 ± 14.7	Male: 38%; Female: 62%	Inuvialuit, Nunavut & Nunatsiavut	Quantitative/Longitudinal	Contribution to energy from TFs had significantly decreased over the ten year period, while consumption of store-bought foods rose remarkably. BMI also significantly increased over the period, particularly for women.
Wein & Freeman, 1992 [26]	Behaviour-Dietary	71 participants; 1 community	≥10	Not reported	Inuvialuit & NWT	Quantitative/Cross-sectional	Climate change was associated with lower TF availability and use. This resulted to reduced intakes of nutrients normally sourced from TFs.
Wein *et al*., 1996 [27]	Behaviour-Dietary	164 participants; 1 community	≥12	Not reported	Nunavut	Quantitative/Cross-sectional	TFs were preferred, rated high, and consumed by majority of adults and young people. However, from a total of 41 foods, adults ranked 25 TFs higher and two store-bought foods lower than young people using a five point hedonic scale.
Wesche & Chan, 2010 [18]	Determinant-Climatic factors	30 communities; ample size not reported	≥15	Not reported	Inuvialuit, Nunavut, Nunavik & Nunatsiavut	Qualitative/Cross-sectional	TF availability was influenced differentially across the communities studied by factors including impact of climate change, harvesting patterns, individual species reliability, availability and access to other food species.
Zotor *et al*., 2012 [12]	Behaviour-Dietary	230 participants; 3 communities	Male:44 ± 14; Female: 41 ± 13	Male: 24%; Female: 76%	NWT	Quantitative/Cross-sectional	Non-nutrient dense foods were consumed at significantly higher frequencies per day, compared to TFs, fruits, and vegetables.

[a]refers to a combination of quantitative and qualitative methodologies

Behavior articles

Dietary

Age- and gender-related consumption of traditional versus store-bought foods

Patterns of dietary behavior have been studied across geographic (Canadian Inuit) regions and distinct demographic (gender, age) factors, 10 articles (10,4,5,28,13,66,67,68) (69) reported on the consumption patterns of TFs versus store-bought foods. A longitudinal study [10] in 18 Inuit communities reported a significant decrease in TF contribution to energy intake compared to store-bought foods between 1999 and 2008. Older adults consistently consumed more TFs than younger people while women consumed less TFs than men, irrespective of age (10). Additionally, cross-sectional studies in Nunavut (4), Inuvialuit (5), and Nunavik (13) reported moderate decline in consumption of TFs and increased intakes of non-nutrient energy-dense store-bought foods. The results were attributed to the shifting dietary patterns from subsistence living to wage economy, the high cost of hunting equipment, and reduced TF sharing practices. Further, an Inuvialuit study (66) determined annual consumption frequencies of 32 species of mammal, fish, bird, and plant by adults and children. The article reported that TFs were significantly less consumed than store-bought foods. Although there were no significant differences in the children's preferential ranking of 31 out of 34 TFs when compared to adults' preferences, children however rated store-bought foods higher than adults. This result was similar to that obtained among Belcher Island Inuit of Nunavut (67).

Five other articles described age-and-gender-related consumption patterns (28,64,68,69,14). Kuhnlein and colleagues found that the consumption of TFs by older adults was greater than intakes by younger adults and children. Consumption of TFs was generally low for all ages compared to pre-contact era when TFs were the only source of foods (28). Contribution to energy from TFs range from 6 to 40 % among adults compared to 0.4–15 % among children, while more than 40 % of children's daily energy was sourced from non-nutrient energy-dense store-bought foods (68). Similarly, results from an earlier study showed that TF consumption by older Inuit was higher than among younger Inuit, and that store-bought foods contributed significantly more to carbohydrates and saturated fat intakes among people less than 60 years

old, while TF contributed more proteins and micronutrients for all ages (except for children and teenagers) and for both genders (69). Furthermore, a cross-sectional study (14) that examined TF consumption patterns of three to five year old Inuit children in16 communities reported that a majority of children met the dietary requirements of most nutrients, although less than 50 % of the children met the fibre requirement. Significant portions of vitamins and micronutrients were generally derived from TF consumption. The findings show that both age and gender are important factors influencing consumptions of both TFs and store-bought foods among Inuit.

Dietary inadequacies

Eight articles (1,6,64,70,71,37,72,27) assessed geographically determined dietary patterns by quantifying the prevalence of dietary inadequacies among various Canadian Inuit populations. The first three articles reported high prevalence of dietary inadequacies in Nunavut (6) and Inuvialuit (1,70) regions. Food insecurity was also assessed in 36 communities spread across three Inuit regions: Nunavut, Nunatsiavut, and Inuvialuit (71). The results indicated that Nunavut has the highest rate of food inadequacy at 68.8 %, which was significantly higher than Nunatsiavut and Inuvialuit regions at 45.7 % and 43.3 %, respectively (71). The pervasive degree of food insecurity in Nunavut was also evident among Inuit children (37). According to Egeland and colleagues, approximately 70 % of the children resided in food insecure households: 31 % of the children were moderately food insecure; 25.1 % experienced severe food insecurity. Two other articles that described dietary sufficiency as a measure of household food security reported that consumptions of fibre, essential vitamins and micronutrients were significantly lower than recommended levels in Inuvialuit (72) and Nunavut (27) communities studied. Less nutritious energy-dense store-bought foods were heavily consumed both in frequency and quantity by participants in both regions. In terms of gender-related differences, food insecurity was correlated with reduced intake of energy, fibre, Iron, Magnesium, Zinc and vitamin C among men. In women, food insecurity was correlated with higher intake of carbohydrate and lower intake of fibre, folate, vitamins C, and D, Magnesium and Calcium. TF consumption was associated with higher intakes of protein, vitamins A and C, lower intakes of carbohydrate,

saturated fat, fibre, and Sodium (64). These findings suggest strong relationships between dietary behaviors (food choices and consumption patterns) and the demographic factors.

Physical activity and fitness

Five articles (40,41,42,43,73) described the fitness and physical activity levels of Canadian Inuit. Of these, two articles reported on a longitudinal study (40,41), the next two articles (42,43) were published on a cross-sectional study conducted in two Inuit regions while the fifth article reported on a multi-jurisdictional study that included other Indigenous groups (73). In the first longitudinal study of Rode and Sheppard (40) changes in fitness levels in a Nunavut community were examined, They found that from 1969 to 1982, and for all ages and genders (except boys 9–15 years), there was a 15 % decrease in predicted maximum oxygen intake, two to four kilogram increase in body weight, an accumulation of subcutaneous fat, a loss of lean muscles, and a decrease in leg extension strength (a measure of lower body strength and fitness).

Twenty years after the 1969/1970 study, Rode and Sheppard conducted a second follow-up assessment of the fitness levels in the face of rapid acculturation process in Nunavut (41). Longitudinal comparisons with the 1969/70 study showed decreases in physical activities, aerobic power and muscle strength, and increases in subcutaneous fats. The BMI of younger men were lower in 1989/1990 compared to the 1969/70, but significantly higher in men 40 years and above. In women, there was a slight difference for those under 40 years while the BMI was higher for women 40 years and over (41). Two more recent articles (42,43) described the levels of physical activity and BMI in three Nunavut communities (42) and three Inuvialuit communities (43). According to the findings, about 89 % of respondents self-reported medium to high levels of physical activity in both regions. Despite this, approximately 72 % and 65 % of Nunavut and Inuvialuit research subjects, respectively, were either overweight or obese, with more women in the obese category than men. There is therefore a co-existence of overweight or obesity and high levels of physical activity among the Inuit. These outcomes contradicted results from a more recent survey by Statistics Canada (73) which reported that only 31 % of Inuit were physically active at leisure time, contradicting the results obtained by Hopping et al. in which 89 % of

respondents self-reported medium to high levels of physical activity (42,43). The inconsistencies in the findings call for new studies that utilize objective methodology for assessing physical activity levels in the population.

Determinant articles

Historical and cultural factors

Three articles (74,75,76) reported on historical and cultural determinants of dietary behaviors and physical activity. In their cross-sectional study, Mead and colleagues (74) examined the factors influencing changing food environment and contemporary dietary practices of Inuit in two communities in Nunavut. The findings showed that, although Inuit cultural values are still being upheld in some communities today, generally, many aspects of Inuit cultural traditions have been eroded, such as hunting and food sharing practices, by the domineering influence of Euro-Canadian lifestyles, particularly among the younger generation (74). Over the past five decades, Inuit have been increasingly consuming store-bought foods at the expense of TFs. This reflects a changing food environment and erosion of cultural traditions [41]. Other researchers (75,74) emphasized the inextricable linkage between TFs and culture among Inuit. Findings from a cross-sectional study by Lambden and colleagues (75) among Yukon First Nation, Dene/metis, and Inuit women in 44 Arctic communities buttressed the notion that TFs are healthy, and are socially and culturally beneficial but the quality has deteriorated over time. Martin (76) reported that traditional practices around food should be seen as “symbolic” of Inuit cultural identity. Underscoring the importance of food as a cultural construction among the Inuit, Meigs (77) explained that certain cultural and social meanings are attributable to food sharing practices by Inuit, and traditional foods consist mainly of land and marine animals. The TFs are a marker of traditional and social practices which are embedded in Inuit cultural identity (77). Thus, over several decades colonization and globalization have profoundly contributed to the erosion of Inuit cultural traditions including the traditional food gathering, consumption, and sharing practices.

Climatic factors

Two articles (62,78) described the impact of the physical environment such as climate change on diet selection. Wesche and Chan (62) conducted a regional case study analysis with Inuvialuit elders to determine the impact of climate change on nutritional health. The study showed that virtually all aspects of species abundance, migration patterns and wellbeing are affected by climate change. Hunter-gatherer movement patterns had equally changed in response to food species migratory patterns which were reportedly influenced by climate change (62). In another cross-sectional study (78), bivalent effects of environmental changes were observed, ranging from migratory patterns of land and marine animals, to quality and availability of food animal species. Although no consistent trends were observed in the study, many aspects of the findings were corroborated by Wesche and Chan (62). Despite the ambivalence about the impacts of climate change in the Arctic, it is increasingly becoming evident that both availability and quality of some food species are being affected.

Socioeconomic factors

A total of nine articles (79,80,81,82,83,84,39,85,86) described the influence of education and income on consumption patterns of Canadian Inuit. In Nunavut (79) and Inuvialuit (80), Hopping and colleagues found a positive correlation between education attainment and higher income with increased frequency of fruit and vegetable consumption. Three articles (81,82,84) reported on the livelihood challenges facing Canadian Inuit in the face of rapid socioeconomic and climate changes in the Arctic. In the first two articles (81,82) research participants in Igloolik community in Nunavut identified socioeconomic factors that include availability and affordability, high cost of harvesting TFs, poor budgeting skills, low education and poor knowledge of nutrition, as challenges to accessing healthy foods. These results were corroborated by earlier findings by Lambden *et al*. (83), which noted further that the extent of the problem varied across communities (83).

In a related study, Ford and colleagues (84) characterized users of community food programs in Iqaluit and determined that the individuals were socioeconomically disadvantaged.

Additionally, two other articles reported on an assessment of the relationship between SES and dietary patterns in three Inuit regions: Inuvialuit, Nunavut and Nunatsiavut (39,86). Huet and colleagues (39) found that food insecure households had lower healthy eating index score, consumed less fruits, vegetables, grains, and dairy products but had significantly more non-nutrient energy dense foods, compared to those from food secure households. These individuals were likely to live on income support, overcrowded homes and houses in need of major repairs, compared to individuals from food secure homes. Lower SES had a stronger impact on food security in households with children (85). As well, participants in a Photovoice study (86) identified high costs and limited choice of healthy foods, poor budgeting skills, and addictions as factors aggravating food insecurity among low SES residents of Iqaluit community in Nunavut. These findings generally underscore the critical role of socioeconomic factors of education and income on energy balance-related behaviors of Canadian Inuit.

Psychosocial factors

Two articles (87,88) described the mediating role of psychosocial factors on dietary behavior and physical activity. Mead and colleagues examined the relationship between food acquisition and preparation behaviors of Inuit in Nunavut (87) and Inuvialuit (88) and the psychosocial and socioeconomic factors influencing these behaviors. According to findings from both regions, intention was positively associated with the frequency of healthy foods acquisition. Further, there was an association between the use of food preparation practices that were considered healthier and increased healthy foods knowledge, intention, and self-efficacy. Higher level of education was positively correlated with increased healthy food self-efficacy. Increased healthy food knowledge and self-efficacy were also associated with greater intentions to make healthier food choices. This suggests potential roles for psychosocial factors in the regulation of energy balance-related behaviors of Canadian Inuit.

Smoking and drinking

Four articles (89,90,29,91) described the impact of smoking and drinking behaviors on dietary adequacy of Canadian Inuit. One cross-sectional study examined the association between smoking status and dietary adequacy among Inuit in three Inuvialuit communities (89) and three

Nunavut communities based on smoking status (90). In another cross-sectional study, the influence of smoking status (29) and alcohol consumption (91) was examined. Rittmueller and colleagues found that smokers tend to consume more energy-dense and less nutritious foods compared to non-smokers, while the study conducted specifically on Inuvialuit women (29) demonstrated that smokers were likely to be deficient in vitamin C. The article by Kolahdooz and colleagues (91) on the impact of alcohol consumption on dietary adequacy reported that alcohol consumption altered nutrient intakes of Inuvialuit women of child bearing age, and that energy intakes of drinkers were higher than non-drinkers, but no differences in nutrient intakes between drinkers and non-drinkers were found except that drinkers had lesser nutrient density (91). Therefore it appears some unhealthy behaviors including smoking and drinking may adversely influence eating habits and diet qualities in the population.

Health promotion intervention articles

Two articles (92,93) reported on health intervention programs designed to promote dietary behaviors and/or physical activity amongst Canadian Inuit. One article (92) reported on health promotion intervention programs that incorporated some psychosocial constructs to address the growing burden of chronic diseases in Nunavut and Inuvialuit. The nutrition and lifestyle intervention program (Healthy Foods North) was underpinned by social cognitive theories of human behavior and implemented in multiple environmental settings such as schools and recreational centers. Pre- and post-evaluation of the intervention program showed an increase in food-related self-efficacy and intentions in intervention communities, compared to participants from comparison communities (92). Additionally, participants who were overweight, obese and had higher SES displayed more improvements in the constructs examined, such as self-efficacy, healthy eating knowledge and behavioral interventions, compared to those with lower SES or those within healthy weights range (92). Another intervention program that was designed for Nunavik children who attended day care centers was reported to have improved the nutrition status of participating children (93). According to the findings, the proportion of children who met the recommended servings of fruits, vegetables, and grains, as well as requirements of vitamins, irons, and other micronutrients through the

nutrition intervention program was significantly greater than those who did not participate in the program (93). Although these studies are limited, the findings on the sociocognitive constructs are promising and present opportunities for further intervention research.

Discussion

The purpose of this study was to identify cultural, environmental, socioeconomic and psychosocial determinants of energy balance-related behaviors among Canadian Inuit. Our main findings indicate that sociocultural and environmental changes are responsible for transitions from healthy traditional diets to less nutrient energy-dense store-bought foods in Inuit communities. We also documented a shift in lifestyle among Inuit from an active hunter-gatherer subsistence living to a more sedentary and motorized lifestyle over the last 50 years. In this section, we discussed the various factors influencing energy balance-related behaviors in Inuit communities and identified areas where additional research is required to foster our understanding of determinants of these behaviors.

Our findings showed that the social and cultural changes that swept across Inuit communities since the first contact with European immigrants have profoundly impacted virtually all spheres of Inuit life, which historically was rooted in Indigenous traditions. It was also evident from this review that many aspects of Inuit traditional life have been eroded, particularly the hunter-gatherer identity and traditional food sharing practices. Food gathering and sharing are essential traditional activities and are both symbolic of Inuit cultural identity (94). However, Euro-Canadian lifestyles and its domineering influence have to a large extent subjugated Inuit cultural tradition, and today, has profoundly influenced the energy balance-related behaviors. Apart from increasingly becoming a less active population in contrast to pre-contact era, there is a growing interest in less nutrient energy-dense store-bought Euro-Canadian diets among the younger generation of Inuit. This has in the last five decades resulted to weight gain, with increasing concerns about obesity trends in the population particularly amongst children. Additionally, a large proportion of Inuit are of lower socioeconomic status (SES), measured by education and income, which further aggravates the problem. A lower SES status and pervasive

household food inadequacy substantially reduce the ability to access healthy foods and perform healthy dietary behaviors in the face of limited affordable choices. All these suggest that policy makers and health interventionists must begin to develop programs and adaptation mechanisms to accommodate the social, cultural and environmental realities of the population.

In the last five decades increasingly less traditional food gathering and culture-based recreational activities have taken place compared to pre-contact era when all foods were locally sourced through hunting, trapping, and fishing. Although TFs are culturally preferred and more nutritious than store-bought foods, studies conducted on the changing dietary patterns of Inuit strongly suggest decreasing contributions of TFs to total energy and nutrient intakes in terms of frequency and quantity, particularly among younger people. The decreasing contributions by TF are attributable to a number of factors. These include the rapidly growing population rate, and increasing population of younger generation with limited hunting skills and growing dependence on wage-based economy, in which individuals earn income from paid employment reducing the need and possibility of actively engaging in TF harvesting and processing (28,64).

Additionally, climate change and the environmental impacts on both flora and fauna were also documented in this review. Increase in environmental temperatures and changes to the migratory patterns of both terrestrial and sea mammals have all combined to reduce accessibility and availability of TFs (95,96). The implication is that Inuit are compelled to be less dependent on TFs, and are increasingly becoming reliant on non-traditional and often less healthy store-bought foods "imported" from Southern Canada, as popular alternatives. The dietary inadequacies among Canadian Inuit are also well documented. At prevalence rates ranging from 43.3 to 68.8 % (71), food insecurity is at a level that can be described as a public health emergency. A large percentage of Inuit population struggle to access adequate nutritious foods. The rate of food insecurity in the region is described as highest of any Indigenous population groups in North America (37).

Published articles that reported on determinants of physical (in)activity in Canadian Inuit population are relatively scarce. It is crystal clear from the longitudinal studies that a change

from hunting-related subsistence ways of life to wage-based economy, mechanized and sedentary living, due to Euro-Canadian cultural influences, were responsible for lower rates of participation in physical activity and corresponding fitness levels. Published results of the more recent studies on physical activities are inconsistent and perhaps unreliable because, despite claims that self-report measures have been validated in this culture, the instruments appear to be questionable measures for determining physical activity levels in Inuit population. For example, such instruments may not fully account for measuring physical activity levels of Inuit who engage in traditional and often seasonal "on-the-land activities". The inconsistencies observed in reported findings [38–40] suggest that more research is needed to determine reliable age-specific physical activity levels in the population. Articles by Hopping et al. (42,43) reported a co-existence of overweight/obesity and high levels of physical activity in both Nunavut and Inuvialuit. This suggests that the use of IPAQ instrument was not appropriate for Inuit. A more objective measure of physical activity, such as accelerometry, might produce better results for the population as was the case for Greenland Inuit. Accelerometry in combination with heart rate measurement produced more accurate assessments of physical activity amongst Greenland Inuit (45,44), and when contrasted with IPAQ, generated more reliable results (45).

There is a general paucity of published articles on physical (in)activity of Canadian Inuit to inform health promotion intervention planning and decision making. To our knowledge, no published articles have explored the socio-economic influences on physical activity-related behaviors, and socioeconomic differences in perceived barriers to physical activity and potential individual, household, community, as well as environmental and policy determinants of these differences. Such information is critical in order to understand upstream factors influencing the environments (built, social, community infrastructure, policy, etc.) and the impacts on leisure-time physical activity among Canadian Inuit. Such information is needed to inform the systematic theory- and evidence-based development of interventions in the population.

A reasonable body of evidence in Nunavut and Inuvialuit suggests influencing roles for SES, measured by income and education, as well as sociodemographic factors of age and gender on dietary behaviors of Inuit. Findings from studies in both Nunavut and Inuvialuit showed that

Inuit households with low education and income, and poor nutrition education, are more likely to consume less fruits and vegetables in terms of frequency and quantity, but more energy-dense store-bought foods (83,84,39,85). Additionally, children and younger adults below the age of 50 were more likely to consume more fruits and vegetables, less TFs and less nutrient-dense foods, compared to older Inuit (79,80). Gender differences were less significant (64,70). Such information on demographic differences can be used to target interventions to population groups, especially based on age, income and education, which may benefit more from intervention programs.

In the context of health promotion, two intervention studies were developed based on social cognitive theories of human behavior and that incorporated some environmental determinants of energy balance-related behaviors. These studies showed some positive changes in energy balance-related behaviors among Canadian Inuit (93,94), but it remains unclear whether these changes were sustained over time. Additional studies are therefore needed to deepen our understanding of cognitive and environmental factors influencing energy balance-related behaviors among Canadian Inuit.

Conclusion/Recommendation

Canadian Inuit have undergone significant environmental, cultural and social changes that have eroded the cultural values and indigenous ways of life leading to very limited traditional resources to support healthy lifestyle. Rapid westernization and globalization due to colonization, as well as environmental transitions due to climate change, seem to be the main causes of these changes observed. The changes have reduced the reliance on TF gathering and processing activities and increased dependence on energy-dense store-bought foods and motorized transportation. Although these environmental and social changes cannot be reversed or stopped, opportunities exist to explore behavioral change models and policy interventions for health promotion in Inuit population. Effective health promotion interventions for Inuit population are at present very limited or non-existing. Therefore, we recommend that future research focus on examining how energy balance-related behaviors at individual, household and

community levels in the Canadian Arctic can be influenced to promote health and reduce chronic disease burden on the population.

Appendices Chapter 2

Search terms string 1: Inuit OR Canadian Inuit OR Arctic Inuit OR Canadian Eskimo OR Nunaat OR Inuvialuit OR Nunavik OR Nunatsiavut OR Nunavut.

AND

Search terms string 2: Physical activity OR exercise OR fitness OR active life OR active OR dancing OR singing, OR hunting OR fishing OR determinant of exercise OR determinant of obesity OR determinant of overweight OR determinant of chronic disease OR determinant of fitness OR determinant of diet OR food gatherer OR food gatherers OR traditional games OR games OR cultural activity OR cultural activities OR traditional activity OR traditional activities OR food gathering OR diet OR dietary OR diet selection OR food habit OR food habits OR eating, eating habit, eating habits, eating behavior, eating behaviors, food, junk food, junk foods, feeding behavior RO feeding behaviors OR traditional food OR country food OR cultural food OR local food OR local foods OR meal OR meals OR meal pattern OR meal patterns OR micronutrient OR micronutrients OR macronutrient OR macronutrients OR sodium chloride OR minerals OR drinking OR snacking OR fruit OR fruits, OR vegetable OR vegetables OR berries OR sugar OR energy-dense OR fat OR fatty OR protein OR carbohydrate OR minerals OR seal OR whale OR fish OR arctic char OR caribou OR vitamin OR vitamins.

Chapter 3

Environmental and Motivational Determinants of Physical Activity among Canadian Inuit in the Arctic

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Abstract

Background

Canadian Inuit have transited from a physically active hunter-gatherer subsistence lifestyle into sedentary ways of life. The purpose of the current study was to measure physical activity levels among Nunavut Inuit adults, and explore the sociocognitive and environmental factors influencing the number of steps taken per day.

Method

Inuit and non-Inuit adults (N = 272) in Nunavut participated in a 7-day pedometer study during summer and winter seasons. Participants were asked to complete the Neighbourhood Environmental Walkability Scale (NEWS) and Behavioral Regulation in Exercise Questionnaire (BREQ-3). Data analyses included descriptive statistics, hierarchical linear regression, and tests of mediation effects.

Results

Participants had limited to low activity at a rate of 5027±1799 and 4186 ± 1446 steps per day, during summer and winter, respectively. There were no seasonal and age effects on the number of steps. Gender effects and community differences were observed. Perceived infrastructure and safety as well as land use mix diversity were found to be positive environmental correlates of steps taken, which were partially mediated by identified motivational regulation.

Conclusion

Physical activity levels among Nunavut adults are generally low, but can be promoted by improving the external physical environment and internal motivational regulation.

Background

The high prevalence rates of chronic diseases such as diabetes Type 2, cardiovascular diseases and certain cancers among Nunavut Inuit have been linked to a shift from an extremely physically active nomadic lifestyle to technology-driven sedentary ways of life (22). These trends have led to a growing call by public health experts to focus efforts on behavioral interventions to promote active living in the population. Nunavut Inuit have experienced rapid social, cultural and environmental changes following contacts with European immigrants over the past decades. The changes in many communities have resulted in significant disruption to traditional ways of life and erosion of cultural practices and values (97,98,34). Nowadays, modernization and technology-driven approaches such as consumption of store-bought processed foods, motorized transportation and white-collar jobs, have largely replaced hunting, fishing, and other traditional subsistence activities of the pre-contact era that involved significant daily energy expenditures (34). Evidence suggests that these adopted Eurocentric ways of life have significantly eroded the moderate to high levels of physical activity and fitness among Nunavut Inuit resulting in weight gain and the attendant health issues. Findings from a longitudinal study in Nunavut (41) indicated decreases in physical activity, aerobic power and muscle strength among Nunavut Inuit over a period of 20 years. The study also found increases in subcutaneous fats and higher body mass index for men and women 40 years and over within the period of the study. While obesity rates and associated chronic diseases have increased in the last 25 years, there has been a dearth of studies that examined physical activity levels in the population. To the best of our knowledge, the current study is the first to report objectively measured physical activity levels among Nunavut adults and the influence of environmental factors and internal motivational regulations.

Environment and Walking Behavior

There is a rapidly growing body of empirical evidence in support of the influence of environmental factors on physical activity (30). The built environment is underpinned by attributes that influence physical activity behavior (30,99,31). This implies that modifications to the built environment may promote physical activity participation or foster sedentary behaviors and the attendant adverse health effects. In Nunavut, changes to the built environment are an

integral part of the social, cultural and environmental shifts that the Canadian Arctic has experienced over the past five decades. The changes are correlated with decreased physical activity participation according to research evidence (41). Particularly, subsistence activities that were associated with walking behavior, such as hunting, fishing, traditional food processing, etc., have remarkably decreased (34). There is empirical evidence in support of a positive relationship between community walkability and residents' walking behavior (32,33,35).

Globally, and particularly in the developed world, the number of steps taken per day is widely used as a reliable measure of physical activity levels in both adults and children (100,101,102,103). Tudor-Locke and colleagues developed a graduated steps index for analyzing the number of steps taken as an indicator of physical activity levels (104,105). According to the index, healthy adults who take ≤ 2500 steps/day are considered as operating at basal activity level; 2500-4999 steps/day is described as having limited activity; 5000-7499 steps/day is low activity; adults who take 7500-9999 steps/day are classified as somewhat active; 10000-12499 steps/day are active; and ≥ 12500/day is rated as highly active. This graduated scale allows experts to objectively determine what fraction of a population is actually physically active. Additionally, to derive optimal health benefits from the number of steps taken, researchers have associated the number of steps taken with positive health outcomes. A study of 93 menopausal women revealed that participants who took 5000-7500 steps/day had significantly lower BMI compared to their counterparts who took less than 5000 steps/ day (106). In the same linear relationship, participants who took 7500-9900 steps/day had remarkably lower BMI in contrast to those who took 5000-7500 steps/ day. However, no significant differences were found between those who took 7500-9900 steps/day and those who took over 9900 steps/day. A similar positive relationship was found in women with depression. According to McKercher et al (107), women who took ≥ 7500 steps/day have been associated with about 50% decreases in depression compared with those who took < 5000 steps/day. Men who achieved ≥ 12500 steps/day also reported 50% reduction in prevalence rate for depression.

Taken together, the findings suggest that a certain minimum number of steps among adults are linked to certain health benefits. Findings from a meta analysis conducted by Bohannon (108) on step-defined physical activity measured by accelerometers and pedometers provided an average number of steps taken by residents of some countries and suggested that physical inactivity is a global problem (102,103). For example, adults in the United States take approximately 5100 steps/day (109); in Japan, the number of steps taken by 15 years and older are 7200/day (110); in Belgium: 9600 steps/day for 25-75 years old (111); in Western Australia: 9600 steps/day (112); In Switzerland: 25-74 years old took 10400 and 8900 steps/day for men and women, respectively (113). In Canada, men accumulate 9500 steps per day and women, 8400 steps/day (101). However, there is a dearth of reliable data about the number of steps taken by the Nunavut Inuit adult population.

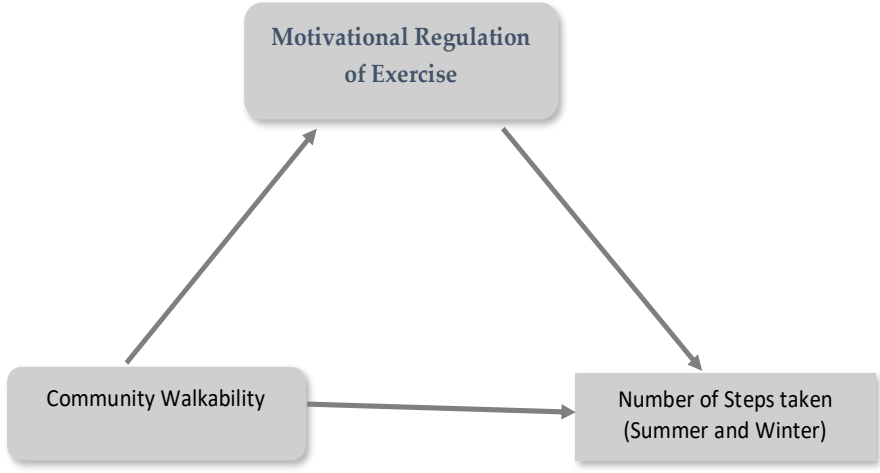
Motivational Regulation

Scholars have proposed to integrate social psychological factors in ecological approaches to determinant studies in order to increase our understanding of the underlying processes and mechanisms leading to behavior change (57,54,58). An example of a social psychological theory that is widely used in predicting self-regulated behaviors such as physical activity is Self-Determination Theory (SDT) (57). The theory is predicated on the notion that the quality of an individual's motivation influences whether the individual will engage in, and sustain, the health behavior (57). SDT distinguishes *six motivational regulations* that reside along a continuum from *amotivation*, via controlled motivation (i.e. *external* and *introjected regulation*), to autonomous motivation (i.e. *identified regulation*, *integrated regulation* and – the optimal form – *intrinsic motivation*). Controlled motivation is characterized by feelings of pressure and lack of choice, either emanating from factors situated outside the person (e.g. punishment, deadlines: *external regulation*), or from inside factors (e.g. guilt, shame: *introjected regulation*). Autonomous motivation, as opposed to controlled motivation, is characterized by experiencing a sense of freedom in one's choices and is driven by feelings of personal relevance (e.g. exercise is important to me because it is good for my health: *identified regulation*), personal identity (e.g. I am a sporty type: *integrated regulation*) or enjoyment (*intrinsic motivation*) (57). Previous

studies have demonstrated that autonomous motivation is associated with more favourable outcomes (e.g. greater well-being, greater participation in physical activity in a variety of contexts and greater perseverance (58,59). Thus, a higher environmental walkability may increase an individual's motivation for exercise, for example the perception of easier walking opportunities may lead to increased perceived behavioral control (54).

The present study aimed to objectively assess the levels of physical activity among Nunavut Inuit adults by determining the average number of steps taken per day. In addition, we explored the environmental walkability and motivational factors influencing the number of steps taken. Based on previous empirical studies (31,35) and theory [e.g., the Environmental Research framework weight Gain prevention (EnRG; (54,114), it was expected that environmental walkability factors would be positively associated with the number of steps taken, and these associations would be partially mediated by motivational regulation (Figure 1). To the best of our knowledge, this was the first study that addressed environmental factors and motivational determinants of objectively assessed physical activity levels among adults in Nunavut.

Figure 1. Research model.



Methods

The Canadian Inuit in the Arctic

The Inuit people are one of the three Indigenous/Aboriginal peoples in Canada. The Inuit inhabit *Nunaat*, *Inuktitut* language expression for traditional Inuit homeland, which spans across the Canadian Arctic, occupying more than one-third of Canada's land mass. *Nunaat* spreads across four discrete geographic regions; Inuvialuit, Nunavik, Nunatsiavut and Nunavut (26). Nunavut is the largest of the four regions, becoming a territory in 1999. The area has a population of 37,082 (84.2% Inuit and 15.8% non-Inuit) and is divided into three regions: Qikiqtaaluk (North and South sub-regions), Kivalliq, and Kitikmeot. The Inuit have the highest population growth rate and are the youngest demographic group in Canada with a median age of 22, compared to 40 nationally (7). Four communities in Nunavut were selected from the three regions: Resolute Bay (North Qikiqtaaluk), Iqaluit (South Qikiqtaaluk), Cambridge Bay (Kitikmeot), Baker Lake (Kivalliq) (see Table 1).

Table 1. Demographic and Environmental Characteristics of the four participating communities.

Community	Population	% Male	% Female	% Non-Inuit	% Inuit	Average Temperatures		Average snow (Jan/Aug)
						Jan. (Winter)	Aug. (Summer)	
Baker Lake	1997	54	46	9.1	90.9	-33.3 ^{0}C	+9.8^{0}C	32 cm / 0 cm
Cambridge Bay	1746	50.5	49.5	20.7	79.3	-32.0^{0}C	+6.8^{0}C	24 cm / 0 cm
Iqaluit	7590	51	49	44.6	55.4	-26.9^{0}C	+7.1^{0}C	22 cm / 0 cm
Resolute Bay	210	58	42	14.3	85.7	-32.0^{0}C	+2.0^{0}C	20 cm / 0 cm

Community Profile

Seven communities were initially contacted and provided with information on the purpose of the study, including potential benefits to the community and Nunavut in general. Four communities were selected based on the letters of support that were received from community leaders/administrators, the population size, and geographic spread across the three

regions. The recruitment procedure strived for participation from the most populated (Iqaluit) to one of the least populated communities (Resolute Bay) in the territory. Demographic descriptions of participant in the four participating communities are presented in Table 2. Approval for the study were obtained from the ethics review committee for psychology and neuroscience at Maastricht University, Netherlands (reference number ECP-148 05_03_2015), and from the Nunavut Research Institute (License number 050 1315-Amended).

Table 2. Demographic Profiles of research participants (sample size n=272).

	Sample size (n)	%
Age		
18-29	117	43.0
30-39	57	21.0
40-49	59	21.7
50-64	39	14.3
Gender		
Male	153	56.2
Female	119	43.8
Ethnicity		
Inuit	203	74.6
Non-Inuit	69	25.4
Community		
Baker Lake	62	22.8
Cambridge Bay	48	17.6
Iqaluit	139	51.1
Resolute Bay	23	8.5

Psychometric Measures

Neighborhood Environmental Walkability Scale

In this study, residents' perceptions of community walkability were obtained by administering the Neighbourhood Environmental Walkability Scale (NEWS), a self-reported perceived environment survey that was originally developed by Saelens and collagues (32). Our study utilized the Confirmatory Factor Analysis (CFA)-based NEWS, which comprised of eight multi-item and five single-item subscales. The CFA-based data analysis is predicated on the scoring algorithms and procedures fully described in Cerin et al (115). We utilized the NEWS

instrument to assess residents' perception of neighbourhood attributes in relation to the number of steps taken per day. Items were grouped into subscales as previously described (33) to evaluate the underlying constructs of land-use mix diversity and land-use mix access, perceived safety from traffic and crime, proximity to stores, schools, and other facilities, residents' perceived access to these destinations, perceived levels of infrastructure and facilities for walking, cycling, and neighbourhood aesthetics.

Motivational Regulation of Exercise

To assess controlled and autonomous motivational regulation for participation in physical activity and determine whether the effect of the environmental factors on the number of steps taken was mediated by motivational regulation, we administered the Behavioral Regulation in Exercise Questionnaire (BREQ-3), originally developed by Mullan and colleagues (116). BREQ is a multi-dimensional 24-item instrument that measures stages of self-determination continuum regarding respondents' motivation to exercise based on a five-point Likert scale (ranging from 1: not true for me, to 5: very true for me). Six constructs/factors of motivational regulation were measured (intrinsic regulation, integrated regulation, identified regulation, introjected regulation, external regulation, and amotivation), and each as a subscale consisting of four items. The score for each factor was determined as the average value of four items that constituted each subscale/factor.

Behavior

Participants were asked to wear the Kaden G-Sport Pocket Pedometer 793 Multi-function Step/distance/calories/ Counter. Participants were asked to wear the pedometer for step counting purposes by attaching the instrument to their waists after dressing up in the morning, ready to proceed with the day's activities. The pedometer was to remain attached to the waist until participants were ready to head to bed in the evening. This provided an average of approximately 13 hours of wear time per participant. Each participant was required to record the reading just before heading to bed, without altering or resetting the pedometer reading. This

was done daily for seven consecutive days. This way, the readings for the seven days were added in a cumulative manner. The readings were cross-referenced with the daily seven daily readings that were recorded by participants. There were no discrepancies between the two readings. The average of the seven-day readings was determined by adding seven readings together and dividing the value by seven, to provide the average number of steps taken per day. The seven-day readings on the pedometers were then used to confirm the reports provided by participants.

Pilot Study

Both questionnaires (NEWS and BREQ) were pilot-tested in Iqaluit among the target population that varied across age, gender, ethnicity, educational, and socioeconomic class. Results from the pilot test necessitated a few changes to the wordings of some items to enable research participants better understand the study and increase the reliability of data by ensuring validity of the assessment of the various constructs that we explored. Some NEWS items were rephrased as suggested by participants who participated in the pilot study. Given the geographical location of Nunavut and some unique environmental factors that are not captured by the NEWS instrument, we developed a six-item "weather conditions" scale to measure respondent's perceptions of the weather conditions (see Appendix X).

Given the lack of documented evidence on prior use of the Kaden G-Sport Pedometer in physical activity studies, we recruited 12 regular users of pedometers to use Kaden G-Sport brand simultaneously with their conventional pedometers (Yamax brands) over a seven-day period. The purpose was to determine the reliability of the Kaden G-Sport instrument. In terms of the number of steps, the overall difference between the two instruments was between 2-4%, indicating that the reliability of the Kaden G-brand is similar to validated brands such as the Yamax's.

Data Collection – Main Study

To determine the number of steps taken per day in the summer (July/August 2016), 153 males and 119 females (n=272), both Inuit and non-Inuit healthy adults 18 years old and over

(mean age: 34.92, SD: 12.62), were selected through a random sampling approach from cross sections of the four communities. Inuit and non-Inuit who were less than 18 years of age, not in good state of health, or adults who were above 65 years of age, were excluded from the study. Each respondent was provided with a pedometer and asked to complete the NEWS and BREQ surveys. Research assistants provided information on the study to research participants and obtained written consents prior to the start of the study. Research assistants also provided necessary supports and clarifications as needed, including guidance on the use of the pedometers, and ensured that the forms were properly completed. The pedometer study was repeated with the same participants in the winter (January 2017), to assess the number of steps taken, and determine if there was a seasonal effect that resulted to a change in the number of steps taken from summer to winter (delta steps). Pedometers were retrieved from the participants after seven days, and the steps data retrieved. Of 272 participants who completed the survey in the summer, only 169 (62%) participated in the pedometer study. The number dropped to 148 participants (12.5% attrition) in the winter when the pedometer study was repeated. No age, ethnicity and community level differences were observed in attrition rates.

Data Analysis

The collected data were entered in IBM SPSS Statistics Version 24 for cleaning and subsequent analyses. Data were analyzed using descriptive statistics, Pearson correlations, hierarchical linear regressions, and test of mediation effects. Five missing values were imputed by item means. Descriptive analyses included the mean and standard deviation of score values. Subscale scores were computed by summing the scores on the respective subscales: the higher the score the more agreeable the respondent to, for instance, the motivation for engaging in exercise.

Internal consistency analyses of the six BREQ subscales revealed good psychometric properties according to their Cronbach alpha (α) values: Amotivation = .65; external regulation = .75; introjected regulation = .76; identified regulation = .63; intrinsic regulation = .82; and integrated regulation = .82. To determine whether the NEWS subscales were reliable, their

Cronbach α values were assessed. For Infrastructure subscale, α = .79. Land-use mix access subscale α = .51, indicating poor internal consistency. However, elimination of one item "it is easier to walk to a transit stop (bus, train) from here" increased the reliability score to .68. This concerted the factor to a three-item subscale. The subscales of street connectivity (.55) and aesthetics (.59) had weak internal consistency. Elimination of items with the least contribution to the internal consistency of these subscales did not significantly improve on reliability score. Thus the original subscales were retained. An assessment of the internal consistency reliability of the newly developed weather scale indicated good psychometric properties at a Cronbach α value of .83. The Cronbach α values of traffic hazard (.10) and crime (.18) were too low, and consequently removed from further analyses.

Scores for the study variables were checked for normal distributions using tests for skewness and kurtosis (117). Pearson correlations were computed to explore relationships among study variables. Further, tests for regression diagnostics for outliers were conducted as recommended by Fox (118). To determine the validity of the hypothesis that motivational regulation would mediate the effect of environmental factors on the number of steps taken (summer, winter and delta steps) as a measure of physical activity, we utilized a hierarchical linear regression model. In stage 1, all the environmental factors (NEWS subscales) were entered as predictor variables and linearly regressed against the number of steps taken in the summer by eliminating the least contributing variables to the model. We then determined the fraction of the variance in the number of steps taken that was explained by the environmental factors in the final model of stage 1 while controlling for demographic factors (age, gender, ethnicity). In stage 2, the six BREQ subscales were added to the model. The final predictor variables (environmental and motivational factors) were identified in the final model as well as the fraction of the variance in the number of steps explained by each. Stages 1 and 2 were repeated for each of winter and delta steps (winter – summer). To determine whether there was a mediation effect on the number of steps taken, we conducted mediation analysis according to MacKinnon et al 2007 (119), using the Bootstrap Confidence Intervals as described by Preacher & Kelly, 2011 (120).

Results

The Mean (SD) of the summer, winter and delta steps taken per day by respondents were 5027 (1798), 4186 (1445), and 835 (572), respectively. Although there were no significant differences between the overall means of summer and winter steps, further analysis using Tudor Lock's graduated step index revealed some moderate to significant differences between summer and winter steps at some levels of graduation (Table 3). A higher proportion of participants engage in walking activities in the summer at steps index ≥ 5000 steps/day, when compared to the winter. The data also suggest that, independent of seasons, significantly fewer people participate in walking activities at levels classified as "somewhat active" to "highly active", that is ≥7500 steps/day.

Table 3. Application of Tudor Locke's graduated Index to the Number of Steps Taken by Research Participants in the Summer and Winter.

Graduated Steps Index	Summer Steps (%)	Winter Steps (%)
<2500 steps/day	3.4	13.4
2500-4999 steps/day	50.7	64.5
5000-7499 steps/day	35.1	18.0
7500-9999 steps/day	8.1	4.1
10000-12499 steps/day	2.7	0

The gender effect was consistent over summer and winter seasons. Men were more active than women. Additionally, people living in Iqaluit were more active than those living in Baker Lake, Cambridge Bay, and Resolute Bay.

In stage 1 of the hierarchical regression model (Table 4), two environmental factors were significantly and positively associated with physical activity in the summer and winter: infrastructure/safety and land use (land-use mix diversity). In stage 2, after adding the six motivational factors to the model, our findings indicated that identified motivational regulation added to the explained variance of the model in both the summer and winter. No other motivational factors had any significant observed regulatory effect.

Table 4. Regression coefficients, P-values and explained variance from regression analysis for the number of steps taken during the summer and winter seasons, and the change (delta) in the number of steps taken from summer to winter (n=272).

Variables	SUMMER STEPS						WINTER STEPS						DELTA STEPS					
	B	P-value	R^2	**β**	P-value	R^2 final model	**β**	P-value	R^2	**β**	P-value	R^2 final model	**β**	P-value	R^2	**β**	P-value	R^2 final model
Age	-.07	.23		-.07	.35	.44	-.10	.20		-.07	.36		-.02	.83		-.02	.84	
Gender	-.15	.04		-.14	.04		-.15	.03		-.15	.02		.00	.99		.00	.99	
Ethnicity	.00	.98		-.02	.74		-.02	.82		-.02	.77		-.04	.65		-.04	.63	
Baker Lake	-.01	.87	.38	.07	.36		-.04	-.06	.34	.05	.53	.40	.08	.36	.12	.09	.31	.12
Cambridge Bay	-.04	.57		.02	.81		-.05	,44		.01	.89		.00	.99		.01	.94	
Resolute Bay	-.40	<0.001		-.41	<0.001		-.41	<0.001		-.16	.06		-.16	.06		-.16	.06	
Land-Use Mix Diversity	.20	.01		--	--		.19	<0.001		.--	--		--	--		--	--	
Infrastructure & Safety	.25	<0.001		.27	<0.001		.23	<0.001		.23	<0.001		.25	<0.001		.25	<0.001	
Identified Regulation	--	--		.25	<0.001		--	--		.27	<0.001		--	--		--	--	

The impact of identified regulation appears to be consistent over the summer and winter. When predicting the change in steps from summer to winter, only infrastructure was a significant predictor, indicating that good infrastructure leads to increases in the number of steps taken by respondents. No significant associations for motivational factors were observed for the change in steps (Table 4). The explained variance of this final model was substantially lower (12%) than in summer (44%) and winter (40%).

Mediation Analysis

Results from the correlation studies and regression analyses indicated that only two independent variables were of significance in the study: Infrastructure/safety and land use mix diversity, and only identified motivational regulation was significantly associated with the number of steps taken in both summer and winter seasons (Table 4).

To explore the mediation effect of identified regulation, we hypothesized that, (1) there was a direct effect of two independent variables, infrastructure/safety and land use mix diversity, on the number of steps taken in both summer and winter seasons. That is, there would be a correlation between each of the two independent variables and the number of steps taken; (2) there would be a correlation between each of the two independent variables and identified regulation; (3) there would be a correlation between identified regulation and the number of steps taken while controlling for each of the two independent variables, and (4) the effect of the independent variables on the number of steps taken while controlling for identified regulation would be zero, indicating a full mediation. The results of mediation analysis indicated a strong relationship between each of infrastructure/safety and land use mix diversity, and identified regulation in the winter season. There was a direct effect of each of the two variables on the number of steps taken, and there was an indirect (mediated) effect. X is the independent variable (infrastructure/safety or land use mix diversity); Y is the number of steps taken in either winter or summer; and M is the mediator variable, identified regulation (Table 5).

Table 5. Partial mediation effects of identified motivational regulation on the number of steps taken in the summer and winter seasons.

Indictors of Mediation	Unstandardized Effect Size and [Bootstrap Confidence Intervals]			
	Summer Season		Winter Season	
	Infrastructure/ Safety	Land use mix Diversity	Infrastructure/ Safety	Land use mix Diversity
Total effect	1342 [(888.17) –(1817.22)]	796 [(383.05) –(1209.12)]	960 [(596.13) – (1324.19)]	542 [(235.92) – 849.26)]
Direct effect of X on Y	1541 [(1065.11) – 2017.21)]	855 [(443.03) – (1267.05)]	1129 [(767.61) – (1489.85)]	617 [(312.05) – (921.42)]
Indirect effect of X on Y	-199.5 [(-360.15) – (-67.05)]	-59 [(-.170.25) – (6.61)]	-169 [(-293.12) – (-69.71)]	-74 [(-159.91) – (-12.06)]
Association between X and M	-.463 [(-.75260) – (-.1733)]	-.2023 [(-.4464) – (.0419)]	-.463 [(-.7024) – (-.1699)]	-.2441 [(-.4624) – (-.0258)

The analyses showed partial mediation by identified regulation given that the direct effect, that is, the effect of the infrastructure/safety while controlling for identified regulation does not equal zero (Table 5). Similar effects were observed in the summer for the infrastructure/safety variable. In contrast, no meaningful relationship was observed between land use mix diversity and identified regulation, and no significant indirect effects were observed between land use mix diversity and the number of steps taken in the summer (the Bootstrapped CI's for the indirect effect and the association between X and M include zero). Note that the associations between infrastructure/safety and identified motivation were negative.

Discussion

The study determined the number of steps taken per day by Nunavut residents as a measure of physical activity in the Canadian Arctic and explored the perceived environmental walkability and motivational regulation as correlates of physical activity in four communities. Our findings showed that only 2.7% of Nunavut residents were physically active at ≥ 10000 steps/day in the summer (and none in the winter) compared to about 35% of adult Canadians who live elsewhere in the country (101). The sharp disparity in the physical activity levels between

residents of Nunavut and the rest of Canada may be associated with unique environmental attributes in the Canadian Arctic in contrast to the southern part of Canada. These attributes are probably related to the weather. Since this is a non-changeable environmental determinant of physical inactivity, insights into the role of the built environment in Nunavut in terms of its density, diversity and design are even more important (121). We found that perceived infrastructure and safety, as well as land-use mix were found to be positive environmental associates of steps taken. In addition,

Our findings suggest that Iqaluit residents are more physically active than residents of Baker Lake, Cambridge Bay and Resolute Bay. The observed differences may be explained in part by dissimilarities in built environment. Evidence suggests a link between increased density and land-use mix, and walking for both pleasure and travel (122). Iqaluit is more densely populated, has better street connectivity, land-use mix, and land use mix access and aesthetics, as well as improved community infrastructure including good roads, street lighting, and fitness centers, compared to the other three communities. When predicting the change in steps, only infrastructure was a significant predictor, indicating that good infrastructure leads to a smaller decrease in the number of steps taken by residents when transitioning from summer to winter conditions. In general, as community land-use mix increases, there is an increased probability that there will be desirable or useful destinations that are in close proximity of one another, that may potentially motivate individuals to walk, rather than drive, to access those destinations. This appears to be the case for Iqaluit in contrast to the other communities. Environmental temperature may also have played a factor as Iqaluit appears to be relatively warmer by five to six degrees in the winter.

In general, our results were consistent with previous findings: improved infrastructure and better land use (land-use mix diversity) were significantly associated with physical activity in both summer and winter seasons. In a sample of 351 Canadian adults, Rhodes and workers (123) found that residing in walkable neighbourhood tended to increase accelerometer-based minutes of cycling and recreational walking and less of motorized transport. In another study involving

Australian adults, neighbourhood walkability was positively correlated with frequency of walking as a means of transportation, although the same effect was not found for recreation walking (124). Additionally, people who live in neighbourhoods with higher residential density, street connectivity, better land-use mix in the United States were found to be more likely to walk and cycle than in neighbourhoods with less of these environmental characteristics (32).

We also explored the contributions of motivational regulation in the observed effects of the environmental factors on the number of steps taken. Identified regulation made a significant contribution to the model. Our findings indicated that environmental effects were partially mediated by identified motivational regulation, especially in the winter season. Identified regulation is an autonomously driven form of extrinsic motivation; it reflects the conscious evaluation of physical activity and the perceived benefits. More autonomous forms of motivational regulation (i.e. intrinsic and integrated regulation) were no significant correlates of physical activity. This may be viewed as a surprise, also in the light of previous empirical investigations (125,126,127,128) that have shown consistent and positive impact of these types of motivation in predicting physical activity. It seems that the Arctic context may hamper the translation of intrinsic and integrated motives (for example, engaging in leisure time sports for enjoyment) into action. The impact of identified regulation in the Arctic context underlines the importance of communication about the (health) benefits of physical activity. These findings provide some foundational work for future studies that aim to identify evidence-informed psychological constructs that are viable and appropriate targets for behavior change interventions (129,130,131,132) to promote increased physical activity in the Canadian Arctic.

It is also important to note that the proportion of the direct effect of environmental walkability on the number of steps that is mediated has a negative value. It is remarkable that when two variables (environmental walkability and identified motivation) are positively correlated, and both of them correlate positively with the outcome variable (number of steps taken), that their relationship in a multivariate analysis is negative. When this occurs, the mediator acts as a suppressor variable and the mediation process is often referred to as

inconsistent mediation (131). In our data, bivariate correlations between Infrastructure/safety and Identified motivation, as well as between Land use mix diversity and identified motivation were positive (r's .11 and .30, respectively). Correlations between infrastructure/safety and number of steps, as well as between land use mix diversity and number of steps were positive as well (r's between .26 and .42 in summer and winter). Bivariate correlations between identified motivation and number of steps were also positive (.22 in the summer and .26 in the winter). Given the problematic nature of estimates from multivariate analysis, it is recommended that decisions on determinants association and reflections on mediation be based on bivariate correlations (132).

Conclusions

According to a description of an effective behavioral change intervention mapping approach described by Kok et al (133), it is expedient to identify a determinant that predicts the behavior and an effective method that can change the determinant. Such method should have practical applications and deemed culturally appropriate for the target population and context. The results of the current study indicate the importance of integrated approaches to the promotion of physical activity, focusing on improvement of infrastructure and land-use mix, in combination with educational interventions addressing the health benefits of being physically active in Nunavut.

Chapter 4

Healthy Dietary Choices and Physical Activity Participation in the Canadian Arctic: Understanding Nunavut Inuit Perspectives on the Barriers and Enablers

This chapter has been published as:

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Abstract

Background

Research shows that unhealthy diets and low physical activity are associated with high rates of obesity-linked chronic diseases amongst Nunavut Inuit. To provide contextual insights and deepen our understanding of the factors that underlie these lifestyle choices, we explored the perspectives of Nunavut Inuit on the barriers and enablers of healthy diets and physical activity participation in the community of Iqaluit.

Method

One-on-one semi-structured photo-elicitation interviews were conducted with 16 participants of 18 years and over (ten women, six men). The interviews uncovered participants' perspectives on the factors influencing healthy diets and physical activity in their community. Interviews were audio-recorded, transcribed and then uploaded to QSR NVIVO Version 12. Data analysis was achieved using an inductive thematic approach.

Results

Six main factors were identified as barriers or enablers to energy balance-related behaviours: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of family and friends; and effect of substance use.

Conclusion

This study identified six broad areas that should be considered while mapping out intervention points during the design of effective and sustainable interventions to reduce the burden of obesity-related chronic diseases in Nunavut communities.

Background

Inuit diets and activity patterns have significantly changed over the past five decades in response to the socio-cultural and environmental transitions in the Arctic. The population has transitioned from the traditional hunter-gatherer subsistence living to Euro-Canadian ways of life. This lifestyle transition is characterized by steady increases in the consumption of energy-dense processed foods (10,4,5) and diminishing rates of physical activity and fitness level (41,40,34,134).

Although the Inuit population is growing at a rate higher than the national average (135), many Inuit continue to live in communities with limited access to healthy food supplies (34) and poor infrastructure for recreational activities. The social conditions are generally suboptimal and appear to be a major contributor to the rise in diet-related health problems such as obesity and chronic diseases such as diabetes type-2 (19,60). For example, diabetes type-2 was alien to the Inuit population five decades ago but the disease is present nowadays at a rate that is similar or higher than the mainstream Canadian population (70).

A body of research evidence has demonstrated comparative health, and social and economic benefits of sustained harvesting of traditional foods in the Canadian Arctic over energy-dense store-bought processed foods (136,137,138). However, healthy traditional foods are consumed less. In their cross-sectional study in Nunavut, Sharma and colleagues found that consumptions of essential vitamins and fibers were lower than recommendations, and significantly less traditional foods were consumed in contrast to sugar-sweetened beverages and energy-dense processed foods (27). An age-dependent generational shift from traditional food

consumption by older Inuit, to store-bought processed foods by the younger Inuit population has been described (69,68,139,140). This change is equally evident in the occupational patterns and the switch from hunting and subsistence living to a wage economy (139,140) characterized by limited physical activity and associated energy expenditure. Younger Inuit men and women are less likely to participate in hunting activities as they generally lack the knowledge and experience compared to their parents and grandparents (141).

As the Inuit population has transitioned from nomadic living to more permanent settlements, food gathering activities including hunting, fishing, trapping nowadays require the use of motorized equipment (140) such as snow machines, four-wheeled all-terrain vehicles, boats, and firearms. Moreover, a hunter's success largely depends on his disposable income; that is, their ability to afford the high cost of hunting equipment including fuel. Less hunting and food gathering activities also means decreased opportunities for physical activity and increased consumption of energy-dense store-bought foods (34). All these developments are suggestive of less physical activity within an increasing obesogenic environment and are likely to combine to increase obesity rates and chronic diseases in the population.

To date, there have been limited studies that aimed at advancing our understanding on the determinants of diet and physical activity among Inuit (34,134). Notably, most previous studies had quantitative research designs, which limits our understanding of belief structures and underlying contexts. We have previously shown in a systematic review (34) that qualitative studies that directly examined the perspectives of Nunavut Inuit on factors influencing their dietary and physical activity patterns are scarce. The main findings from the review indicated

that sociocultural and environmental changes are responsible for transitions from healthy traditional diets to less nutrient energy-dense store-bought foods in Inuit communities. We also documented a shift in lifestyle amongst Inuit from an active hunter-gatherer subsistence living to a more sedentary and motorized lifestyle over the last 50 years (34). A qualitative inquiry may provide contextual insights and deepen our understanding of the underlying factors that embed the dietary choices and physical activity participation in the population. Low literacy levels, socioeconomic status of research participants, and cultural differences between research participants and the researcher often limit the ability of the researcher to gain insights into the world of research participants. Thus, it becomes challenging to engage in discourses and capture salient information that cannot be provided through the use of questionnaires. It is necessary to understand the perspectives of Inuit on the factors that constitute barriers and enablers to making healthy dietary choices and increasing the physical activity levels in the population. An in-depth understanding of the factors that is predicated on Inuit's lived experiences is critical to developing appropriate interventions by policy makers and public health officers.

In line with the proposed research objectives in this Indigenous population, we employed photo elicitation method for this qualitative inquiry. According to Harper (142), photo elicitation is a research approach that bridges the cultural gap between the researcher and the participants. While integrating photographs into their research, Epstein and colleagues described photo insertion in the research method as "ice breaker activity to create a comfortable space for discussion between two individuals who perhaps have different cultural identities and hold differing world views" (143). This approach is particularly relevant given the cultural differences

between researchers and the Inuit research participants. In the current study, photo elicitation was used to initiate conversation on the research topics, and through participants lived experiences and views, uncover the barriers and enablers of healthy dietary choices and physical activity participation.

2. Materials and Methods

This study was part of a larger project that aimed to explore the determinants of dietary behaviour and physical activity in the Canadian Arctic. The Inuit population in Nunavut and the nature of the built and food environments have been previously described (34,134). We utilized an exploratory qualitative study approach to understand the barriers and facilitators of healthy dietary choices and physical activity participation among Inuit. Approvals for the study were obtained from the ethics review committee for psychology and neuroscience at Maastricht University, Netherlands (reference number ECP-148 05_03_2015), and the Nunavut Research Institute (License number 050 1315-Amended).

Study Population

The Inuit are one of the three Indigenous Peoples of Canada (26). The Inuit population has the highest growth rate and is the youngest demographic group in Canada with a median age of 22, compared to 40 nationally (7). Participants for the qualitative study were recruited in Iqaluit, the territorial capital. Iqaluit is the largest and the most culturally diverse community in Nunavut with a population of 7950 of whom 55.4% are Inuit and 44.6 non-Inuit. Participants

were Nunavut Inuit, 18 years or older and had lived for at least 10 years in Nunavut prior to the study, and are fluent in the English language.

Photo Elicitation Interviews

Data collection was divided into two phases. Phase one consisted of Photoshoots in the community and collection of historical photographs for the photo elicitation interview (PEI). PEI is defined as the insertion of photographs in an interview. Photographs are used in qualitative inquiry to trigger memory and evoke responses to interview questions. In the current study we included photographs in the semi-structured interviews that were conducted with Inuit participants.

Two interviewers, VOA and TOF took photographs of the contemporary built and food environments in Iqaluit during summer and winter and collected a few historical photographs of the neighbourhoods, streets, houses, motor vehicles, walkways, playgrounds, fitness/sports centre, etc. The historical photographs depicted the community built and food environments as they were 30 to 50 years ago. The contemporary photos included photographs of food items in the two main grocery stores with prices as well as traditional foods, to gather photographic representations of the current food environment. These photographs were then included in the photoelicitation interviews to advance our understanding of how certain components of the food environment might affect dietary choices for Iqaluit residents. In addition, photographs of roads, streets, walkways, parks, sport/fitness centre, and objects such as buildings, motor vehicles, snow mobiles, etc. were taken to capture the current state of the built environment in

Iqaluit. Photographs selection for the interviews (both contemporary and historical) was guided by the perceived environmental attributes in the built environment and known to influence walking behaviour (32,31). The aim was to understand from the perspective of Iqaluit residents, how neighbourhood attributes such as the constructs of land-use mix diversity and land-use mix access, perceived safety from traffic and crime, perceived levels of infrastructure and facilities for walking, cycling, and neighbourhood aesthetics, constitute barriers or enablers of physical activity. Ten photographs (five historical and five contemporary) were selected for each of the built and food environments. It is worthy of note that the first two authors VOA and TOF are not necessarily outside researchers who "parachuted" into the territory, rather, they are Nunavut residents with a reasonable understanding of the Inuit culture and ways of life. They have both lived in communities in the territory over a period of six to eight years where they worked with Inuit families and community leaders.

Participants were recruited using a purposeful sampling technique (144). The sample size was guided by the recommendations by Clarke and Braun, (145); Fugard and Potts, (146), for data and thematic saturations. Posters were advertised in public areas such as grocery stores and in the community centre. Information sheets describing the study were provided to potential participants who initially expressed interest in the study. The information was written in plain language at reading grade six level and contained information such as the participation criteria, opt-in and opt-out procedures, confidentiality requirements, ownership, control, and access to data. In total, 22 participants (14 women and 8 men) were initially recruited for this study upon showing interest, and demonstrating an understanding of the research goal and participation

process through a question-and-answer session. These individuals were fully briefed in two separate sessions about the purpose of the study and, finally, the signing of the research consent form. Of the 22 who initially expressed interest, 16 respondents (10 women and 6 men) were included in semi-structured photo-elicitation interviews and subsequent data analysis. Of the six participants who dropped out of the study, three persons (two female, one male) informed the researcher of their inability to participate due to family commitments. The remaining three persons (two female and one male) expressed a desire to drop out due to a lack of interest in the areas of research focus.

One-on-one semi-structured interviews were conducted based on the photographs. Each participant was asked to select five photos from the 10 photographs that were presented by the researcher for discussions of food and built environments. Each participant chose five photographs of interest from a list of healthy traditional and non-traditional foods including caribou meat, seal meat, arctic char, pasteurized milk, berries, spinach, etc.; and unhealthy foods such as potato chips, frozen pizza, white bread, cookies, sugar-sweetened beverages, etc. Healthy and unhealthy diets amongst Nunavut Inuit were previously described in detail in a systematic review (34). As well, five photographs of interest were chosen by each participant to elicit conversation about the built environment and infrastructure in the city of Iqaluit in relation to physical activity participation. These included the streets, walkways, sports centre, buildings, park, motor vehicle, snowmobile, etc. For each group of five photos, semi-structured questions were asked. Participants were first asked to describe each photo, followed by what they perceived as the event that was captured in the picture and how this related to food choices and

consumption pattern of Inuit and Inuit life generally. Further, participants described what factors or elements constituted barriers or facilitators of a healthy diet, both personal and structural, in the past and in the contemporary age. Similar questions for the built environment and physical activity were asked, including what factors or elements based on what they saw in the photos constituted barriers or facilitators of an active living lifestyle in their community. Interviews were successfully conducted with 16 participants although data saturation was reached after interviewing the 14th participant. At this point no new information was provided by research participants and no additional themes were generated on the topics under investigation. Interviews were audio-recorded and later transcribed using Rev Transcription Software 2017, San Francisco CA.

Data analysis was conducted using an inductive thematic approach (12). By way of confirmation, the themes, subthemes and insights generated from the data were member-checked by the participants (147). Following data collection and analyses, VOA and TOF returned to research participants to briefly present, and confirm, if the findings and interpretations reflected participants' realities and participants were in agreement with the conclusions reached based on their own individual interviews. Participants were largely in agreement except for minor corrections that yielded additional information during clarification.

Transcribed data were uploaded on QSR NVIVO Version 12 to conduct text search and word frequency queries, find connections within data, and generate patterns and themes. We utilized a three-stage coding system. In the first stage, each transcript was read repeatedly to identify phrases that could be organized into general themes. In the second stage (axial/pattern coding),

the initial codes that were developed in stage one were grouped into smaller themes. In stage three (selective coding), all codes were reviewed and further refined into thematic categories. The second coder, TOF, cross-checked the three coding stages and based on discussion with VOA made changes to the codes with mutual agreement. The thematic categories were then linked through logical deductions to achieve the highest level of validation for the central themes and subthemes presented below. In the Results section, it is stated whether the participant was male (M) or female (F).

3. Results

The factors hindering and facilitating physical activity participation and healthy eating among Canadian Inuit from participants' perspectives are categorized under six broad themes: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of family and friends; and effect of substance use.

3.1. Cost and affordability of healthy choices

The main perceived barrier to healthy food choices and participation in physical activity that participants identified was affordability. Participants mentioned that many community residents cannot afford the high costs of healthy foods, both traditional, e.g. caribou meat, seal meat, arctic char, etc, and non-traditional foods such as beef, milk, eggs, fruits, and vegetables, which could be 50% to 300% higher than the prices in the southern part of Canada. They noted that unhealthy (junk) foods are cheaper and preferred by many Inuit with low income. According

to the participants, traditional foods are increasingly becoming expensive because of the cost of hunting equipment and lower availability of hunters with the appropriate hunting skills:

"If you consider everything, it will drive you crazy, so you have to stop looking at the prices… ... Every now and then I'll look at the price, but not very often because it just drives you crazy. Although, I get to the point when I'm really angry because I know I don't need to pay this much, you know? So you kind of walk over ... You're not angry at anybody, you're just kind of angry that you have to pay this much" (F).

"I believe they're the ones that are in control of the food prices for many of the healthy foods. If there were other ways to bring it up north, more in bulk, and cheaper ways, I think food prices would be lower cost, they're the ones controlling it all I believe" (M).

"Especially having lived elsewhere where the food was affordable, then it's great, you know. But if you haven't gone anywhere then they don't know any better, you know? Youcould Like her, first met you was here, we ordered a club sandwich from the snack, it cost us $50. She actually posted it and said, "Look, a $50 club sandwich" (F).

"…and ordered breakfast and paid a $30 price for breakfast, which would only cost $7 in Ottawa, you know?" (F)".

Cost and affordability impact physical activity as well. The high cost of hunting equipment resulting in less hunting activities and the exorbitant cost of registration fees at fitness centres or sports equipment in the face of relatively low household income, all combine to reduce physical activity rates and fitness levels in the Inuit population:

"You know, there's a difference. Not every family, in a family has machines to go hunting. When we all had dogsleds, everybody went, everybody could go, but now we have machines to take us everywhere, and none of them are under 10 grand" (F)

"You've got to be rich to play [ice] hockey. So you've got to make sports accessible to Inuit and not charge them a lot because it's them that suffer when you do a bit pull like that, do you know what I mean? It's only mostly the elite which are all from the southern part. So hockey maybe not be a good example to show me" (F).

3.2. Availability of traditional foods and activities

Another barrier that was mentioned by participants was related to availability of healthy choices including traditional foods and cultural activities. Some participants argued that it is one thing to know the importance of healthy food choices and be interested in adopting healthy eating as a lifestyle, and be able to afford this, it is a different issue entirely to find these healthy food options in the store on a regular basis. Explaining further, some respondents commented that there are certain government regulations that restrict the number of animals such as caribou that can be harvested in certain parts of the territory, thus impacting its availability and accessibility.

"[Traditional food] is accessible to certain degree. For example, we have the country food shop near the library, which is nice. We can go there and grab tuktu, grab fish, but sometimes there's also moments where you'll go looking for something and you can't find that. That's one. Two, there's also like the days where you can't really go hunting because of the weather, because

nowadays the weather is very topsy turvy. You can't predict it as much so I'd say those are the two main factors" (F).

"For caribou when my nephews and cousins travel to the west, where they have no quota limit on caribou, if it's available and they are coming back with fresh caribou. If family or friends share their, what they have, if it's family dinner going on" (M)

Several decades ago traditional hunting was a lifestyle, a cultural activity that promoted active living and provided healthy food supplies to households. Inuit lived a nomadic and active lifestyle, promoting physical health and fitness. One participant stated:

"I think back then it was a lot more physical activity because we were, and what I know we were often migrating with the animals, following their migration routes. Moving from camp to camp, consistently looking for food and maintaining shelters, and clothing, hunting tools. I believe one was never idle back then, I think idle back then was considered lazy and I believe today there's a lot more, more things are given to us, and we are taking it for granted. That they're able to, not required to do as much to live in today's age" (M).

According to some participants, a general shift from traditional hunting as a means for subsistence to wage economy also influences availability:

"So not everybody can do that. Most of our people are working nine to five, Monday to Friday, so they don't do this on a regular basis, but they may go out and do a variation of this on the weekend" (F).

Moreover, colonization and sociocultural assimilation have disrupted Inuit cultural practices and disparaged traditional values such that many Inuit have attached less social significance to hunting and as a way of life, and suggesting that "food sharing" practices should be promoted as traditional value to improve access.

"But we're totally immersed in this [Euro-Canadian] culture here in….. not so much in the communities"

"I get access to ... If I had relatives that went hunting, people share. They're on Facebook, people saying, "We're having the meal today, please come. Anybody come." Those are the other options. The third option, final option, would be to go to a store. We have a country food store here. It's an arm and a leg, but when we're craving we crave big" (F).

3.3. Weather conditions and climate change

The changing climatic conditions were identified by some participants as contributing to low participation in activities that are tied to healthy diets and active living. As well, it was suggested that the long winter season that ranges from six to eight months at very low temperatures are deterrent to engagement in physical activity, thus reducing participation rates. Commenting on the effect of weather on physical activity, a participant opined: *"Sometimes it's cold outside. You don't wanna walk all the way……so you just decide not to go, you know? But yeah, also the weather conditions. You know that a lot of people don't even like getting out of their house during the winter 'cause it's so dark out, you know, so mentally they just kind of don't wanna do that stuff any more"*

When asked of one perceived barrier to active living as a lifestyle, one participant said: *"The cold weather. If it's very cold out, I try and stay indoors"* (M).

According to one participant: "[*The government] is not willing to acknowledge that climate change and global warming, are occurring and having a large impact on the circumpolar nations…..and [Inuit] culture will slowly diminish away, where they will not be able to practice their traditional practices of hunting on their land. Because if global warming continues, then [this] particular ice flow, this ice rift that's here, will become much wider apart, and it'll be far unsafe for this particular person to go out on the land to hunt for any sea animals" (F).*

Further into the discussion on weather-related challenges that Inuit face while trying to access resources during winter, one participant emphasized the need for adequate facilities and the need for these amenities to be strategically located in the community. She argued: *"……but some people who live, for example, all the way in Happy Valley, or not even Happy Valley, in like Tundra Valley or something. They're gonna probably be less likely to drive all the way, especially in the winters, drive all the way to work and they drive all the way back. It's not something that a lot of people do, so just having the facilities open, whether that's closer to a lot of household places, in buildings, stuff like that" (F).*

3.4. Infrastructure and community resources

Nunavut is a resource-limited environment compared with southern provinces. The availability of adequate resources and the level of infrastructural development in Inuit communities continue to pose barriers to healthy diets and active living, according to

respondents. Thus, increasing community-level resources would increase the participation rates in physical activity and the chances that a healthy eating behaviour would be adopted in the population:

"……We don't have sidewalks here in Iqaluit. We have no sidewalks, so we walk on pavement. So to have sidewalks where people could actually walk on. A place where you can put salt on to de-freeze things, you know, preventing you from slips, of black ice, where most people can actually walk, because if you were to have those things set up, then perhaps people would want to engage in more activities outdoors" (F).

"….. in the winter the sidewalks are not as maintained. In the summer you could sort of go anywhere, and everywhere quicker as compared to walking in deep snow, or snow banks to go around" (M).

Commenting further, a participant commented on the need to engage community elders as resource persons to teaching of Inuit traditions and transfer of cultural legacy such as hunting to increase the number of Inuit who are accessing healthy traditional foods:

"... And…[give] opportunities to children and adolescence to learn the skills of hunting. Because it's important to continue the traditions onward as opposed to it simply dying from the elders and not being passed through the intergenerational learning" (F).

Although resources and infrastructures are limited, adequate funding and personnel continue to pose significant challenges to the maintenance of existing infrastructures in the community:

"Hmm. It exists, at least from my understanding, it exists from the infrastructure that's present within the north. It's quite difficult to maintain sidewalks, because realistically, we are living north of 60. We are in a circumpolar area, and that results in lots of snow falling. And the maintenance of infrastructure such as sidewalks is uncertain, because I've seen before that there are sidewalks that were created by putting large rocks on the side of the road. And this creates a sidewalk, giving that illusion that it is that. But at the same time, in order for it to change, it's difficult, because you can't do so much with the municipal budget to create a sidewalk that will eventually get covered up by snow" (F).

3.5. Social networks of family and friends

Healthy choices tend to converge with those of close social connections including family and friends, especially in settings where communal lifestyle and social inclusion and cohesiveness are important cultural values. Norms of appropriate food choices and participation in physical activity are set, or at least influenced, by the behaviours of other people, but also shared cultural expectations and environmental cues. Participants indicated that Inuit are likely to follow choices that are perceived "acceptable" based on social comparison:

"To keep healthy, but also my parents tease me a lot so I think that's another reason why I work out. 'Cause I came back from international travel. I went to Africa for a couple of weeks, and so I ate a lot of rice there. My parents came up and they saw me and they're like, "..., I think you've gained some weight." They don't bother me about it. They just kind of mentioned it, but I'm like, hey, and I also feel like my pants are a bit tighter now. So I'm, "Okay, I need to actually buckle up and to get a bit healthier." Also you feel good too, so ...yeah" (F).

"Primarily just my family household. My dad works out, my brother works out. We go hiking and stuff like that. That's one thing, but other things? If I was to be totally honest with you I think a lot of it is also just how people ... You know, like fat shaming, stuff like that.." (F).

"Social things like how, if you're fat you're "fat", in quotation marks. If you're fat then you're just less of a human being. So I think there's a lot of social stigma that goes around it. For me though, specifically, I think it's just wanting to look healthy and fit for myself (F).

3.6. Effects of substance use.

Further, participants were asked about other healthy and unhealthy habits they engage in, and whether any of these plays a role in healthy eating behaviour and physical activity participation. Engagement in certain unhealthy behaviours is a barrier to participation in physical activity and healthy diet choices for many of the participants and relatives. One participant said:

"Because I smoke cigarettes all the time and it makes me tired if I try to exercise" (M).

A packet of cigarette costs $20 to $25 in Nunavut, and on average a smoker consumes about 10 sticks per day. Alcohol consumption is significantly high even in communities where alcohol is prohibited. A bottle of liquor is sold for over $200. In many households, cigarette/marijuana smoking, drug use, and alcohol consumption all combine to decrease the available funds to purchase healthy foods, ice-hockey equipment and gym memberships. On why a lot of people do not exercise, one participant responded:

"Smoking weed? Drinking booze? There's too many…. that drink and smoke weed, so it affects their kids too. So yeah, it affects a lot of kids" (M).

Another participant corroborated the influence of these unhealthy behaviours: "*It affects us a lot, especially for us people that have no employment. That are seeking like ... drug dealing or bootlegging, they resort to that, because they don't have money to feed their children or to put food on the table. So they have to you know, make ... find another way to make money you know*" (M).

Some respondents emphasized the need to promote Inuit health through public education, ensuring that people understand the benefits of quitting binge drinking, smoking and drug use, and promoting the adoption of healthy behaviours such as healthy food choices and active living as a living lifestyle:

"We need to tell people to quit smoking, to find a new habit, we need therapy … we need a lot of therapy for our cigarettes" (M).

4. Discussion

The aim of this study was to explore the barriers and facilitators of healthy diet and physical activity participation amongst Canadian Inuit adults in Nunavut. Findings from participant interviews and data analyses indicated that six factors, acting either as barriers or facilitators, are essential to the promotion of healthy eating and physical activity promotion amongst Nunavut Inuit: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of family and friends; and effects of substance use.

The most significant perceived barrier to a healthy energy balance-related behaviour is the cost and affordability factor. This is largely due to low income and high level of poverty amongst

Nunavut Inuit, and further aggravated by exorbitant costs of both traditional and non-traditional foods. In addition, high costs of hunting equipment resulting in less hunting activities and the exorbitant cost of registration fees at fitness centres or sports equipment in the face of relatively low household income, all combine to reduce physical activity rates and fitness levels in the population.

Our findings are corroborated by a body of research evidence (83,79,81,82) that demonstrated an influencing role of income on the consumption patterns of the Canadian Inuit. For example, Hopping and colleagues (79) established a positive correlation between income and frequency of fruit and vegetable consumption in Nunavut. In response to the cost and affordability-related persistent food insecurity issues in Nunavut, community leaders and public health advocates have relentlessly asked the federal and territorial governments for intervention programs. Nutrition North Canada, a food subsidy program that was launched in 2011, was the federal government direct response to the call (148). The subsidy focuses on perishable healthy foods and the fund is administered by southern suppliers and local retailers in the community, who then pass on the subsidy to consumers at the point of sale (148).

In a similar manner, the cost-affordability factor also plays an influencing role on physical activity participation in Nunavut. According to participants, hunting equipment are not affordable and accessible due to high cost, resulting in less hunting activities. Moreover, the exorbitant cost of sporting equipment and registration fees at fitness centres limit Inuit participation in physical activity. Participants' views on barriers and enablers and attitude

towards participation are well corroborated by results of a previous study that reported cost and affordability as limiting factors to participation in physical activity among Australian Indigenous adults (149). The prohibitive cost of sporting equipment, expensive gym registration fees and low social economic status, all combine to form a formidable barrier to physical activity in these Indigenous populations. Similarly, two other studies in Canadian (150) and Australian (151) Indigenous populations reported a lack of access to low cost recreation activities as a barrier to physical activity participation.

Apart from direct personal costs in the face of limited income, a majority of Inuit participants in the current study raised concerns regarding inadequate community resources and infrastructural development compared to southern cities and communities. They attributed their low participation in physical activity to very limited availability of community resources, including sporting centres, limited options for traditional and western-oriented sporting activities, and poor conditions of roads and walkways for walking. In addition, absence of road and rail transportations presents a critical infrastructural deficit in Nunavut and adversely affects healthy food supplies from the Southern part of Canada where over 80% of the food items are sourced. In contrast to other jurisdictions in Canada, there are no roads or railways connecting Nunavut to any of the Southern provinces, or between any two Nunavut communities. Air travel is the only means of travel and transportation of goods between communities, and from the rest of Canada (63), except during summer when sealift activities take place and dry and non-perishable items such as canned foods are shipped by sea. This results in high cost of living: high expenditures on airfares, medical and food supplies, and housing (63).

Participants also raised climate and environmental concerns as barriers to their healthy dietary choices and physical activity participation. There is a widespread belief amongst Inuit that global warming has disrupted Inuit cultural practices generally, and specifically adversely impacted their ability to go on the land for caribou hunting or on the sea for seal hunting. Hunting activities have significantly reduced as a result of the global increase in temperatures resulting to melting ice and disruptions to migratory patterns of animals in the Arctic. A study by Wesche and Chan (62) described the moderating role of climate change in the physical environment. The changing climate influences food species availability and migratory patterns, and indirectly the hunter-gatherer movements and diet selection (62). Additionally, the built environment is underpinned by attributes that influence physical activity behaviour (31,30,99). Changes to the built environment may alter physical activity participation with attendant health effects. In Nunavut, such changes are an integral part of the social, cultural and environmental shifts that the Canadian Arctic has experienced over the past five decades (34), and are correlated with decreased physical activity participation according to research evidence (31). For example, subsistence activities (hunting, fishing, traditional food processing) that were associated with healthy diets and walking behaviour have remarkably decreased (34). Further, participants in the current study indicated that they are likely to follow choices that are perceived "acceptable" based on sociocultural expectations. In clear terms they expressed how family members and friends play key roles in their dietary choices and influence their participation rates in physical activity. Social networks of families, friends, neighbours, and others have been shown to have remarkable influence on health behaviours (152,153,154) and an individual's ability to modify unhealthy behaviours (155).

Low participation rates in physical activity are attributed to engagement in substance use behaviours, and invariably linking low energy, interest, and tiredness to substance use. Generally, cigarette smokers spend considerably less time on sports and aerobic activities compared to non-smokers given that nicotine dependent smokers are less likely to engage in physical activity (156). This is important, particularly in Nunavut where smoking rate at 63% (157) is at least three times the Canadian average. A recent Nunavut Chief Medical Officer's Report indicates that the prevalence rate in some Nunavut communities is 84% (158) which is very concerning. When the financial cost of smoking combines with that of excessive alcohol consumption and drug use, the impact is beyond the individual level, as the menace aggravates food insecurity in households and reduces the chances that healthy dietary options will be pursued. Taken together, these findings suggest that while addressing physical inactivity and unhealthy diets in the Inuit population, it is critical to consider a cluster of related unhealthy behaviours for targeted interventions to bolster the chances of success, effectiveness and long-term sustainability of such efforts. Overall, women readily expressed interest in the research topics with greater participation rates than men. Moreover, women provided deeper insights than men, describing the various barriers impacting the dietary and physical activity behaviours of members of their households. The women's passion and depth of insights may be associated with their role as main economic providers and caregivers in most households in the community.

Study Limitations

The generalizability of the study may be limited due to the complex environment in Nunavut and variabilities across the 25 communities. Community resources, community-level capacities, and infrastructural development vary from one community to another. This particular study was conducted in Iqaluit the territorial capital, the most diverse, resourced and populated community in Nunavut. Despite the differences across communities, it would be logical to contextualize our findings, extrapolate and make some inferences, based on our understanding of Nunavut communities and their characteristics. For example, the barriers identified by participants in Iqaluit may be aggravated in other smaller communities because of the relatively limited resources and community infrastructure. Another limitation is the use of photographs that were provided by the researchers instead of a more empowering approach in which participants would take and select their own pictures for interviews, as is the case in Photovoice method (159,160). While the latter might be consistent with research expectations in Indigenous populations and other marginalized groups, we intended to keep the focus of the study on the barriers and enablers. Thus, we confined the area of research interest and discussions by identifying only relevant photographs and utilizing them to prompt interviewees during discussions. This was an "ice-breaker" activity that took place during participant interviews.

It is also worthy of note that only participants who spoke and understood the English language were recruited and included in the study. This presents a limitation given that unilingual participants were excluded from the study and their contributions might have enriched the data. While there is a concern that our approach may have introduced some bias in the research, we

acknowledge that a significant proportion of Nunavut Inuit is fluent in English language, thus providing a good pool of potential participants to provide Inuit perspectives on the subject. This pool covers a broad range of demographic groups independent of age, gender, socioeconomic class and geographic locations in the community. One comparative advantage of the recruitment of English speaking participants is that it removed the potential challenges of exorbitant cost and technical difficulties that are usually experienced with translations and reverse translations from and to the local Inuit language (Inuktituk) and the multiple dialects that are spoken by residents who moved from other communities to Iqaluit.

5. Conclusions

Despite the limitations to the present exploratory qualitative study, it is evident from our findings that the following key factors are critical to the promotion of healthy energy balance-related behaviours in Iqaluit: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of family and friends; and effects of substance use. While the findings from this study may be generalizable across Nunavut communities, additional qualitative studies involving smaller communities across Nunavut are required to deepen our understanding of the subject. As well, quantitative research across Nunavut communities is required to assess the relative importance of identified facilitators and barriers in promoting physical activity and healthy eating in the population. These two complementary approaches will further strengthen the development of sustainable intervention efforts. More importantly, the strategic role of transportation infrastructure in the food systems with regards to access and affordability, and

overall impact on health and general wellbeing of Nunavut Inuit compels a call for both political and policy interventions by the territorial and federal governments. Such interventions would address this critical infrastructural gap that exists between Nunavut and the rest of Canada. In addition, an effective and sustainable food policy intervention by both governments is required to reorient food supply systems and improve the food environment for the residents.

Chapter 5

Exploring Nunavut Public Health System's Readiness to Implement Obesity Prevention Policies and Programs in the Canadian Arctic

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Abstract

Background

Rapid changes in the food and built environments in the Canadian Arctic have contributed to a dramatic increase in the prevalence rates of obesity. The objective of this study was to explore the determinants of Nunavut public health system's commitment to implement obesity prevention policies and programs in the territory to reduce the burden of obesity-related diseases.

Methods:

In total, 93 program managers, program officers and policy analysts who are responsible for program and policy development and implementation within the Nunavut Department of Health (NDH) were randomly recruited and asked to complete the validated Organizational Readiness for Implementing Change (ORIC) questionnaire. Organization-level readiness (commitment) was determined based on aggregated individual-level data using bivariate correlations and multivariate linear regression analyses.

Results

Organisation-level commitment to implement obesity prevention policies and programs was low. Only 2.9% of respondents strongly agreed that NDH was committed to implementing obesity prevention policies and programs. The study showed a strong positive correlation between NDH's commitment and perceived value ($r = .73$), perceived efficacy ($r = .50$), and resource availability ($r = .25$). There was no correlation between commitment and knowledge. In the multivariate linear regression model, perceived value was the only significant predictor of NDH's commitment to implement obesity prevention policies and programs ($\beta = 0.66$).

Conclusions

Successful adoption and implementation of obesity prevention policies and programs in the Canadian Arctic largely depend on the perception of value, benefits for, and believe in the change efforts among employees of the Nunavut Department of Health. Convincing policy

makers of the value of preventive policies and programs is an important and necessary first step towards decreasing the prevalence of obesity in the Inuit population.

Background

Canadian Inuit have been undergoing rapid lifestyles transition in the last five decades (1). The shift in patterns of food consumption and physical activity has led to the development of the so-called 'energy balance-related' health problems such as diabetes and cardiovascular diseases (2,3). The rates of overweight and obesity in the population are particularly alarming. For example, Egeland et al. (18) reported that 29% of Inuit men and 41.6% of Inuit women are obese. The prevalence of abdominal obesity, measured by waist circumference, was particularly high among Inuit women at 59.8% compared to 40%, nationally. An increasing body of evidence suggests that unhealthy behaviors such as the consumption of energy dense food and sedentary behavior have resulted in significant weight gain, and are major drivers of the rising rates of diet-sensitive chronic diseases (19,20,21,23). The development and implementation of effective solutions to the growing problem require concerted efforts from the health systems organization in Nunavut. Moreover, findings from research conducted in healthcare settings suggest that assessing an organization's readiness to implement change efforts is of interventionistic importance (161,50,162).

According to the World Health Organization (163), obesity remains a formidable but preventable risk factor for a number of life-altering chronic diseases. In Nunavut, the prevalence of Diabetes Type II was about 1% in 2002, and had increased to 4.4% by 2008/2009 (60). As a result, there is a growing concern among health professionals about the rising rates of obesity-related problems in the population. This has led to increasing calls for more focused health promotion interventions to address the trending public health problem (6,4,10,5). The direct and indirect costs of obesity have equally become causes of concern amongst healthcare professionals, with an estimated share in excess of 6% of total health-care costs in many countries (164)[18]. In Canada, the economic burden of obesity is estimated to range from $4.6 billion to $7.1 billion annually (165). Apart from the effects on physical health, psychosocial

impacts of excessive weight gain on individuals and families are well documented among Inuit (166,167) and other populations (168). A large proportion of obese individuals have low self-esteem and face negative attitudes and stereotypes in a variety of settings such as work, school, the social media, and within the healthcare system (165).

Despite the increasing rates of obesity in Nunavut Inuit population and the attendant physical, psychosocial, and economic impacts, the extent to which Nunavut Department of Health (NDH) is committed to implementing change efforts is not known. This has not been previously examined. Evidence from past literatures suggest that relatively little is known about factors influencing implementation of change efforts within healthcare organizations (169,170). Change commitment is integral to successful implementation of an effective intervention. According to Weiner, both change commitment and change efficacy determine readiness. Weiner defined change efficacy as a measure of perceived collective capability of an organization for the desired change. The organizational will to fight the "wicked problem" (49) appears to remain elusive to the responsible government departments across Canada, including the Government of Nunavut Department of Health (NDH). The mandate of NDH includes the implementation of change initiatives which are developed to address the upstream risk factors of obesity as well as the health and psychosocial impacts.

According to Stokols (53), there has been an increasing shift in focus from individually-oriented analysis of health behavior, to "behavioral strategies of health promotion with efforts to strengthen environmental supports within the broader community that are conducive to personal and collective wellbeing" (p. 282). Efforts required to strengthen certain elements in the environment are often beyond an individual's capacity. For example, research has shown that organizational readiness for change is a critical factor for successful and sustained implementation of change initiatives (50,52,51). Government policies and regulations are upstream factors that control the food environment, physical activity, and healthcare systems in general terms. All these elements directly and indirectly impact on choices, accessibility, affordability, and consequently, obesity rates in the population.

In the current study, we examined the commitment of NDH as an upstream macro environmental factor influencing the implementation of effective and appropriate obesity prevention policies and programs in the Canadian Arctic. This government department is mandated to formulate health policies and standards, including implementing initiatives such as obesity prevention programs and services. This study therefore examined the collective organizational readiness of the NDH to implement obesity prevention policies and programs in the territory. To date, research on the topic has largely focused on individual readiness, and less on collective readiness at organizational level (162). Research is needed to advance our knowledge on organizational readiness and increase our understanding on the subject. Our study sought to provide evidence-based guidance on determinants of collective readiness at NDH, and particularly, elucidate elements that might enhance the organizational readiness for implementing obesity prevention policies and programs, given the impacts of obesity on the quality of life of affected individuals in Nunavut.

To explore NDH's commitment to implementing obesity prevention policies and programs in view of the rate in the territory, we utilized a validated instrument called Organizational Readiness for Implementing Change (ORIC), developed by Shea et al (162). This measure was used to assess whether NDH organizational members are "psychologically and behaviorally prepared to implement the change" (162) required to reduce the growing epidemic of obesity in the territory.

Organizational Readiness for Implementing Change (ORIC) Measure

The measure of organizational readiness is a psychometric instrument that is underpinned by Weiner's theory of organization readiness for change (162,51). According to Weiner, organizational readiness is a multilevel and multifaceted construct that can be measured at individual level or collectively (at team, departmental, and organizational levels) in a healthcare organization that is responsible for implementing change efforts. ORIC is based on the assumption that the successful implementation of innovative solutions often requires

collective and well-coordinated actions by employees of an organization (162). In the current study, we group-referenced items, for example, using “we know….” Instead of “I know….” as previously described (162) to pivot participants’ attention and responses on the team’s collective readiness rather than personal readiness of individuals. In the study, we administered a 30-item ORIC questionnaire using a five-point Likert scale that ranged from “strongly disagree” to “strongly agree”. Since ORIC is a multifaceted construct, we examined four facets of change commitment according to the model (Figure 1) and their determinants.

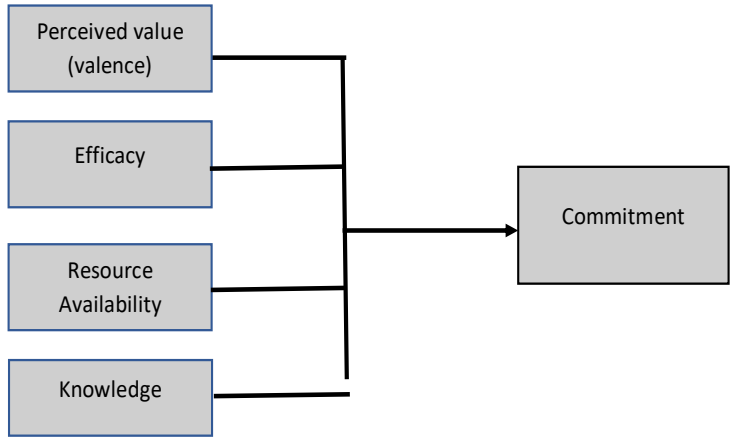
Methods

Nunavut and Research Context

Nunavut is located in the Arctic Region of Canada. The territory covers an extensive area of 2,093,190 km^2, accounting for 21% of Canada’s land and freshwater area (16). Nunavut is unique compared to other jurisdictions in Canada owing to the remoteness of its 25 communities in the Arctic, the dispersion of the small population of approximately 38,243 (17), and its total reliance on air transportation. All these combine to make healthcare delivery a very challenging task (171). Households in Nunavut rely on air transportation with its attendant prohibitive costs in order to access essential commodities such as medical, food, and other household supplies. Accessibility and availability of foods and medical supplies are therefore impacted by this mode of transportation except in the summer when non-perishable supplies are sealifted (34).

The Government of Nunavut Department of Health is responsible for delivering health care services in the territory, including developing policies and legislations that govern the health care system and programs for prevention of illnesses and elimination or reduction of risk factors of diseases including obesity.

Figure 1: Research model explaining the relationships between NDH's readiness (change commitment) and the determining factors.



Data Collection

Ethical approval was obtained from the Ethical Review Committee of Psychology and Neuroscience at Maastricht University, Netherlands (Reference# ECP-148 05_03_2015) as well as through a research licence from the Nunavut Research Institute (License# 050 1315-Amended). An initial pilot was conducted with a random sample of 10 volunteers who were program officers and policy analysts in the Department of Health. The purpose of the study was discussed with the volunteers who later reviewed the research questions, completed the questionnaires, and provided comments. In response to the feedback, we provided definitions of terms used in the facets of change commitment being explored: valence or perceived value (intrinsic attractiveness of the change efforts, and to what extent is the change valued); efficacy (shared belief in the employees' collective ability to engage a course of action that will lead to change); resource availability (collective perception by employees that resources needed to implement are available, including fund, personnel, equipment and infrastructure); and

knowledge (perceived knowledge about resources, time and tasks requirements for implementing the desired change). Further, we provided examples of healthy public policies and both conventional and innovative approaches that have either been adopted by regional and national governments or proposed by obesity prevention experts: increasing taxes on junk foods and subsidies on healthy foods (172), fruit and vegetable initiatives, active living policies, social marketing campaigns (163), and increasing access to, and availability of, traditional foods and on-the-land/water activities including hunting, trapping and fishing to promote active living (34). The descriptions and examples were included to increase the participants' understanding of the purpose of the study and thus increase the reliability of the data provided.

The ORIC questionnaire was distributed to all public/population health and health policy personnel who were responsible for policy or program development, implementation and evaluation in the Department of Health. Of the 93 questionnaires that were distributed only 67 were returned and fully completed across relevant divisions within the NDH.

Data Analysis

Following collection, data were entered in IBM SPSS Statistics Version 24 for cleaning and subsequent analyses. Data were analyzed using descriptive statistics, Pearson's correlations and multivariate linear regressions. Missing values were imputed by the item means. Scores for the study variables were checked for normal distributions using tests for skewness and kurtosis (173). Further, test for regression diagnostics for outliers were conducted as recommended by Fox (118). Descriptive analyses included the mean and standard deviation of score values. Subscale scores were computed by summing the scores on the respective subscales: the higher the score the more agreeable the respondent to, for instance, the NDH's commitment to change efforts.

Internal consistency analyses of the constructs of organizational readiness revealed good psychometric properties according to their Cronbach alpha (α) values except the concept of knowledge. The alpha (α) values of the concepts were: change commitment = .91; perceived value .85; Efficacy = .83; Resource availability = .61; and Knowledge = -.29. Given the poor

reliability of the knowledge factor, we decided to use each of the three items (knowledge-time, knowledge-resources, and knowledge-actions) that constituted the factor as an independent single item subscale. Associations with organization-level readiness (commitment) were determined based on aggregated individual-level data using bivariate correlations and multivariate linear regression analyses.

Results

Seventy-two percent (n=67) of the public health workers fully completed the survey for analysis, representing 72% of the public health workforce. Of these, 82% were women and 18% were men, approximately reflecting gender distribution in the Department of Health's workforce. Our findings showed that only 2.9% and 35.7% of respondents strongly agreed and agreed, respectively, with the statement that "we are committed to implementing obesity prevention policies and programs". On the other hand, 28.6% of respondents disagreed or strongly agreed with the statement. Another 28.6% of respondents neither agreed nor disagreed that NDH was committed to implementing obesity prevention policies and programs.

Relationships between the variables were examined (Table 1). Strong positive correlations were observed between change commitment and perceived value, efficacy, and resource availability. Additionally, there was evidence of a positive association between commitment and two knowledge variables, knowledge-time and knowledge-actions. There was a strong positive relationship between perceived value and two variables - efficacy, and resource availability. There were strong positive relationships between efficacy and resource availability as well as the knowledge-actions. In addition, a strong positive correlation was observed between resource availability and knowledge-actions. However, there was no significant relationship between commitment and knowledge-resources, and perceived value. No significant relationships were observed between efficacy and knowledge-time, and knowledge-resources.

In the multivariate linear regression model, perceived value and the knowledge-time were strongly correlated (Table 2) with NDH's readiness for implementing obesity prevention policies and programs (standardised beta = .66; p<.01 and standardised beta = .18; p<.04, respectively).

Table 1: Mean scores, standard deviations, and bivariate Pearson correlations for study variables (n=67)

Variables	**Mean (SD)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Commitment	15.15 (4.16)	1						
2. Perceived value	41.28 (5.39)	.73**	1					
3. Efficacy	21.87 (4.39)	.50**	.55**	1				
4. Resource availability	16.26 (2.62)	.25**	.34**	.60**	1			
5. Knowledge-time	2.42 (.78)	.27*	.10	.22	-.02	1		
6. Knowledge-resources	4.03 (.65)	.07	-.02	.02	.02	-.14	1	
7. Knowledge-actions	3.61 (.82)	.26*	.29*	.41**	.30*	.07	-.21	1

*P < 0.05; **P<0.01

Table 2: Standardised regression coefficients, P values and explained variance from regression analysis for organizational readiness (commitment) to implementing obesity prevention policies and programs (N=67).

Predictor variable	**β**	**P value**	**R^2**
Perceived value	.66	<.001	.60
Efficacy	.11	.40	
Resource Availability	.06	.58	
Knowledge-time	.18	.04	
Knowledge-resources	.11	.19	
Knowledge-actions	.06	.54	

Discussion

The study examined the degree of NDH's commitment to the implementation of effective and appropriate obesity prevention policies and programs. Results showed that organisation-level commitment to implementing obesity prevention policies and programs was generally low. Research evidence in the field has suggested that a lack of organizational readiness for change may account for as many as half of all unsuccessful change initiatives in a variety of fields including healthcare. This often necessitates a redesign of intervention efforts (174,175) in the face of limited resources.

Our results indicated that only 2.9% of the employees were very confident of their organization's commitment to implementing obesity prevention policies and programs, and approximately one-third of the employees was somewhat confident. Our findings demonstrated that perceived value, efficacy, and resource availability were positively associated with NDH's commitment to implementing obesity prevention policies and programs in Nunavut. This is in line with Weiner's theory of organizational readiness for change which postulates that change commitment and perceived capacity for desired change (change efficacy) combine to determine

organizational readiness (52,51). These are subject to how favourably organizational members perceive and evaluate the implementation capability and associated tasks (perceived value), resource availability and other inherent factors that are likely to facilitate or hinder change efforts such as leadership commitment and environmental factors (176).

The large number of individuals surveyed relative to the numerical strength of the employees in the lines of work, the high response rate, and the gathering of independent responses from employees in the lower and management cadres within NDH, can all be considered as strengths of the study. Our research provides preliminary empirical confirmation of Weiner's framework of organizational readiness. The findings also provide a strong basis for a more extensive investigation given the importance and relevance of organizational readiness to a successful and sustainable implementation of changed efforts in healthcare organizations. In the context of NDH, it is important for the organization to critically examine the underlying factors mediating the abysmally low organizational commitment to implementing obesity prevention policies and programs. The responses obtained from the NDH employees showed low efficacy and perceived value, suggesting that the collective capability to engage a course of action that will lead to change is suboptimal. The perceived collective value of the implementation efforts appears to be lower than what is needed to move changed efforts in a positive direction.

Our results call for the redesign of intervention efforts that focus on eliminating barriers and promoting facilitators of changed efforts. For example, collective perception by employees that resources needed to implement required policies and programs as well as other situational factors must be fully analyzed and appropriate elements incorporated in the re-design of an intervention strategy.

Organizational readiness is a team rather than individual effort. Lehman et al (177) described the construct as collective perceptions of institutional resources, the prevailing organizational culture and climate as well as motivational readiness. Thus, the fundamental

contextual factors of culture and climate need to be examined in more detail to understand the proximal explanatory role of perceived value and knowledge. Convincing policy makers of the perceived value of preventive policies and programs is an important and necessary first step towards decreasing the prevalence of obesity in the Inuit population. But it is likely that such efforts will increase in effectiveness when additional energy is put in understanding and changing the policy context in NDH.

Conclusions

The Canadian Arctic has undergone significant social and environmental changes resulting in the disruption of Nunavut Inuit traditional ways of life. The changes have reduced the reliance on traditional food gathering and processing activities and increased dependence on energy-dense store-bought foods and motorized transportation. As a consequence, many Nunavut Inuit have become overweight or obese and developed diet-sensitive chronic diseases. Although these sociocultural and environmental changes cannot be reversed or stopped, opportunities exist to explore policy and program interventions for the population. Despite the severity of the problem and the urgent need to identify effective solutions, findings from the current study suggest that the collective capacity within the NDH to effectively respond by developing and implementing interventions is low. Efforts should therefore focus on how employees' perceived value and efficacy can be improved to translate implementation efforts into tangible health and psychosocial outcomes.

Chapter 6

General Discussion

Introduction

The goal of this dissertation was to explore the socio-cognitive and environmental determinants of dietary behavior and physical activity participation amongst Nunavut Inuit to identify elements that could be targeted in effective, integrated and culturally relevant approaches to prevent obesity in the population. We conducted a preliminary study to objectively measure physical activity levels in the population and assess the environmental determinants and motivational regulation of physical activity. To deepen our understanding on Inuit energy balance-related behavior, the perspectives of Nunavut Inuit adults were explored on the barriers to and enablers of healthy diets and physical activity participation at the community level. As an organization with the responsibility and authority to develop and implement strategies, we examined the readiness of the Nunavut Department of Health to develop obesity prevention policies and programs.

This chapter provides an overview of the dissertation. First, the main findings of the four studies that were conducted are described. Second, some methodological issues that arose while conducting the studies are discussed to guide the interpretation of the findings. Consequently, the implications of the findings are described for practice purposes and theoretical considerations. Finally, some general conclusions are drawn and directions for future research are presented.

Main Findings

The extant literature on factors influencing dietary behavior and physical activity among Canadian Inuit in the Arctic was systematically reviewed in Chapter 2 to provide information on the gaps in knowledge and directions for this dissertation work. A total of 45 articles was evaluated. Overall, it was evident from the findings that many aspects of Inuit traditional life have been eroded over the past 50 years, especially the hunter-gatherer subsistence lifestyle and traditional food sharing practices. The Euro-Canadian lifestyles and its domineering influence

have remarkably subjugated Inuit cultural traditions and profoundly influenced the energy balance-related behaviors of this Indigenous group. Findings from behavioral studies suggest that Inuit men and Inuit over 50 years of age consume more traditional foods and less store-bought energy dense processed foods than women and younger Inuit adults. Findings from environmental studies indicate that availability and quality of food species are affected by climate change and other environmental factors such as changes to land-use that results in physical planning. This alters the physical environment and impacts the flora and fauna in the ecosystem. Further, it was evident that affordability and accessibility of healthy foods are determined by the SES (education, employment, and income) while a cluster of other unhealthy behaviors such as smoking, drinking, and drug use impacts a household's dietary adequacy. The major gap in empirical studies in the Arctic was related to a lack of understanding of the patterns of physical activity. The few studies that focused on physical activity were based on self-reported measures and provided inconsistent results. Moreover, the literature review showed that little is known about the motivational regulation of energy balance-related behaviors in this Indigenous group.

Chapter 3 provides the results of the objectively measured physical activity levels using accelerometry among Nunavut Inuit adults. We also investigated the perceived environmental walkability and motivational regulation as correlates of physical activity in the four participating communities (Iqaluit, Baker Lake, Cambridge Bay and Resolute Bay). Our findings showed that a maximum of 10.8% of Nunavut Inuit adult residents were physically active at ≥7500 steps/day between summer and winter compared to the national average of 52%. It was also evident that perceived infrastructure, safety and land-use mix are positive environmental associates of steps taken. Upon investigation of the effect of personal motivation regulations we found that only identified regulation (i.e. the behavior is explicitly recognized as important and the benefits are valued by an individual) made significant contributions to the observed effects in the model. The impact of the environmental factors on the number of steps taken were partially mediated by identified motivational regulation, especially in the winter season. Taken together, these findings provide some foundational work for future studies that aim to identify evidence-informed

psychological constructs that are viable and appropriate targets for behavior change interventions to promote increased physical activity amongst Canadian Inuit in the Arctic.

In Chapter 4, we describe our findings on the barriers to, and enablers of, healthy dietary choices and physical activity participation from the perspectives of Nunavut Inuit. Our findings from the semi-structured interviews with participants showed that there are six main factors serving as barriers or enablers to energy balance-related behaviors of community residents: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of family and friends; and the effect of substance use. Understanding these barriers/facilitators are important first steps in the design of effective health promotion interventions for diet-sensitive chronic diseases in the population.

Chapter 5 examines the Nunavut public health system's commitment to implement obesity prevention policies and programs to reduce the burden of obesity-related diseases. Our findings showed that the organization-level commitment to implementing obesity prevention policies and programs was generally low; only 2.9% of the employees were very confident of their organization's commitment to implementing obesity prevention policies and programs, and approximately 33% of the employees were somewhat confident. Further to the findings, there is low efficacy and perceived value amongst Nunavut Department of Health (NDH) employees, implying that the collective capability to engage in a course of action that might lead to change is suboptimal.

Linking Findings to Theories

This research utilized the social (psychological) ecological model (SEM) as the overarching theoretical framework to delineate the determinants of energy balance-related behaviors (EBRB) in the Nunavut Inuit population and opportunities for action. The SEM is a robust theoretical approach that aligns well with the research questions, the research environment/location and

the study population. The territory of Nunavut is geographically unique, given its remoteness and being the least infrastructurally developed region of Canada. More importantly, the Nunavut Inuit population is economically disadvantaged and constrained by the broader social determinants of health. Thus, rather than utilizing a self-limiting individual-level determinant theory which are predicated on changing knowledge, attitudes and intentions, this research focused on identifying personal and broader environmental variables and interplays that influence EBRB amongst Nunavut Inuit adults. The five levels of the SEM (individual, interpersonal, organizational, community, and government/public policy and their interactions) were examined as we sought to understand the contributions of each level within the larger ecosystem to the dietary choices and physical activity participation of Nunavut Inuit.

In the first level of the SEM, the role of an individual's characteristics and the underpinning psychology was explained by the Self-Determination Theory or SDT (57). The SDT enriches our understanding of the role and quality of motivation in an individual's EBRB. This is particularly important because motivation is a predictor of whether a behavior would be sustained. According to the findings in the study on environmental and motivational regulation of physical activity (number of steps taken per day), identified regulation was uncovered as the prevailing type of motivation amongst Nunavut Inuit adults, independent of age and gender. This implies that individuals would participate in physical activity mainly because they recognized and valued the importance of this healthy behavior. In the second level (interpersonal relationship), the influence of social networks of family, social circle-peers and co-workers was examined. This is important because evidence suggests that healthy choices usually converge with those of close connections within an individual's social networks. It was evident in our study that explored the perspectives of Nunavut Inuit adults that both participation in physical activity and consumption of healthy diets are influenced by interpersonal relationships and what is perceived as socially and culturally acceptable by individuals.

At organizational and public policy levels, we examined the broader healthy public policies that enabled the built and social environments in communities, and how obesity

prevention policies and programs were supported or inhibited by the presence or absence of adequate resources. According to the findings, the level of commitment of the Nunavut Public Health System to develop and implement obesity prevention policies and programs was low. At community level, results from the study indicated that the lack of adequate community resources and poor state of infrastructure constituted critical barriers to physical activity participation and healthy diets consumption. It was evident from our findings that proper interventions would require broad healthy public policies (through intersectoral partnership) and programs at federal and territorial levels. Participants copiously expressed a need for policy and program interventions that include making healthy food options available and affordable through appropriate and sustainable subsidy programs, addressing community infrastructural deficits and increasing local capacities for maintenance of infrastructure and amenities. There are overlaps across the levels of the SEM, particularly in the area of government/public policy, a critical factor that requires the most attention in the face of interventions. It was evident from the views expressed by participants that political will and focused leadership are needed for change to occur. The SEM approach also provides the ground work for intervention mapping and opportunities for action across the various layers of the broader environment. Multiple potential intervention points were identified across the layers and serve as potential opportunities for critical action to promote and sustain healthy diets and physical activity participation in Nunavut.

Methodological Implications

It is advisable that the results obtained from these studies be interpreted in light of several methodological considerations. Demographic characteristics of participants and techniques used in the recruitment are discussed below, including financial incentives, and communication methods. Ethical issues and methods of data collection are also considered.

Participant Recruitment

Similar to most research proposals in Indigenous communities in Canada, the studies reported in Chapters 3, 4, and 5 had their own share of the difficulties regarding participants' recruitment. Although a lot is unknown regarding the determinants of Inuit energy balance-

related behavior (EBRB), there is a general apathy towards research amongst Indigenous groups and elders, with claims that the populations have been "researched to death" (178,179). The national Inuit organization and advocacy group in Canada, Inuit Tapiriit Kanatami, in their position paper on Inuit research strategy described Inuit as "one of the most studied Indigenous groups on earth" (180). Given an assumption that a high level of research activities is taking place in Inuit communities, Inuit leaders have argued that the region and its people are vulnerable to exploitation through research activities without proper Indigenous oversight. According to the organization, a significant proportion of research that is being conducted in Inuit communities by researchers are done with little to no inputs from Inuit. Research objectives are generally perceived by the Inuit as less relevant to community needs but usually beneficial to the researchers, some of whom appear to use questionable practices, thus generating mistrust.

Given the argument that there is limited involvement of Inuit in setting research agenda, research priorities appear to be heavily skewed towards biological and physical sciences with limited attention on social and health sciences. This partly explains why there are limited data on Inuit health, particularly EBRB, since most studies are focused on the biological and physical sciences. To address this bias, the territory of Nunavut established the Nunavut Research Institute (NRI) with a mandate to assess research applications, evaluating objectives and their value to Nunavut Inuit, and how research findings will be communicated back to host communities. Researchers are also required to engage prospective participating communities to secure letters expressing interest in such research and support from community leaders. Also, the non-participatory approaches that are used by Euro-Canadian researchers with Western epistemologies are often in conflict with the Indigenous ways of knowing. In response to these concerns and to ensure that our research added value to Nunavut communities, our research process followed the guidelines provided by the NRI. Our research proposal was submitted after due consultations with the four communities. A letter of support was obtained from community organizations stating that our research objectives are relevant and the proposed outcomes would advance the health and wellbeing of Nunavut Inuit in the area of obesity prevention, particularly focusing on diet-sensitive chronic diseases. A research licence was consequently secured from NRI which enabled us to recruit participants. It is also worthy of mention that the

author of this PhD work is not necessarily an outside researcher who “parachuted” into the territory, rather, he is a Nunavut resident who lived in some communities in the territory including two of the four communities where the research took place over a period of eight years and worked directly with Inuit families and community leaders during the period. His lived experience in Nunavut has enriched the research process and through this the engagement has contributed to research capacity in Nunavut. Following the completion of this research and dissertation defense, findings will be communicated back to the participating communities as well as NRI. A plain language summary will be provided in the four Nunavut official languages.

Given the low SES in Aboriginal communities there was a need to compensate responders for their participation. It is recommended that Inuit participants be compensated financially for the Indigenous knowledge they contribute through participation, being “researchers” in their own rights (181). Local Inuit research participants may be compensated by direct cash payment or rewarded with gift cards based on the extent of their contributions, depending on the agreement reached during negotiations. Outside researchers are equally advised to make other non-monetary contributions to host communities through knowledge generation and translation (181) as a corporate social responsibility. The financial compensation is also used as an incentive to attract and retain participants, particularly in longitudinal studies. In the studies reported in Chapters 3 and 4, participants were provided a gift card worth $25.00 each, if they completed the NEWS and BREQ questionnaires and participated in the semi-structured one-on-one interview.

The financial reward/gift card was an effective recruitment tool to motivate participants who went further to refer their friends and co-workers to participate, resulting in a snow-ball effect. The incentive provided limited but immediate financial relief to participants who largely rely on government social assistance. Respondents to the ORIC questionnaire in Chapter 5 are predominantly non-Inuit (90%), and no compensation was provided as a recruitment incentive. Recruitment for this particular study was predominantly based on a longstanding work relationship that the researcher had established with various teams within the Department of Health. However, one major challenge faced by studies reported in Chapters 3 and 4 was the level of English language proficiency of some participants, beyond conventional conversation.

This was addressed by rephrasing the questions where necessary based on the initial piloting and testing in the target population. Particularly, some of the items used in the NEWS and BREQ surveys were reworded to improve participants' understanding of the subject or question. Although the questionnaire could have been fully translated in the local languages to aid comprehension, the benefit of this approach on the findings would be negligible. This is because following an initial pilot, specific portions of the questionnaire that appeared to be complex and somehow problematic for participants were reworded at reading grade level six.

Measurement Issues - Accelerometry

The built and food environments in the Arctic are unique and appear to influence energy balance-related behaviors of the Indigenous group. The study discussed in Chapter 3 explored the environmental factors influencing physical activity among Inuit using the Neighbourhood Environmental Walkability Scale (NEWS), which essentially depends on the components of the built environment in participating communities. The NEWS was adapted to the Nunavut environment by rewording a few sections and adding a "weather scale" to account for a potential impact of the unique climate on physical activity. In Chapter 4 the built and food environments were examined through the lived experiences of Iqaluit Inuit, particularly to understand how these environments shape their physical activity participation and dietary choices.

Recent technological advances and the need for accurate measurements of physical activity in light of unreliability of self-reported data have spurred a tremendous interest in objective assessment of physical activity by accelerometers and pedometers. Objective measurement of physical activity by accelerometers is supported by technology that is capable of capturing free-living physical activity information expressed as activity counts on a minute-by-minute basis for weeks at a time (182). The device possesses a timing mechanism and a memory capacity that records movement parameters over a determined range of time. Activity count cut points developed in the laboratory then translate these activity data into estimates of activity duration in specific intensity categories (182,183). This technology is not cheap to acquire; accelerometers may cost as much as $300 -$400 per unit and require technical expertise and

additional hardware and software to calibrate, input, distill, and analyze data. Moreover, accelerometers are less feasible for use in certain clinical applications such as screening and self-monitoring, or for physical activity surveillance purposes due to the exorbitant cost and technical requirements (182). The technical requirements suggest that accelerometers are less suitable for use amongst the Inuit given the low literacy levels and the potential high cost of instruments acquisition for health promotion intervention in economically disadvantaged Nunavut communities.

Pedometers however offer the benefits of a more practical, user-friendly, inexpensive and technically feasible alternative for surveillance, screening, health promotion intervention, and program evaluation. A low-tech option is simple and inexpensive, costing as low as $5 per unit. In contrast to accelerometers, pedometers are not technically designed to capture pattern, intensity, or type of physical activity. Nevertheless, they detect steps taken with acceptable accuracy, reliability, and convergent and discriminative validity (184,185,182). Studies conducted by Tudor-Locke concluded that pedometers such as the Yamax brand, have a strong correlation (r = .84 - .93) with accelerometers depending on the specific instruments used. This finding was corroborated later by Strycker and colleagues who obtained reliability coefficients of .80 or greater with five or more days of data collection in the youth sample and 2 or more days in the sample of older women.

There is no documented evidence on prior use of the Kaden G-Sport Pedometer in physical activity studies in contrast to several other validated brands like the Yamax brand. To address this concern, we recruited 12 regular users of pedometers to use Kaden G-Sport brand simultaneously with their conventional pedometers (Yamax brand) over a seven-day period. The purpose was to determine the reliability of the Kaden G-Sport instrument. In terms of the number of steps, the overall difference between the two instruments was between 2-4%, indicating that the reliability of the Kaden G-brand is similar to validated brands such as the Yamax's. Although the outcome of the pilot indicated that the instrument is reliable, a properly designed validated study would be more appropriate and would provide more reliable, generalizable, and acceptable results.

Further to a strong justification for objectively measured physical activity, capturing contextual information that provides exact location and under what conditions a physical activity takes place may advance our knowledge on the determinants of physical activity (186) in a population. This context would be particularly relevant in our study that was conducted within the Inuit culture. Understanding the fractions of the exercise that is related to traditional activities and those that are more Euro-Canadian in nature, such as going to the gym, etc, could have provided useful information on the role of cultural determinants of physical activity (187). Further, a deeper understanding of the influence of weather conditions is required. The information would then become strategic to developing an effective physical activity intervention in the population. Such location question "where" may be gathered via a location tracking device such as the geographic positioning system, by direct observation, or by asking participants to fill out a questionnaire (187) or by taking notes immediately after the exercise. Each of these measures comes with its own challenges. Accelerometer/pedometers may not have location tracking capabilities. The accuracy of the information provided in the questionnaire will depend on the participants' memory, while entering the data immediately after the exercise will depend on the extent to which participants are committed to the activity and the research process.

Attrition

Attrition is a common problem particularly in longitudinal studies and other studies with repeated measures. Participants were asked to wear pedometers in the summer and winter to determine if there were differences across seasons. An attrition rate of 12.5% that was observed in our study from summer to winter is modest given the notion that less than 5% attrition leads to little bias while greater than 20% poses serious threat to the validity of research findings (188) depending on the sample size. A review of attrition problems in geriatric psychiatry clinical trials indicates that average attrition rates in 68 studies is 27.3% ranging from 3.1% to 54.1% (189).

Attrition rate may affect mean estimates and not regression estimates. Generally, mean estimates become increasingly biased as attrition rates increase. Larger sample sizes can accommodate the upper ends of the acceptable limits compared to smaller sample sizes without

posing a threat to the validity or reliability of the results. At 50% and 70% attrition rates, mean estimates are extremely biased (190). A modern missing data technique was used to account for some missing variables in our analysis (that is, input by item means). According to past literature, psychosocial issues, illness and low education increase the probability of attrition (190). These same factors were observed amongst Nunavut Inuit who participated in the current study. A majority of the participants is facing psychosocial issues such illiteracy, poverty, food insecurity and inadequate housing. Some of the participants were equally not available because of illness or out of the territory as medical escort, being a care provider to a family member. We had predicted an attrition rate of up to 20% amongst the participants given a myriad of psychosocial issues faced by Nunavut Inuit in the territory, and had mitigated the possibility in hindsight by taking a number of steps. We recruited as many participants that met the inclusion criteria over the period; our recruitment and retention strategies included financial reward for participation; properly screening participants and explaining the need to be available for the follow-up study; and limiting interviews to a maximum of one hour to retain attention and secure participants' interest in follow-up winter sessions. These efforts reduced attrition rates to 12.5%, which is considered moderate given the target population and the sample size. The demographic characteristics (particularly age and gender) of those who dropped out are similar to those who completed the study in the winter. No changes were observed.

Recommendations for Practice and Future Research

Findings from the studies presented in this dissertation, the theoretical and methodological considerations as well as our practical experiences while conducting the research in the Arctic underpin the following recommendations for practice and future research.

Recommendations for Practice:

- It was evident in our study that the built environment in Nunavut generally lacks the infrastructural development that would normally support physical activity participation. Thus, utilizing the built environment as an intervention for improving physical activity offers

unique advantages. In contrast to individual-level approaches, developing a supportive, well-resourced environment may assist in achieving sustainable, population-wide increase in physical activity (191) and facilitate behavior change maintenance (192). We recommend significant improvements to the existing community-level infrastructure and resources that address the current challenges within the built environment in Nunavut communities. For example, where walk-ways are available, their poor maintenance during winter is a deterrent to walking behavior amongst residents, particularly in Iqaluit. In smaller communities like Resolute Bay, walk-ways are almost non-existing, leaving residents to struggle as they attempt to walk within their community during the 8-10 months of snow falls per year. Additionally, community resources for indoor sporting activities are very limited in general terms, and where they exist there are inadequate skilled human resource personnel such as trained recreation workers to organize activities on a regular basis to promote adoption of such activities as a lifestyle.

- The mandate of Nunavut Department of Health (NDH) includes the implementation of change initiatives to address the upstream risk factors of obesity in the population. Currently, the organizational will (commitment) to address obesity in Nunavut is low based on our findings from the employees. The perception of the senior management regarding the implementation of change efforts is not known, hence constitutes a limitation to the study. Change commitment is integral to the successful implementation of effective behavioral interventions (161,50). Moreover, change commitment and change efficacy determine readiness to implement the change efforts (52). Thus, we recommend that the collective perception that resources needed to implement change initiatives, including the perceived value and knowledge as well as situational factors within the organization be included in the redesign of an intervention. Our study reveals that community engagement and collaboration at all levels based on shared values will assist in setting priorities, identifying new resources or allocation/reallocation of existing resources, and in moving the system in a direction of collective change.
- A major barrier to healthy diets among Nunavut Inuit is affordability and accessibility. Unsuccessful attempts were made through a food subsidy program (Nutrition North Canada)

to remove the financial barrier (148). The subsidy focuses on perishable healthy foods and the subsidy fund is administered by southern suppliers and local retailers in the community, who then pass on the subsidy to consumers at the point of sale (148). Unfortunately, a significant proportion of the subsidy is not passed onto consumers and discounted fraction is not disclosed in a transparent manner for accountability purposes. The ineffectiveness of the current subsidy program calls for government at all levels to identify innovative interventions for implementation to address the growing food insecurity among Inuit and that will increase access to healthy foods in Nunavut communities. The subsidy should be applied directly to food items at the point of sale, such that community residents are aware of the fraction of cost per item that has been discounted.

- We recommend community-level obesity prevention interventions that provide opportunities for support and encouragement from extended family and close friends. Such support remains a major source of motivation for engaging in, or sustaining, a healthy behavior. Healthy choices tend to converge with those of close social connections (152,153), especially in Indigenous society where communal lifestyle and social inclusion and cohesion are important cultural values.
- Given the aspiration of the Nunavut Inuit to sustain their cultural identity and the strategic importance of traditional on-the-land activities in promoting healthy living, we recommend that the government fund community-based programs that will promote hunting, fishing, trapping, traditional games, etc. Participation in these traditional activities may strengthen cultural identity. Such activities are equally associated with healthy diets and increased walking behavior amongst Nunavut Inuit adults (34).

Recommendations for Future Research

- Generally, studies that focus on the determinants of dietary behavior and physical activity amongst Inuit are limited, and no prior study had objectively measured physical activity in the Inuit adult population. However, our physical activity study in Nunavut was limited to four of 25 communities, which somewhat limits the generalizability and transferability of the

results in the territory. We therefore recommend a repeat of the study with an expansion to additional communities and some improvements to the study design. Such improvements could include an opportunity to capture traditional activities and determine what fraction of the physical activity is traditional, when and where they take place. This is important considering a complexity of factors that may predispose residents of one community to physical (in)activity compared to people who live in another community.

- Although our research on environmental and motivational determinants did not capture the complex and salient environmental differences that exist across Nunavut communities. The uniqueness of the Canadian Arctic in the context of the built, social, and natural environments influenced strongly by the extreme climate, necessitates a deeper understanding of the socioecological factors at play, and the moderating role of motivational regulation. We require further studies to deepen our understanding of the impacts of these socioecological factors on energy balance-related behaviors of Nunavut Inuit. The knowledge that is uncovered through such investigation will assist in identifying some socioecological elements that are modifiable and can be included in the (re)design of unique interventions for physical activity promotion in Nunavut communities.
- Given that Kaden G-Sport pedometer was not validated prior to our study, we recommend a full-scale validation study on the instrument. Kaden G-Sport is relatively low cost and offers potential benefit to research involving a large sample size. One piece of Kaden-G instrument costs about 10% of one piece of the Yamax pedometer brand, and approximately one percent of a typical accelerometer such as ActiGraph which costs between $300-400 per unit. Such validation studies should be conducted with a larger sample size and in multiple research environments.
- Although our qualitative study identified the barriers to, and enablers of, healthy eating and physical activity amongst Nunavut Inuit in Iqaluit, we recommend that the study be extended to other communities to capture the perspectives of Nunavut residents who live in other, smaller communities. Iqaluit is the territorial capital, the most diverse, populated, and infrastructurally developed community in Nunavut. The social and physical environmental

attributes may influence an individual's perspective on the barriers and enablers of energy balance-related behavior.

- The Canadian Arctic environment is less studied in terms of its contributions to obesity rates in Inuit communities. Our studies, particularly the research that focused on the environmental determinants of physical activity provided evidence that suggests the obesogenicity of the Nunavut environment (193). We recommend further studies to examine crucial elements of Nunavut's obesogenic environment.

General Conclusion

Studies described in this dissertation show that over the past five decades there have been significant environmental and sociocultural transitions in Inuit communities, especially the shift away from the hunter-gatherer subsistence living to Euro-Canadian ways of life. The Euro-Canadian lifestyles and its dominant influence have remarkably subjugated Inuit cultural traditions and adversely impacted the energy balance-related behaviors of the Indigenous population. Less than 3% of Nunavut residents were physically active at ≥10000 steps/day in the summer, compared to about 35% of adults in other Canadian jurisdictions, independent of seasons. It was also evident that perceived infrastructure and safety, and land-use mix, are crucial environmental associates of steps taken. Our findings from the qualitative study identified five main barriers or enablers to energy balance-related behaviors in Nunavut communities: cost, affordability and accessibility; climate change and weather conditions; community resources and infrastructure; social networks of families and friends; and clustering of unhealthy behaviors (e.g., substance use). It would be reasonable to conclude from our studies that incorporation of the identified barriers and enablers into design for multi-level interventions will improve physical activity participation and promote healthy diets in Nunavut communities. At the institutional level, it is evident that organization-level commitment to implementing obesity prevention strategies was generally low. Only a small minority of the employees were very confident of their organization's commitment to implementing obesity prevention policies and programs. In addition, the collective efficacy and perceived value of obesity prevention policies and programs

amongst NDH employees were low, suggesting that the organizational capability to engage in a course of action that will lead to change is suboptimal. Our results call for the redesign of obesity intervention efforts within the NDH by taking action on the abysmally low organizational commitment, including eliminating identified barriers within the system (e.g. shortage of healthcare professionals) and promoting facilitators such as food subsidy programs and nutrition literacy.

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Summary

Summary

Increased dependence on Western diets and low physical activity have largely contributed to weight gain and associated chronic diseases in the Canadian Inuit population. There is a growing concern amongst health professionals about the rising rates of obesity, Diabetes Type II, cardiovascular diseases, and some cancers amongst Nunavut Inuit, with increasing calls for understanding the drivers of weight gain and subsequent design of effective health promotion interventions to address energy balance-related behaviors in the population. In order to guide the development of appropriate interventions it is important to identify factors influencing the dietary and physical activity behaviors that potentially have the strongest impact on energy balance. This information is of strategic importance to diet- and physical activity-related chronic disease prevention in Inuit population. The aim of this dissertation was to explore the determinants of dietary and physical activity behaviors as critical components for potential health promotion interventions in the Canadian Inuit population. In **chapter 1,** formative research was conducted to understand the current state of knowledge and proceeded to define the scope of the current research based on identified gaps in literature.

Chapter 2 of the dissertation describes the results of the systematic literature review. The aim was to identify the factors influencing dietary and physical activity behaviors of Canadian Inuit, uncover gaps in knowledge and propose priority areas for research. Literature searches were conducted between May 2014 and July 2014, and inclusive of articles published up until July 2014. Articles were searched using four databases: PubMed, PsycINFO, SocINDEX, and Psychology and Behavioral Sciences Collection. Eligible studies focused on diet and/or physical activity or determinants of diet and/or physical activity in Canadian Inuit population, and were published in English. A total of 45 articles were included in the analysis. A detailed appraisal of the articles suggested that many Inuit have disconnected from the traditional ways of life, including harvesting and processing of traditional food species and the associated physical activity. In the last two decades there has been a significant shift from consumption of healthy traditional foods to energy-dense store-bought foods particularly among younger Inuit (<50 years of age). Additionally, low socioeconomic status (SES) and high transportation cost affect

food accessibility and contribute to poor dietary choices in the population. The few articles that described the mediating role of motivational factors reported that increased healthful food knowledge and self-efficacy towards healthy dietary behavior were associated with greater intentions to make healthier food choices and participate in physical activity. It is evident that the rapid social, cultural, and environmental changes in the Arctic have altered dietary and physical activity behaviors of Canadian Inuit. However, our understanding is limited on how these behaviors might be influenced in the face of these changes. We concluded that prospective studies are needed to determine physical activity levels and advance our knowledge of cognitive and environmental determinants of Inuit energy balance-related behaviors. These studies can inform the development of health promotion interventions to reduce the burden of obesity in the population.

Chapter 3 presents our findings from the objectively assessed physical activity levels amongst Nunavut Inuit adults and the socio-cognitive and environmental factors influencing the number of steps taken per day. Although research evidence suggests that Canadian Inuit have transited from a physically active hunter-gatherer subsistence lifestyle into sedentary ways of life over the past five decades, there is a paucity of studies that examined physical activity levels in the population. Where such studies exist, they were based on self-reported measures which are quite unreliable. Inuit and non-Inuit adults (N = 272) in Nunavut participated in a seven-day pedometer study during summer and winter seasons. Participants completed the Neighbourhood Environmental Walkability Scale and Behavioral Regulation in Exercise Questionnaire. It was evident that participants had limited to low activity during both summer and winter. There were no seasonal and age effects on the number of steps. Gender effects and community differences were observed. Perceived infrastructure and safety as well as land use mix diversity were found to be positive environmental correlates of steps taken, which were partially mediated by identified motivational regulation. Although physical activity levels among Nunavut adults are generally low, it is evident that Nunavut Inuit may become more active by improving the external factors related to the physical environment and internal factors related to motivational regulation.

The perspectives of Nunavut Inuit on barriers to, and enablers of, healthy diets and physical activity participation are presented in **chapter 4**. The aim of the study was to provide contextual insights and deepen our understanding of the factors that influence these lifestyle choices through the lived experiences and views of Nunavut Inuit in the community of Iqaluit. In total, 22 Nunavut Inuit adults were initially recruited using a purposeful sampling technique. One-on-one semi-structured photo-elicitation interviews were held with 16 participants (ten women, six men) who met the inclusion criteria and provided consent. Interviews were conducted to uncover participants' lived experiences and thoughts regarding factors influencing healthy diets and physical activity in their community. Interviews were audio-recorded, transcribed and analyzed using an inductive thematic approach. Six main factors were identified as barriers or enablers to energy balance-related behaviors following thematic analysis: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of family and friends; and effect of substance use. This study identified six broad factors that should be considered while mapping out intervention points in the design of effective and sustainable health promotion programs to reduce the burden of obesity-related chronic diseases in Nunavut communities.

Given the role of the Government of Nunavut in developing standards, policies and programs, **chapter 5** presents our findings on a study that examined the level of government readiness to implement change efforts. The aim of this study was to explore the determinants of Nunavut public health system's commitment to implement obesity prevention policies and programs in the territory to reduce the burden of obesity-related diseases. In total, 93 program managers, program officers, and policy analysts who are responsible for program and policy development and implementation within the Nunavut Department of Health (NDH) were asked to complete the validated Organizational Readiness for Implementing Change (ORIC) questionnaire. Organization-level readiness (commitment) was determined based on aggregated individual-level data using bivariate correlations and multivariate linear regression analyses. Of the 93 questionnaires that were distributed 67 (72%) were returned fully completed. Organization-level commitment to implement obesity prevention policies and programs was

low. Only 2.9% of respondents strongly agreed that NDH was committed to implementing obesity prevention policies and programs. The study showed a strong positive correlation between NDH's commitment and perceived value, perceived efficacy, and resource availability. There was no statistically significant correlation between commitment and knowledge. In the multivariate linear regression model, perceived value was the only significant predictor of NDH's commitment to implement obesity prevention policies and programs. Successful adoption and implementation of obesity prevention policies and programs in the Canadian Arctic largely depend on the perception of value and benefits of and belief in the change efforts among employees of the Nunavut Department of Health. Convincing policy makers of the value of preventive policies and programs is an important and necessary first step towards decreasing the prevalence of obesity in the Inuit population.

In **Chapter 6** the main results, methodological considerations, and implications for practice and future research, are discussed. Moreover, intervention studies that are predicated on the determinants that have been identified in the current research, and are thought to influence dietary and physical activity behaviors, are recommended. Such studies should include mapping out intervention points during the design of effective and sustainable health promotion programs to reduce the burden of obesity-related chronic diseases in Nunavut communities.

Impact

Impact

The rates of obesity and the associated diet-sensitive chronic diseases in Nunavut continue to rise disproportionately, in comparison with the national averages. Empirical evidence shows that unhealthy dietary and physical activity behaviors create an energy imbalance that results in overweight and obesity among Inuit. The aim of this dissertation was to address the limitations in our understanding of the factors influencing energy balance-related behaviors of Canadian Inuit and explore potential areas for concerted action. Euro-Canadian lifestyles and its domineering influence have remarkably subjugated Inuit cultural traditions and influenced the energy balance-related behaviors in the Canadian Arctic. In contrast to the past, fewer Inuit, independent of age and gender, consume healthy traditional foods nowadays. However, Inuit men and Inuit over 50 years of age consume more traditional foods and less store-bought energy-dense processed foods than women and younger Inuit adults. Further, upon objective assessment of the patterns of physical activity amongst Nunavut Inuit adult including the environmental and motivational determinants of the number of the number of steps taken, it was evident that approximately 10.8% of Nunavut Inuit adult residents are physically active at ≥7500 steps/day between summer and winter compared to the national average of 52%. The study also showed that perceived infrastructure, safety and land-use mix are positive environmental associates of steps taken.

Further, the impact of the environmental factors on the number of steps taken were partially mediated by identified motivational regulation, especially in the winter season. Findings from another study that was based on semi-structured photo-elicitation interviews with Inuit adult participants revealed six main factors serving as barriers or enablers to energy balance-related behaviors of community residents, which then present opportunities for necessary action in the population: cost and affordability of healthy choices; availability of traditional foods and activities; weather conditions and climate change; infrastructure and community resources; social networks of families and friends; and effect of substance use. Moreover, within the realms of political control and intervention development, this dissertation reveals that organization-level commitment to implement obesity prevention policies and programs within the

Government of Nunavut Department of Health is generally low. Only 2.9% of the employees were very confident of their organization's commitment to implementing obesity prevention policies and programs, and approximately 33% of the employees were somewhat confident. This dissertation elucidated various factors influencing dietary and physical activity behaviors amongst Inuit including identifying areas of opportunities for action. The dissertation has both scientific and societal value and the findings present good foundational work for future researchers and potential opportunities for intervention developers.

Scientific Impact

The built and food environments in the Arctic are unique and appear to influence energy balance-related behaviors in Nunavut. Environmental factors influencing physical activity among Inuit were explored using the Neighbourhood Environmental Walkability Scale (NEWS), which essentially depended on the components of the built environment in participating communities. The NEWS questionnaire was adapted to the Nunavut environment by rewording some sections and adding a "weather scale" to account for a potential impact of the unique weather on physical activity. There was no prior research involving the use of the NEWS instrument in Nunavut. The adaptation and utility of the instrument in the Arctic environment is a positive step for future investigations and interventions in the region.

Further, recent technological advances and the need for accurate measurements of physical activity in light of unreliability of self-reported data have spurred a tremendous interest in objective assessment of physical activity by pedometers and accelerometers. Thus, in contrast to past studies in the Canadian Arctic that relied on self-reported data, physical activity levels were objectively assessed amongst Nunavut Inuit adults using pedometers. Contrary to accelerometers, pedometers offer the benefits of a more practical, user-friendly, inexpensive and technically feasible alternative for surveillance, screening, health promotion intervention, and program evaluation. Although pedometers are not technically designed to capture pattern, intensity, or type of physical activity, nevertheless, the device detects steps taken with acceptable accuracy, reliability, and convergent with discriminative validity. Additionally, the instrument is more suitable for use amongst the Inuit because of the low literacy levels given the

technical requirements of accelerometers, and the potential high cost of instruments acquisition for health promotion intervention in economically disadvantaged Nunavut communities. Future research that focuses on objectively measured physical activity in the population is therefore relatively made easier and financially attenable given this foundational work with pedometers.

In the qualitative study, one-on-one semi-structured photo-elicitation interviews were conducted to explore Nunavut Inuit perspectives on barriers and enablers of healthy dietary and physical activity behaviors. Photo-elicitation is based on empowerment principles and is congruent with the Indigenous cultures. The visual images in the photographs trigger memories and the approach is often used as "ice breaker" activity, creating a comfortable space for discussions. Photo elicitation also bridges potential cultural gap between the researcher and the respondents. Most of the results of the studies reported in this dissertation are published in international scientific journals. In addition, most of the results have been disseminated at international scientific conferences.

Societal Impact

Results of the objectively measured physical activity and the environmental and motivational regulations of the number of steps taken have been shared with most of the participants in the study and public health teams of the Department of Health. This has generated a lot of interests and discussions, especially on potential areas for health promotion interventions amongst Inuit across settings such as the schools, workplaces, playgrounds, and health services centres. Public health officers and nutritionists are equally exploring opportunities for increasing nutrition education in communities, in response to the findings that showed that younger Inuit under 50 years of age and women consume more store-bought processed foods than healthy traditional foods.

In response to the finding of low organization-level commitment within the Nunavut Department of Health, the level of commitment of Nunavut Public Health System to implement obesity prevention policies and programs has moderately increased in the territory, particularly in the Kivalliq region. The findings of the study on commitment to change efforts was shared

with the Nunavut Directors of Population Health, who are currently prioritizing obesity prevention programs through various health promotion and education campaigns, including organizing Health Fairs in five communities in the Kivalliq region in the past year, and collaborating with community organizations to design, develop, and implement a fitness program, nutrition education, cooking and traditional food harvesting programs. These programs are being implemented through program reprioritization which involved reallocation of existing resources to reduce the burden of obesity-related diseases in the territory.

Upon completion and defense, key findings from this dissertation will be shared with community leaders, the Nunavut Research Institute, and the executive management committee of the Government of Nunavut Department of Health for deliberation and necessary action. High level collaboration between community leaders, the Department of Health and other stakeholders including the Nunavut Department of Community and Government Services, will be fostered to prioritize community development by increasing cultural resources and infrastructural support. These efforts are expected to promote healthy food consumption through traditional food harvesting and sharing, advocacy for improvement on the federal government food subsidy program – the Nutrition North, as well as provision of cultural resources such as Inuit traditional games, improvements to walkways and regular maintenance of sports facilities to increase and sustain physical activity participation. It is anticipated that a well-resourced and supported community will facilitate a population-wide change towards healthier diets and increased physical activity participation.

Biography

Biography

Victor Olatunde Akande was born in Ibadan, Nigeria. He is a Nigerian-Canadian. Victor started his career in 1994 as a Veterinarian at Selcon Farms Limited, Kano - Nigeria, and rose to the position of General Manager in 1998. His career in health promotion began in 1996 while volunteering at a not-for-profit organization where he worked with women and youth on nutrition, reproductive health issues and economic empowerment. Driven by his passion for community health and development, he accepted an offer to serve as Project Manager on a national immunization project, coordinated by a consortium of organizations (the United Nations International Children's Emergency Fund, the World Health Organization, the European Economic Community and the Federal Government of Nigeria). He later emigrated to Canada in 2004 to pursue advanced education. Victor has been working for the Government of Nunavut - in the Canadian Arctic region since 2012, and currently serves as Executive Director Health Operations within the Department of Health. He had previously worked in the same department as Territorial Lead Chronic Disease and Injury Prevention and Territorial Manager Public Health Strategy Implementation. Prior to working in Nunavut, Victor was Risk Prioritization Officer and Food Defense Specialist at the Canadian Food Inspection Agency in Ottawa, where he conducted risk profiling, prioritization, and ranking of foodborne illnesses, in collaboration with federal, provincial and territorial authorities. Victor graduated from the University of Ibadan, Nigeria with a Doctor of Veterinary Medicine (DVM) degree in 1994; completed MSc. degree in Nutritional Physiology from Dalhousie University, Halifax - Nova Scotia (2006); and MPH degree in Public Health Sciences from the University of Waterloo, Waterloo- Ontario (2011). He is a Fellow of the Royal Society of Public Health (FRSPH) of the United Kingdom.