

**Emerging Obesity and Dietary Habits Among James Bay
Cree Youth: 3 Communities**

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**I would like to dedicate this thesis to my adorable parents
Monique and Chaouki**

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ABSTRACT

The present project provides information on the nutritional health of James Bay Cree children and youth who have been deeply affected by nutrition transition and are now at risk for overweight and poor diet quality. The current thesis found that 63.2% of the Cree youth aged 9 to 18 years old were at risk of overweight while 47.2% were overweight. Almost all of the participants reported consuming high-sugar and high-fat foods which accounted for 12.8% and 40% of their total energy intake respectively. Furthermore, all youth had notably lower fruit and vegetable and milk and milk product consumption than recommended. Traditional food consumption was low. However, youth who consumed traditional food at least once a week had a significantly lower BMI percentile and a higher fruit and vegetable intake than those who consumed traditional food less frequently. The findings highlight the urgent need for dietary interventions among Cree youth. It is hoped the project will build awareness and capacity to effectively deal with the obesity epidemic in Cree communities and also be of value to other communities affected by this global obesity epidemic-recently referred to as “globesity” by the WHO.

RÉSUMÉ

Cette étude vise principalement à souligner les problèmes nutritionnels auxquels font face les Cree de la Baie James qui souffrent aujourd'hui d'un taux élevé de surpoids et qui ont été profondément affecté par les changements qu'ont subis les conditions de vie, notamment en matière d'alimentation et l'accès aux biens de consommation. Les résultats du projet suivant montrent que 63.2% des Jeunes Cree âgés entre 9 et 18 ans se sont avérés en risque de surpoids tandis que 47.2% souffrent de surpoids. Environ tous les participants ont affirmé avoir consommé des aliments riche en sucre et en gras, qui représentent respectivement 12.8% et 40% de leur énergie totale. D'ailleurs tous les jeunes ont généralement une consommation de fruits et légumes et lait et produits laitiers plus faible que celle recommandée. La consommation d'aliments traditionnels est en générale faible. Néanmoins, les jeunes qui ont consommé au moins 1 aliment traditionnel par semaine ont en moyenne un BMI percentile plus bas et ont démontré une consommation plus élevée de fruits et légumes. Ces conduites appellent au besoin urgent d'interventions nutritionnelles a l'égard des Jeunes Cree. Il est espéré que ce projet va alerter les gens au sujet de surpoids et mieux guider les interventions pour combattre l'obésité dans les communautés Cree ainsi que dans les autres communautés affectées par l'épidémie d'obésité.

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LIST OF ABBREVIATIONS

AMDR: Acceptable Macronutrient Distribution Range

BIA: Bioelectrical Impedance Analysis

BMR: Basal Metabolic Rate

CBHSSJB: Cree Board of Health and Social Services of James Bay

CCHS: Canadian Community Health Survey

CDC: Center for Disease Control and prevention

CHO: Carbohydrates

CINE: Center for Indigenous Peoples' Nutrition and Environment

DQI: Diet Quality Index

DQI-R: Diet Quality Index Revised

E: Energy

EM-1-A: Eastmain-1-A Powerhouse and Rupert River Diversion hydro project

FAO: Food and Agriculture organization

HDL: High Density Lipoprotein

HEI: Health Eating Index

IOM: Institute of Medicine

MF: Market food

MFFQ: Market Food Frequency Questionnaire

P: Protein

rEI: reported Energy Intake

SD: Standard Deviation

TEE: Total Energy Expenditure

TF: Traditional Food

TFFQ: Traditional Food Frequency Questionnaire

TV: Television

USDA: United States Department of Agriculture

WHO: World Health Organization

WC: Waist circumference

CONTRIBUTION OF AUTHORS

A manuscript entitled “**Emerging Obesity and Dietary Habits Among James Bay Cree Youth: 3 Communities**” has been prepared and is included as part of this thesis.

Contributions of the author to this manuscript follow.

As first author, I was responsible for analyzing the data, preparation of the tables and writing this manuscript. Since the first part of the data was done in 2005, I was responsible for collecting the second part of the data during the summer 2007 in the north. In addition I was in charge of supervising the nutritional interviews, entering the information and double checking the data entry. I conducted the analyses and put the information in appropriate tables.

Editorial assistance was provided by Dr Egeland. Dr Egeland also provided guidance during the analyses, writing, and interpretation of results and provided guidance throughout the whole project.

1. INTRODUCTION

Overweight and obesity are associated with many life-threatening morbidities such as type 2 diabetes, hypercholesterolemia, hypertension, heart disease and other related all-cause mortality (Alpert and Powers 2005; Statistics Canada 2006). As the prevalence of obesity has been steadily increasing among children and youth, it has become a major health concern (Dehghan, Akhtar-Danesh et al. 2005; Choudhary, Donnelly et al. 2007). Early detection, prevention and treatment of obesity will prevent children from suffering morbidity complications later in life. Moreover, preventing and treating obesity at an early age prevents children from suffering further morbidity complications later in life (Choudhary, Donnelly et al. 2007). The world-wide epidemic of obesity has now been termed “globesity” by the World Health Organization and Canada is no exception where increasing rates of overweight and obesity have been noted. According to data from the Canadian Community Health survey (CCHS), a high percent of all Canadians and aboriginal people in particular are overweight or obese with the Aboriginal population being at greater risk in age-adjusted analysis (Statistics Canada 2006). Nevertheless, studies have found that children, aboriginal people and immigrants are especially at high risk of excess weight, for whom the increase in overweight and obesity has been the greatest (Belanger-Ducharme and Tremblay 2005).

Fast food consumption, high sugar intake and physical inactivity are three risk factors associated with obesity. The rapid increase of fast food restaurants, which are convenient for adolescents, in addition to the increase in portion sizes have been related to excess energy intake and weight gain (DJ and Rogers 1998; Lin, Guthrie et al. 1999; Alpert and Powers 2005). Furthermore, high fat foods and sugar-rich drinks are easily accessible by children, thus leading to reduced consumption of healthy, nutritious food in their diet. Physical inactivity has also been shown to be linked to the development of obesity (Weinsier, Nelson et al. 1995; Weinsier, Hunter et al. 1998).

While data on the actual prevalence of obesity among northern communities are available, relatively few studies evaluates eating patterns in high risk populations (Bernard, Lavallee et al. 1995). As Cree have one of the highest rates of overweight and

obesity in Canada, the current study was undertaken to evaluate dietary habits of youth in three Cree communities of James Bay (Belanger-Ducharme and Tremblay 2005; Vanasse, Demers et al. 2006). It is hoped the findings will guide future public health interventions.

2. LITERATURE REVIEW

2.1 Obesity

Overweight and obesity define ranges of weight that are greater than what is generally considered healthy for a given height. Having a body weight within those ranges has been shown to increase the likelihood of certain diseases and other health problems. Moreover, for children and teens, having excess body weight is labeled as "at risk of overweight" and "overweight" and is related to age and sex.

In Canada and the United States the prevalence of overweight and obesity has progressively increased over the past 40 years (Alpert and Powers 2005). Amongst Canadians, overweight has risen from 40 % in 1970 to 50.7 % in 1998 (Katzmarzyk 2002). Obesity has more than doubled over the same 13-year period where for the years 1985, 1990, 1994, 1996 and 1998 the prevalence of obesity was 5.6%, 9.2%, 13.4%, 12.7% and 14.8% respectively (Katzmarzyk 2002).

2.1.1 Obesity amongst youth

Similarly as adults, Canadian children are also becoming more overweight, thus posing a greater risk for their health. Tremblay and Willms have reported that the prevalence of overweight among Canadian children from the period of 1981 to 1996 has increased by 92% for boys and 57% for girls (Tremblay and Willms 2000). In addition, the prevalence of overweight in children aged 7-19 years has increased from 15% to 28.8 % among boys, and from 15% to 23.6% among girls (Andersen 2000; Tremblay and Willms 2000). Throughout this time period, obesity has also increased significantly from 2% to 20% amongst Canadian boys and 2% to 9% amongst Canadian girls (Belanger-Ducharme and Tremblay 2005). Recent data from the Canadian Community Health survey (CCHS) have shown an increased trend in obesity from 3% to 8%, from 1978/8 to 2004 in children aged 2 to 17 (approximately 500,000 children). Similarly, in the United States, statistics have shown that 25% of American children were overweight while 11% were obese (Dehghan, Akhtar-Danesh et al. 2005).

Obese children are more prone to social and psychological challenges in comparison to normal weight children of the same age. Furthermore, overweight children are also at greater risk than their leaner counterparts in terms of growth disorder, hyperlipidemia and glucose intolerance (Dietz 1998). It has also been shown that children who are overweight during childhood are most likely to increase in weight and reach overweight status by adolescence (O'Brien, Holubkov et al. 2004). It has been demonstrated that approximately 70% of obese children tend to become obese adults as they age. Thus, early detection of weight status during childhood is essential in order to prevent future weight related-morbidities in adulthood, such as atherosclerosis, hypertension and other cardiovascular diseases (Cheng 2007)..

2.1.2 Measuring obesity among youth

Body mass index (BMI), a key index for relating a person's body weight to height, is a common indicator to estimate a person's body fat level based upon a person's weight and height measurements (Must and Anderson 2006). However, this indicator has shown to be unreliable in terms of assessing childhood overweight and obesity at different ages and sex. In order for BMI to be more reliable, it should be compared to a reference standard that takes into account a child's age and sex. For example, using the BMI charts a 5 year old boy with a BMI of 19 will be categorized as overweight while a 15 year old boy having the same BMI would be considered as normal weight (Must and Anderson 2006). In 2000, the Center for Disease Control and Prevention developed age-specific BMI percentiles for children aged 2 to 20 years. These charts represent an updated version of the 1977 NCHS weight-for-stature charts that were based on children only in the U.S. region (Kuczmarski, Ogden et al. 2002). Instead of using the BMI categories applied for adults, a child's weight status is determined on a percentile bases (Center for Disease Control and Prevention 2000).

BMI percentiles are commonly used to indicate and evaluate the size and growth of a child, in addition to measuring adiposity change. Percentiles indicate the relative position of a child amongst other children of the same age and sex. The categories used with children and teens are shown on the growth charts: BMI percentiles between the 85th

and 95th percentile indicate that a child is at risk of overweight while BMI percentiles above the 95th percentile indicate that a child is overweight (Flegal, Wei et al. 2002).

2.2 Dietary risk factors associated with the increase of obesity

Given the increasing rates of obesity worldwide, it has become a necessity to evaluate associated causal factors that lead to an imbalance between energy intake and energy expenditure (Janssen, Katzmarzyk et al. 2004). Studies have shown that obesity is a factor of both biological and environmental elements (De Onis 2004). Nevertheless, it is believed that environmental, physical and social factors, rather than genetic factors or biological changes, are more likely to contribute to the increasing obesity epidemic (Jeffery, Baxter et al. 2006). In order to properly address the underlying problem, a deeper understanding about the factors leading to obesity is an urgent need. Taking a closer look, it is believed that readily available high energy foods and an increase in sedentary behavior are likely driving the increasing prevalence of overweight and obesity (Andersen 2000). In particular, some behaviors are shown to be directly associated with the obesity epidemic such as diet composition, energy and fast food intake, high sugar drink consumption, and physical inactivity.

2.2.1 Diet composition and energy intake

Weight gain theoretically occurs when energy intake chronically exceeds energy expenditure. Many studies found a positive relationship between energy and diet composition or both with body weight (Gazzaniga and Burns 1993; Hill and Prentice 1995; Tucker, Seljaas et al. 1997; Gillis, Kennedy et al. 2002). However, other studies found contradicting results and failed to find a relationship between fat or energy intake and adiposity (Maffeis, Pinelli et al. 1996; Atkin and Davies 2000; Maffeis 2000; Maffeis, Provera et al. 2000). Therefore, results from dietary studies to date are inconsistent and no specific conclusions can be derived concerning the effect of increased energy and macronutrients intake on obesity (Rodriguez and Moreno 2006).

2.2.1.1 Positive relationship between energy and macronutrient intake and obesity.

Gazzaniga and Burns were among the first to examine the relationship between diet composition and body fatness in children (Gazzaniga and Burns 1993). A total of 48 children aged 9 to 11 were categorized into a normal weight (BMI <85th percentile) and an obese group (BMI >85th percentile). Height, weight, skin fold thicknesses and resting energy expenditure (REE) were measured. Dietary intakes were analyzed using three consecutive 24-hour recalls using food models to enhance children's accuracy and understanding. After adjusting for body weight, obese children were found not to consume more energy than non-obese children. However, obese children were observed to consume a greater proportion of their total energy in the form of fat and less carbohydrates. The association remained constant even after adjusting for physical activity which is also a factor between diet composition and childhood obesity. Surprisingly, protein intake only slightly increased in the non-obese children which raises a question about the type of foods that obese children are consuming, which are likely higher in carbohydrate and fat content. However, the case-control nature of the study as well as the use of the 24-hour recall, which is a short term measure of diet and is not representative of a subject's typical diet, could not lead to any causal interpretation (Gazzaniga and Burns 1993).

Gillis et al. showed a positive correlation between total energy consumption and juvenile obesity (Gillis, Kennedy et al. 2002). Obese children were also found to consume significantly more total energy, total fat and saturated fat than did non-obese children. Obese children were also found to consume significantly greater amount of sugar (167g) than normal weight subjects (134g). Therefore, it is hypothesized that the extra energy consumption may have come from the excess consumption of sugar products such as candy and sweet drinks, which would have contributed to the weaker relationship between fat intake and body weight.

However, other studies have reported inverse results showing that sugar consumption was lower in overweight than normal weight youth (Hill and Prentice 1995; Janssen, Katzmarzyk et al. 2005). The positive relationship between energy intake and body weight found by Gillis et al., may have been due to the accuracy of the dietary

assessment method using a 24-hour recall, a food frequency and questions to verify intake and portion sizes, in addition to the presence of a parent during the child's interview. Underreporting was also monitored since the obese children were scheduled a treatment, and each participant was taught the importance of reporting accurate food in order for them to receive help for their health problem.

An important limitation in the previous study was that the cut-off percentile for normal weight children was set at a BMI less than the 75th percentile compared with the 85th percentile used in other studies. Thus, children with a BMI between the 75 and the 85th percentile have been excluded from this study, resulting in two distinct groups of normal weight and overweight children with different lifestyle habits (Gillis, Kennedy et al. 2002). The dietary history assessment method used in the study, the relative big sample size compared to other work and the presence of a parent during the interview were considered important factors that yielded more accurate results. It is of note that in both studies, when the results were expressed as energy per kg of body weight, the obese children consumed less energy than the non-obese (Gazzaniga and Burns 1993; Gillis, Kennedy et al. 2002).

2.2.1.2 No direct relationship between energy and macronutrient intake and obesity.

On the other hand, some studies have also reported on the negative association between energy intake and diet composition in relation to body weight. Gibson investigated on the association between foods high in extrinsic fat and sugars and their relation to BMI in adults (Gibson 1996). Dietary records consisting of 7 day 24-hour recalls as well as body weight and height were measured. Intake of extrinsic sugars was estimated according to the consumption of total sugars and the contribution from 51 summary food groups excluding milk and fruits. The cut-off points for the sugar and fat groupings were set at 15% and 40% of energy respectively. An important strength to consider is that overweight people dieting or consuming less than 1.2 times their energy intake metabolic rates were excluded from the study to avoid confounding with subjects underreporting energy intake. In contrary to the author's hypothesis, a negative association was found between individuals consuming higher level of sugary fatty foods and their respective BMI. These findings indicate that such specific foods are vulnerable

to under-reporting because they are often considered as prohibited foods. High consumers of energy from sugar and fat have shown to be correlated with lower BMI which may suggest that the heavier consumers are more active than their counterparts. Moreover, it had been thought that it is hard to study the effect of sugar on BMI since sugar itself may be correlated with fat energy. However, these findings suggested an inverse relationship between sugar and BMI independent from both fat and energy intake as well as under reporting (Gibson 1996).

Other cross sectional studies failed to confirm a positive relationship between fat intake and adiposity (Maffeis, Pinelli et al. 1996; Atkin and Davies 2000; Maffeis, Provera et al. 2000; McGloin, Livingstone et al. 2002). Atkin and Davis have evaluated whether diet composition in pre-schooled children is related to percentage of body fat (Atkin and Davies 2000). A four consecutive days food records was used by the mother or caregiver to assess the child's dietary intake. Body composition was measured by the total body water technique, in conjunction with the double labeled water method used to measure physical activity. Even though reliable and accurate methods were used to determine the body weight and composition as well dietary intake, no relation between energy, fat, carbohydrates or protein intake with percentage body fat was found in these children. The results also indicate that physical activity had a larger influence than diet composition on children's body fat. However, the young age of the child is a factor which may have affected the results.

Maffeis et al. investigated in 2000 the association between nutrient intake and parent's adiposity in comparison to their children's body weight (Maffeis, Provera et al. 2000). Dietary intake was assessed using a diet history and body composition was obtained by measuring skin fold thicknesses in 7 to 11 year-old children. When parents' BMI was taken into account, diet composition was not found to explain the children's adiposity. Therefore diet composition was not considered as an independent factor on childhood obesity but had an influence along with parents' BMI for obesity.

However, the cross sectional design of these studies does not allow us to draw any cause-effect conclusions. Therefore, another study by Maffeis et al. investigated the relationship between diet, body composition, physical activity and parent's fatness with

children's fat gain over a four year period (Maffeis, Talamini et al. 1998). A diet history was used to assess dietary intake, anthropometrics were used to measure body composition and a questionnaire to evaluate physical activity. After following 298 children aged on average 8.7 years for four years, the families were called again for a second visit and the same measurements were taken. From the results of the 112 children who attended the second visit, nutrient and energy intake failed to explain the variance of BMI in children while both the mother's BMI and TV viewing time taken into account. Besides, energy intake and diet composition did not affect the change of BMI over time when parent's BMI were taken into consideration. The lack of relationship may have been caused by puberty since during the age of 8 to 12 years puberty growth acceleration starts and boys tend to be leaner where girls have a larger fat deposition. The increased growth may have compensated for the energy and fat intake and created an energy balance as suggested by the fact that 32 % of the obese children at baseline became lean 4 years later.

2.2.2 Fast food intake

The North American diet, which is high in saturated and trans-fatty acids has been cited to contribute to the obesity epidemic (Alpert and Powers 2005). Fast food restaurant use is growing rapidly and it was cited in the literature that the money spent on eating away-from-home represented 25% of overall food spending in 1970 compared to 47.5% in 1999 (Lin, Guthrie et al. 1999). Moreover, fast food consumption is expected to increase in the coming years. Fast food restaurants are convenient for adolescents and families who have no time for food preparation and therefore resort to quick ready-to-serve meals. However, these meals are high in fat and represent a larger proportion of energy intake, compared with those eaten at home (Lin, Guthrie et al. 1999). A strong association was observed between fast food restaurant use and energy intake: total energy intake was 40% and 37% higher among males and females who reported three or more visits to fast food restaurants per week compared to non-fast food consumers. Fat intake was also higher with 9% and 13% for the male and female adolescents respectively (French, Story et al. 2001).

2.2.2.1 Positive association between fast foods and obesity

The influence of fast foods and their effect on energy intake and weight gain has been studied in depth. Surprisingly, energy density of a meal is related to a compensatory response of suppression of energy intake only among the very young. It has also been stated that the most important factor that increases eating in children aged 6 to 9, when having a high density meal, is the meal's effect on changing the eating behaviors of the subjects by increasing the consumption of the same kinds of foods (DJ and Rogers 1998).

Obesity was also found to be related to the trend of eating away from home especially in “fast food” restaurants (Jeffery, Baxter et al. 2006). In fact, when people eat out, they consume food with higher energy and in bigger portions (Rodriguez and Moreno 2006). Children have been observed to consume larger amounts when bigger portions are offered. Consequently, children who eat fast food meals consume more energy per gram of food (0.29kcal/g) and more total fat (9g) when compared to non-fast food meals (Bowman, Gortmaker et al. 2004). In Brazil, the more common occurrence of overweight and obesity among children and adolescents has been related to changes in their life style and especially their eating habits; children's diet of 8 to 10 years old changed along with the nutrition transition detected in the country. Fast foods rich in energy and fat have emerged and are constantly at the disposal of the children (Triches and Giugliani 2005). In fact, a study on youth (4 to 19 years) carried in the United States in 2003 showed that 30.3% of children and adolescents ate a fast food meal on a typical day (Bowman, Gortmaker et al. 2004).

In the United States, children who ate fast food added an additional 187kcal/day to their diet thus accounting for an average of 57 kcal to their daily energy intake. Presuming that their energy expenditure is unchanged, this energy increment could be responsible of a weight gain of 6 pounds per child per year resulting in a greater BMI-percentile (Bowman, Gortmaker et al. 2004). A longitudinal study looking at the effect of physical activity and dietary eating habits on weight change and BMI among 9 to 14 year old girls and boys showed a positive association between an increase in energy intake over a one year period and a larger BMI (Berkey, Rockett et al. 2000).

2.2.2.2 No direct association between fast food and obesity

Even though increasing obesity has been related to fast food intake, some studies showed no direct association between the two characteristics. A review by Rodriguez and Moreno about the relationship between fat intake and body fatness in youth showed that many factors together are responsible for the emerging obesity in children and adolescents (Rodriguez and Moreno 2006). Fast food consumption is only one of the factors contributing to excessive energy intake, in addition to physical inactivity, food composition and general eating patterns and behaviors which have contributed to the overweight epidemic. Excess consumption of high energy and fast foods associated with an increase in daily energy intake may cause an imbalance in total energy intake. Interestingly studies have found that the levels of total and saturated fat in breakfasts and lunches in American schools in 1999 were above the dietary guidelines for American target. These guidelines suggest that every meal or snack served in the schools should contain less than 30 percent of its total energy from fat and less than 10 percent of energy from saturated fat (Wechsler, Brener et al. 2001). In addition, the foods available in the vending machines are suggested to be even higher in fat compared with food sold as part of a lunch program (Wechsler, Brener et al. 2001). Considering that more than 50% of schoolchildren eat either breakfast or lunch at school (Wechsler, Brener et al. 2001), and 35 to 40% of total daily energy intake is consumed at school (Kubik, Lytle et al. 2003), high fat meals and snacks available in schools is of concern.

However, the causality between fast food intake and increasing obesity is hard to demonstrate, but the changes in eating behaviors that occur along with the fast food epidemic such as bigger portion sizes, higher appetite, less frequent meals, displacement of nutrient dense food, reduction in energy expenditure, eating less energy at breakfast and more at dinner, fewer family meals and more TV watching all together likely contribute to the emergence of obesity (Rodriguez and Moreno 2006).

2.2.3 High sugar drink consumption

After World War II, the human diet has shifted markedly with an increase in the consumption of refined sugar especially in the form of sugared fruit and soft drinks (Popkin and Nielsen 2003). Between 1962 and 2000, a 74-kcal/d increase of caloric sweetener consumption has been observed. Moreover, data shows that soft drinks and sugar fruit drinks represents 80% of the actual caloric increase (Popkin and Nielsen 2003). In particular, U.S. children and adolescents have dramatically increased their soft drinks consumption; In 1997, more than half of American adolescents (74% and 65% for boys and girls respectively) consumed sugar drinks on a daily basis (Borrud L, Wilkinson Enns C et al. 1997). Interestingly, an increase of consumption by 100% among adolescents (11-17 years) has been noted during the past 2 decades (French, Story et al. 2003). Soft drink consumption of children aged 8 to 13 years was strongly associated with parents' taste, children's television viewing, extensive promotional efforts of companies selling these drinks and availability of these drinks at home and school vending machines (Grimm, Harnack et al. 2004). In particular soft drink machines were found to be present in more than two thirds of 25 schools in Minnesota metropolitan area (French, Lin et al. 2003).

The three major concerns regarding high-sugar drink consumption are the amount of sugar they contain, their low nutrient content, and the possible excess energy intake that they produce (French, Lin et al. 2003). In the actual American diet, soft drinks are considered the leading source of added sugar contributing daily to 36g of sugar for adolescent girls and 57g for boys (Ludwig, Peterson et al. 2001). Interestingly, a 12-ounce can of soda contains approximately 10 teaspoons of sugar (Schwartz 2003). These figures clearly exceed the USDA recommendations for overall added sugar consumption of 6 to 10% of total daily calories. In addition, these drinks contribute to a displacement of food considered as primary sources of nutrients such as milk, fruits and vegetables (French, Lin et al. 2003; Overby, Lillegaard et al. 2004). The reduced consumption of such foods has caused a concern in the lack of obtaining essential nutrients such as calcium, folate, magnesium, vitamin A, and other micronutrients needed for growing children (Harnack, Stang et al. 1999). Thus, the pattern of the consumption of these

drinks by youth can have a strong affect with their overall nutritional status (Forshee and Storey 2003). In addition, data from a US national survey showed that children and adolescents with a high soft drink consumption consume overall more calories and less milk (Harnack, Stang et al. 1999). Moreover, it was hypothesized that in the short term, when a liquid is consumed the energy is not compensated for in later meals as opposed to solid consumption (Ludwig, Peterson et al. 2001; Gillis and Bar-Or 2003). In fact, there is evidence that when individuals increase their liquid carbohydrate consumption, they increase their daily energy intake without any reduction in their solid food intake (Raben, Vasilaras et al. 2002). Therefore, the excess of calories caused by these drinks is important.

The high consumption of sugar-rich beverages such as soft and fruit drinks has been linked to the obesity and overweight epidemic by causing a long-term energy imbalance (Sanigorski, Bell et al. 2007). It has been observed in a one year cross-sectional study that obese children and adolescents consume significantly more fat and sugar-sweetened drinks in comparison to their non-obese counterparts. In particular obese boys had the highest consumption of sugar-sweetened drinks (Gillis and Bar-Or 2003). In addition, energy intake was found to be positively related to the consumption of soft drinks in American children aged 2 to 18 years; energy intake was observed to be higher for children in the highest soft drink consumption (Harnack, Stang et al. 1999). Because children are increasing their soft drinks consumption, these findings are a major concern when thinking about the excess energy provided by these drinks and its contribution to childhood obesity (Harnack, Stang et al. 1999). In fact, one serving of soda provides 150 kcal with 40-50g of sugar; if these calories are added to a typical US diet, 1 can of soda per day could lead to a gain of 15 pounds per year (Apovian 2004).

Sanigorski et al conducted a study to examine the intake of beverages of children aged 4 to 12 and its association with their weight status. Children who drank fruit drinks 2 times or more per day were 1.7 times more likely to be obese/overweight than those who have these drinks less than once per week. Besides, the children who drank more than 3 servings of soft drinks the day before the interview were 2.2 times more likely to be overweight or obese when compared with non-soft drink consumers on the preceding day.

The study results clearly showed an association between overweight and the over consumption of both types of drinks (Sanigorski, Bell et al. 2007).

A prospective study that examined the long-term effect between the rising prevalence of obesity and the consumption of sugar sweetened drinks showed that although the cause of obesity is more likely to be multi-factorial, sugar sweetened drinks was observed to be one of the factors leading to obesity (Ludwig, Peterson et al. 2001). Ludwig et al. also found that among 548 children aged 11 and 12 followed for 19 months for each additional serving of high sugar drink that a person consumes, the BMI and the frequency of obesity increased. The consumption of sugar sweetened drinks was associated with obesity in these children (Ludwig, Peterson et al. 2001).

Results from cross-sectional studies on children and adolescents found a significant association between the sugar-sweetened beverage intake and overweight (Troiano, Briefel et al. 2000; Giammattei, Blix et al. 2003; Gillis and Bar-Or 2003; Nicklas, Yang et al. 2003; Berkey, Rockett et al. 2004). Moreover, other prospective cohort studies found the same significant positive association (Ludwig, Peterson et al. 2001; Phillips, Bandini et al. 2004). Thus, there is strong evidence to support the positive relationship between excessive intake of sweetened drinks and increased body weight among children. This association was also related to the nutritional transition that these foods are responsible for by causing a displacement of energy from food considered as primary source of nutrients such as milk, fruits and vegetables (French, Lin et al. 2003; Overby, Lillegaard et al. 2004).

2.3 Physical activity

Metabolic factors, diet and exercise are considered the three factors that modulate body weight. In particular, physical inactivity is thought to be an important factor contributing to the predisposition of obesity and linked to the emergence of obesity by reducing activity-related energy expenditure (Weinsier, Hunter et al. 1998). In addition it is considered as a main factor to the maintenance of obesity. In fact, in the present climate of easy accessible food and restaurants serving high energy meals, recommendations

alone are not likely to help stabilize weight in a population. Dietary changes and increases in daily physical activity are needed (Weinsier, Hunter et al. 1998).

Moreover, the emergence of electronic media, TV shows and internet in the lives of children causes a significant decline in physical activity (Must and Tybor 2005). In fact it was shown that the amount of leisure inactivity of children aged 14 to 20 increases with time (Caspersen, Pereira et al. 2000). It was also proposed that people may have a different predisposition to exercise depending on their muscle fiber types and metabolic characteristics; for instance the muscle fibers of obese people have an increased proportion of fast-twitch types. These fibers have a decreased oxidative capacity and may decline the ability to be active by increasing the level of fatigue which could also be a cause of obese' physical inactivity and a potential boundary to obese' exercise ability (Weinsier, Hunter et al. 1998).

Data from the prospective study completed by Weinsier et al showed that physical inactivity could have caused the rebound weight gain among the 24 post obese women who were followed up for 4 years (Weinsier, Nelson et al. 1995). Results showed that women who reported exercising regularly gained a mean of 6.0 ± 8.8 kg during the whole follow up compared with 11.6 ± 9.3 kg and 12.8 ± 7.8 kg for those who exercised occasionally and those who did not exercise at all. The difference in weight gain was significant between regular exercisers and non exercisers (Weinsier, Nelson et al. 1995).

Measuring physical activity is very challenging especially in children. Since the objective measures of physical activity are time consuming, the collection of information is usually done by questionnaires and interviews which can lead to misclassification of exposure (Must and Tybor 2005). A study by Adair et al. was conducted to examine the relationship between physical inactivity and activity patterns and overweight. It showed lower overweight among US adolescents who exercise more moderate to vigorous activity and watch less TV per week (Gordon-Larsen, Adair et al. 2002).

Another important study designed to investigate a longitudinal relationship between the fat mass of 12 to 28 year-old subjects and their lifestyle showed that a high physical activity over that period is related to a low fat mass (Kemper, Post et al. 1999).

In what relates to physical inactivity, most studies of obesity are cross-sectional which cannot lead to any cause-effect conclusions. However, the available up to date prospective studies suggest that increasing physical activity and decreasing sedentary behavior protects against weight and fat gain during childhood and adolescence (Must and Tybor 2005).

2.4 The nutrition transition among Indigenous Peoples

2.4.1 Consequences of the nutrition transition among Indigenous Peoples

The overweight epidemic had a major impact on Indigenous Peoples whom were considered to have experienced the most extreme dietary change in the last few decades (Kuhnlein, Receveur et al. 2004). Indigenous Peoples are considered as the most vulnerable groups at risk for excess weight and for whom the increase in weight has been greater than other populations (Belanger-Ducharme and Tremblay 2005). Genetic and environmental factors have been thought to be the most important two determinants of obesity in American Indians. A hypothesis about a possible "thrifty gene" was suggested by Neel in 1962, proposing that many American Indian tribes have been affected by alternating periods of famine and excess food over time, and thereby developed the ability to store energy efficiently (Neel 1962). Individuals stored surplus energy as fat when food was available in order to use it as energy in time of famine. The thrifty gene became a problem when food was constantly available with the dramatic environmental changes resulting with an increase in the incidence of obesity (Neel 1962).

On the other hand, environmental factors including behavioral and lifestyle conditions related to diet and physical activity play a key role in the high rates of obesity (Story, Evans et al. 1999). Since most American Indians developed obesity in the past 1 to 2 generations, Boyce and Swinburn had the idea to examine the composition of the traditional diet of Pima Indians of 100 years ago. The traditional diet consisted of 70-80% carbohydrate, 8-12% fat and 12-18% protein while the current diet is composed of 47% carbohydrate, 35% of fat and 15% of protein (Story, Evans et al. 1999). To further assess the possible impact of the prevalence of obesity, Ravussin et al compared the diet of Pima Indians of Arizona who have adopted a more "westernized" diet with the dietary lifestyle

of Pima ancestry living in a traditional environment (Ravussin, Valencia et al. 1994). Mexican Pimas were found to be leaner with significantly lower body mass indexes and lower plasma total cholesterol levels than Arizona Pimas showing that a traditional lifestyle could be protective against the development of obesity (Ravussin, Valencia et al. 1994). Moreover, Indigenous Peoples in Canada were affected by the nutrition transition of decreasing consumption of traditional food while enhancing consumption of market food high in fat and sugar imported from the south (Blanchet, Dewailly et al. 2000).

In particular, the Cree of James Bay were and continue to be deeply affected by the nutrition transition. The traditional diet of Cree was based mainly on hunting and fishing, a diet rich in protein, moderate in fat and low in carbohydrates. The Cree high energy needs due to their high energy requirement were compensated by their traditional active lifestyles along with their extreme cold weather and at times seasonal macronutrients shortage (Gittelsohn, Wolever et al. 1998). In 1975, the James Bay and northern Québec Agreement, which consisted of a monetary compensation for the use of the land, and gave the Cree the opportunity to further develop their respective communities, was signed between the governments of Canada and Québec, the Cree and Inuit of northern Québec and Hydro-Québec. The communities have grown and public facilities such as restaurants, grocery stores and transportation companies were developed (Aanischaukamikw Cree Cultural Institute). This has led to a growing dependence on store-bought foods shipped from the south and purchased in stores along with a reduction in the importance of traditional food based on plants and animals harvested from the local environment (Kuhnlein, Receveur et al. 2004).

While 79% of Cree still participate in traditional activities in 1991, the proportion of Cree who make a living from land-based activities has diminished over time. In fact, in 2001-2002 the percentage of hunters and trappers decreased to 20% (Torrie, Bobet et al. 2005). As a result of the deep changes affecting the James Bay Region, the Cree people replaced their traditional foods with low nutritional quality market foods purchased in stores (Willows 2005).

2.4.2 Traditional food

The concerns about the presence of contaminants and heavy metals in traditional food (TF) need to be evaluated within the context of the health implications of the shift away from TF. Receveur et al. evaluated the use of traditional food among 16 communities of the Canadian northern territories and the influence of TF on diet quality (Receveur, Boulay et al. 1997). Data on the quality of the diet was gathered with the use of a TF frequency questionnaire accounting for seasonal change and a 24-hour recall. Communities were classified as high TF users if TF accounted for more than 20 % of their total dietary energy and as low users otherwise. Results showed that low TF users consumed more total energy in particular from carbohydrate, and total and saturated fat. However, when only market food was consumed, the nutrient profile shifted towards higher carbohydrate, fat and saturated fat. It was concluded from the study that Dene/Metis are observed to decrease their TF intake especially in the younger generation and that the shift toward a diet composed exclusively from market food is illustrated by an increase in energy and the contribution of carbohydrate, fat and saturated fat in the diet (Receveur, Boulay et al. 1997). Along with the previous finding, data from 44 representative communities from the Yukon, Dene/Metis and Inuit communities showed similar results (Kuhnlein, Receveur et al. 2004). On days when TF was consumed adults showed a significantly lower consumption of fat, carbohydrates and sugar in their diet. In parallel, days without traditional food had significantly higher percentage of energy as carbohydrate, fat saturated and poly-unsaturated fats. However, no significant difference was found for TF use by BMI categories. Besides, older individuals were found to consume more TF than those who were younger (Kuhnlein, Receveur et al. 2004).

In order to better understand children's TF and market food use, Nakano et al. described the food use of Dene/Metis and Yukon children (Nakano, Fediuk et al. 2005). TF contributed to 4.5 % of the total energy intake in all children aged 10 to 12 years old who participated in the study. Girls had a slightly higher intake but TF was mostly found to be more consumed in northern communities than in those further south. Several studies conducted among children and adults separately have shown that moose, caribou, and fish (whitefish, char, trout) were found to be the most heavily consumed TF items in children

(Kuhnlein, Receveur et al. 2004; Nakano, Fediuk et al. 2005). When foods were grouped according to Canada's food guide, dairy, fruit and vegetables, grains and meat contributed to less than half of the energy intake while 55% of energy came from fat, sweets, mixed dishes and 'extra' items. Finally, when comparing days with and without TF intake, children consuming TF had significantly higher protein intake while market food meat, alternate products and grains were higher for children not consuming TF (Nakano, Fediuk et al. 2005).

However, when Kuhnlein and Receveur studied the contribution of nutrients of traditional foods for Arctic Canadian Indigenous Peoples, differences occurred between children and adults. Dietary data were analyzed separately for days with 1 or more serving of TF compared with days with no TF consumption. In the adults' diet, days with TF were characterized by significantly more energy and less carbohydrate and fat. However, for children days with TF were not different in terms of energy, carbohydrate or fat intake compared to days without TF (Kuhnlein and Receveur 2007).

Consistent with the literature available on the use of traditional food among children and the effect of consumption on the total diet, we can conclude that consuming TF is associated with a diet lower in energy, fat and saturated fat (Kuhnlein, Receveur et al. 2004; Nakano, Fediuk et al. 2005). However, a shift toward a diet rich in market foods and lower in traditional food was observed among native population; this shift leading to a lower consumption of traditional food was associated with a consumption of more energy in particular from carbohydrates and saturated fat (Receveur, Boulay et al. 1997).

2.4.3 Obesity among aboriginal youth

In view of the nutrition transition, Northern communities characterized mostly by aboriginal populations shows the highest rates of obesity in the country; the prevalence of obesity for adults above 18 years of age is 26% and exceeds by 11% the Canadian obesity rate (Belanger-Ducharme and Tremblay 2005). In addition, a recent study (2006) of Vanasse et al. testing the regional obesity across Canada stated that the rate of obesity in adults aged 20 years and up varied significantly between the health regions, from 6.2% in Vancouver to 47% in the aboriginal population and the Cree population of James Bay

(Vanasse, Demers et al. 2006). In the Canadian Community Health Survey (CCHS) 41% of Aboriginal children aged 2 to 17 years had a BMI greater than 25, from which 21% were overweight and 20% obese, consisting of a greater prevalence than seen for other ethnic groups (Shields 2006). In another study that used measured data, First Nation children aged 4 to 19 years living in Manitoba were found to have high BMIs; 64% of girls and 60% of boys exceeded the 85th percentile while 40% of girls and 34% of boys exceeded the 95th percentile (Young, Dean et al. 2000).

As of 2001, from 56-62% of children were estimated to be at risk/overweight in the 9 Cree Communities (Torrie, Bobet et al. 2005). It should also be noted that none of the regions was overrepresented since the Cartograms technique used takes into consideration the differences in population density between the different areas (Vanasse, Demers et al. 2006). Additionally, a study conducted among Cree children from both Chisasibi and Eastmain emphasized the high prevalence of overweight in younger Cree. Results showed that 38% of the children were classified as overweight from which 17% were obese cutting off at the 95th percentile (Bernard, Lavallee et al. 1995). More recent findings showed similar results in children and adolescents in five aboriginal communities (DENE METIS and YUKOUN) and in other Canadian Indigenous communities (Jackson 1993; Potvin, Desrosiers et al. 1999; Hanley, Harris et al. 2000; Nakano, Fediuk et al. 2005).

2.4.4 Measuring obesity among aboriginal youth

Nurses and physicians who work in Northern Canada frequently ask whether new special growth charts should be developed for Aboriginal children (Canadian Paediatric Society 1987). Even though some differences in growth have been seen between Canadian and Aboriginal children, the recommendations still confirm that the growth charts used for the Canadian children at that time are also suitable for use in Aboriginal communities due to regional variation and small sample size (Canadian Paediatric Society 1987). Since recent findings have been showing a difference of pattern of growth in Aboriginal's children especially, a debate began as to whether these criteria to obesity and overweight are appropriate for all populations (Razak, Anand et al. 2007). Some Aboriginal children such among the Cree tend to be heavier at birth (Canadian Paediatric Society 2004), while others are not significantly different at birth but their weight-for-height diverges after 6 to

12 month (Tigchelaar, Jong et al. 1998). For instance, Jamison found a high weight-for-height patterns among Canadian Inuit children (Jamison 1990). Moreover, when data from Inuit youth aged between 5-18 years was compared with the NCHS growth curves, weight was found to lie between the 50th and 75th percentiles while weight-for-height were between the 75th and 95th percentiles (Zammit, Kalra et al. 1993). Moreover, differences in the physique were found when comparing Canadians of First Nations and European ancestry using the somatotype; First Nation boys had significantly greater endomorphy than Canadians while girls aged 5 to 19 years old were not significantly different but followed the same direction of the boys with greater endomorphy (Katzmarzyk and Malina 1999).

Whereas these new findings would suggest the use of separate growth charts for Aboriginal people, the Canadian Paediatric Society recommended in a recent statement in 2004 that a special grow curve for each ethnic group would provide little purpose (Canadian Paediatric Society 2004). In addition, these separate growth charts are not recommended since studies with a level 2 evidence supported the principle that environmental rather than genetic influences resulted in differences in growth patterns among children (Canadian Paediatric Society 2004). Thus, the CDC growth charts are considered an acceptable method for all Aboriginal groups.

2.5 Methodological challenges in evaluating the role of diet in the emergence of obesity

2.5.1 Underreporting

Underreporting of energy intake is a persistent problem especially among overweight and obese individuals. It is recognized that when participants reports their energy intake, food and nutrient consumption is often underestimated (Johnson, Friedman et al. 2005). In a study testing the under-reporting of energy intake in women, 49% of the participants aged 23 to 53 years under-reported their energy intake. A possible cause to this bias can be that a great part of the subjects, especially those being overweight and obese, are either unaware or ashamed of their intakes with a special emphasis on sweets and snacks. Some participants found it hard to estimate their intake when eating in a

restaurant or declared that they did not have a reference to calculate approximately food portions. However, no relationship was found between underreporting and body weight or fat (Scagliusi, Polacow et al. 2003).

Under-reporting of energy was also related to higher BMI in adults men and women (Heerstrass, Ocke et al. 1998; Johansson, Wikman et al. 2001). However, analysis testing children's reporting accuracy over multiple 24-hour recalls showed different results. For the first trial, overweight children had the lowest omission rate. The omission rate was defined as the items observed eaten but not reported eaten. As well, the intrusion rate consisted of all items reported eaten while not observed. The mean omission and intrusion rate increased then stabilized over three trials (Baxter, Smith et al. 2006). A study conducted among 11 year old children to evaluate dietary reporting accuracy as a function of their weight and macronutrients intake showed that underreporting tends to occur among heavier children having higher body fat and relative weight. Psychological measures such as children's body satisfaction and weight concern might result in misreporting, though no differences in macronutrient composition of the children's diet was observed (Fisher, Johnson et al. 2000).

A possible cause of underreporting is that subjects tend to report their intake in a socially desirable way by reporting less frequently food considered unhealthy or fattening such as sweets and fat foods (Scagliusi, Polacow et al. 2003). In particular under-reporters showed a lower percentage of energy from fat and carbohydrate than non-under-reporters in contrast to higher percentage of energy from protein (Lafay, Mennen et al. 2000). Making the subjects comfortable in answering the questions with the use of a short none tiring questionnaire and the use of portion sizes measurements aids can be useful to attenuate underreporting in population based studies (Scagliusi, Polacow et al. 2003; Godwin, Chambers et al. 2004).

2.5.2 Algorithms to assess the level of underreporting

Nutritional epidemiological studies are based on the hypothesis that self-reported energy intake reflects accurately habitual intake. However, previous research in dietary assessment showed that sometimes errors might occur in self-reported dietary information especially by underreporting energy intake (Fisher, Johnson et al. 2000; Livingstone and

Robson 2000; Scagliusi, Polacow et al. 2003; Baxter, Smith et al. 2006). Total energy expenditure (TEE) estimated by double labeled water is the most common method used to determine inaccurate dietary reports (Livingstone and Robson 2000). However, this technique is expensive and difficult to perform in remote community settings.

Therefore, Goldberg et al. generated a new concept to identify misreporting by comparing reported energy intake (rEI) to a multiple of basal metabolic rate (Black 2000). They defined minimum cut-off limits of energy intake below which a person could not live a normal life-style using fundamental principles of energy physiology. Individuals having an energy intake as a percentage of energy requirements within these cut-offs, which depends on sample size and duration of measurements, would be considered plausible reporters. However, this approach has only been studied by Goldberg in adults.

Huang et al. were the first to establish a direct link between eating patterns, energy intake and obesity among children and adolescents aged 3 to 19 years in the US (Huang, Howarth et al. 2004). Research in children and adolescents is challenging since relationship between diet and obesity might be explained by the impact of large development differences. Huang et al. (2004) is the only study up to date to screen for implausible children basing their work on Goldberg's methodology by using cut-offs ± 1 SD for rEI as a percentage of predicted energy requirements using updated equations to estimate energy requirements. Total energy expenditure was predicted in terms of age, weight, height and physical activity level. In addition, the equations included a constant value representing energy deposition for growth. The plausible sample consisted of 45% of the 3 to 5 years old children, 48% of the 6 to 11 years old children and 43% of the 12 to 19 years old adolescents. EI was positively associated with higher BMI in 6 to 11 year-old boys and 12 to 19 year-old boys and girls categorized as plausible reporters. Moreover, percentage energy from fat was positively related to BMI percentile only in boys of 12 to 19 years of age. The process used in this study requires more than 1 recall for each subject and needs to set up specific cut-offs and SDs specific to each population being studied. In addition, these cut-offs and SDs need to take into account the coefficient of variations in energy intake and TEE measured by doubly labeled water (Huang, Howarth et al. 2004).

In their study about the prevalence of obesity in low income school children Johnson-Down et al. proposed a simple methods to estimated underreporting in children using only one 24-hour recall. Basal Metabolic Rate (BMR) was calculated using the FAO/WHO recommendations using both actual and ideal body weight (Johnson-Down, O'Loughlin et al. 1997). Mean ratio of EI/BMR was calculated and a cut -off of < 1.5 was considered to indicate underreporting in adults in previous studies. A higher ratio of < 1.8 was used for children given that their estimated energy expenditure is higher due to the additional energy needed for growth. Overall, the mean EI/BMR was 1.79 ± 0.71 indicating no serious underreporting. However, children in the highest BMI quartile in that study had a mean value of 1.31 ± 0.45 showing evidence of significant underreporting of energy intake.

2.5.2.1 BMR

BMR is the amount of energy expended in a neutrally temperate environment while at rest and in a post-absorptive state. The energy released in this state is only sufficient for functioning of the vital organs of the body. BMR represents about 65-75% of total energy expenditure in sedentary individuals. Besides, physical activity represent 15 to 30% of his/her daily energy expenditure depending upon the individual's physical activity level (Schneider and Meyer 2005). Numerous studies tested the accuracy of predictive equations to calculate a person's BMR by comparing the outcome with results from the indirect calorimetry measurements that determine energy expenditure.

Schofield (Schofield 1985) and the World Health Organization (WHO) (FAO/WHO/UNU 1985) were the first to recommend the use of prediction equations to estimate BMR in 1985. These findings were followed in the nineties by Harris and Benedict's suggested equations, and are together the most notable and most commonly used methods to calculate BMR (Frankenfield, Muth et al. 1998).

Wong et al. compared BMR values obtained for 76 Caucasian and 42 African-American children and adolescents with the use of calorimetry with BMR values calculated from predicted equations. Among the equations proposed, the FAO/WHO/UNU and the Schofield equations based on weight yielded the most accurate

results when the resulted BMR was compared with mean BMR by whole body calorimetry (Wong, Butte et al. 1996). It was also noted that the overestimation of BMR was higher in African American subjects than the Caucasians due to the fact that African-American grow faster and have more lean body mass than their counterparts. Thus, it was recommended that future refinement of these equations should include ethnicity (Wong, Butte et al. 1996). For instance, the Schofield and WHO equations originated from sample of North Americans and Europeans populations (Schneider and Meyer 2005).

Dietz et al. found no significance between measured BMR and that estimated by the WHO equation in obese and non-obese children (Dietz, Bandini et al. 1991). When comparing results from several equations for calculating BMR in 110 healthy obese children, the WHO equation was found to be the most accurate one (Tverskaya, Rising et al. 1998).

A more recent study by Schneider and Mayer concluded that the use of estimated BMR in a mix group of overweight and obese boys led in most cases to an overestimation of energy requirements. However, when measured BMR through calorimetry was compared with values obtained through the most used predicted equations, the Harris and Benedict equations were the only ones showing no differences between measured and predicted BMR values and the FAO/WHO/UNU equation was the least to overestimate the measured BMR values (Schneider and Meyer 2005). Accordingly, we can say that the WHO equation is appropriate to use with children and can possibly be applied in overweight and obese children according to the literature available to date.

2.5.2.2 Actual/Adjusted body weight

Since BMR is related to the fat free mass in the body, it is hypothesized that equations for overweight individuals might overestimate energy needs. Because overweight might have the same fat free mass and BMR as normal weight individuals (DeLany, Harsha et al. 1995), the use of adjusted body weight to calculate BMR should be considered as an alternative to actual weight for overweight an obese.

Many BMR equations have been shown to overestimate energy needs for overweight subjects. Some studies analyzed the use of an adjusted weight substituted in predictive equations. Frankenfield et al. evaluated several equations for predicting BMR rates against measured values and tested the effect of using adjusted body weight in the Harris and Benedict equation. Use of this adjusted body weight for overweight subjects with a BMI > 25kg/m² caused a significant underestimation compared with the use of actual body weight (Frankenfield, Rowe et al. 2003). As well, in 2005 Frankenfield et al. found that when using adjusted body weight, the risk of overestimating BMR is reduced but the underestimation error is drastically increased (Frankenfield, Roth-Yousey et al. 2005). Research to date concluded that the use of adjusted body weight has not been shown to be a reasonable option in the clinical setting.

2.5.3 Parents involvement in their children's recall

Children's ability to remember food eaten the previous day was tested to investigate their dietary recall accuracy. Fourth graders were observed while eating breakfast and school lunch prior to being interviewed in person as well as by telephone. It was reported that in both interviews children only reported 67% of items observed (Baxter 2003). Parent's involvement was suggested to be beneficial to complete children's responses. Mother's recall of their children's diet appears to be useful when they compared observed meals eaten by children and mother's recall. Nine out of 10 of the most frequently eaten foods observed were reported identically. Some overestimation and underreporting of specific food items such as vegetables oils and fats was observed which raises a certain concern about using the mother's recall as an assessment methods (Basch, Shea et al. 1990).

Moreover, when children aged 4 to nine were observed eating a single meal there was no observed significant difference between observed and reported mean intake of total calories and other macronutrients by the mother or father of the child (Eck, Klesges et al. 1989). It is of importance to note that the participants in Basch et al. study were of educational attainment compared with that of the participants of Eck et al., which were of middle to high economic classes. The difference in socioeconomic status of the participants in both studies might have accounted for the difference in the results.

2.6 Indicators that relates to obesity

2.6.1 Diet quality indexes

Many approaches have been published for measuring overall diet quality based on the examination of the food nutrients and groups (Kant 1996). The most relevant methods reported in the literature to determine diet quality indexes are based on nutrients and food groups together because knowing only the individual nutrients in a food for instance will not provide the overall diet quality of the meal; in addition, the results of factor analysis on food groups alone may not be easy to understand by all readers (Kant 1996). In particular, Diet Quality Index (DQI) and the Healthy Eating Index (HEI) are both scientifically developed instruments to measure the multidimensional complexity and quality of diet. They are the two measures used currently in the evaluation of the overall quality of diet (Patterson, Haines et al. 1994; Haines, Siega-Riz et al. 1999).

2.6.1.1 The diet quality index

The original DQI developed by Patterson et al. in 1994 included weighting nutrient and food recommendation from the committee on Diet and Health of the food and nutrition board in 1989 (Haines, Siega-Riz et al. 1999). In order to establish the DQI the diet and health recommendations were selected and weighted and the variables were scaled equally despite their unit of measurement (Patterson, Haines et al. 1994). According to these recommendations, the highest priority was given to total fats, saturated fats and cholesterol, each given a weight of three. The following fourth and fifth elements were attributed to servings of fruits and vegetables and servings of grains and legumes respectively. The last three recommendations were related to protein, sodium and calcium were given the least weight (Patterson, Haines et al. 1994). The DQI was scored to differentiate between people complying and not complying with the recommendations. A score of 0 was given to those who met a diet and health goal. Others with a fair diet were given one point and the ones with poor diets were given two points. Thus, the possible scores ranged from 0 (excellent diet) to 16 (poor diet), after the points of the eight diets were summed (Patterson, Haines et al. 1994; Haines, Siega-Riz et al. 1999). After comparing the results of indices of fat intake or complex carbohydrate

with the diet quality index, it was clearly seen that ranking with a single nutrient is considered inferior in performance when compared with the nutrient and foods used for the evaluation of the DQI and can lead to substantial misclassification (Patterson, Haines et al. 1994).

Following the creation of the food pyramid in 1992, the dietary guidelines for Americans of 1995 and the release of the Dietary Reference intakes, the DQI had to be revised (Haines, Siega-Riz et al. 1999). Therefore, the Diet Quality Index Revised (DQI-R) was developed to incorporate modified methods to estimate food servings and new measures of dietary variety and moderation (Haines, Siega-Riz et al. 1999). Within the revision the scale components and the scoring practices were modified; with 10 dietary characteristics the score was also changed to a total of 100- points with an opposite interpretation of the results considering the lowest scores as poorer achievement of dietary recommendations and higher scores as better diet quality. Dietary diversity and moderation were the two DQI-R indicators added to the previous eight components (Haines, Siega-Riz et al. 1999).

According to the results, the DQI-R has shown to capture overall diet quality by reflecting the variation in the individual components. It is the best method to explain the full complexity of the diet compared with the use of a single dietary measure such as procedures correlated with overall energy intake. For instance, a measure considering the proportion of energy from fat can erroneously dilute the mean percentage of fat of a high energy low nutrient diet. Such diets may appear healthier than they really are. Conversely, the DQI-R is much less susceptible to this issue (Haines, Siega-Riz et al. 1999).

2.6.1.2 Healthy Eating Index (HEI)

The HEI measures how well the American diet conforms to the recommendations for healthy eating patterns (Kennedy, Ohls et al. 1995). It was based on the DQI and both indexes have many similarities and some differences. While the HEI is reported for persons aged 2 and older, the DQI-R utility has not been tested on children and was reported for persons aged 18 and older (Haines, Siega-Riz et al. 1999). However, the process to compute both indexes by determining the quantity of foods counting for

serving is somewhat complicated (Kennedy, Ohls et al. 1995). For instance, bread is broken down into its constituent of flour, eggs and several constituents of milk, including the milk fat and the milk solids. This highlights how serving sizes of each food groups should be computed. In addition food servings are predicted from a regression line based on the recommended energy requirements (Kennedy, Ohls et al. 1995).

2.6.2 Canada's food guide

The Canadian's first food guide was introduced by the Federal Health Department in 1942. The Food Guide has been altered many times having all along the same purpose of guiding Canadians to select their food, promote their nutritional health and reduce the risk of nutrition-related chronic disease (Katamay, Esslinger et al. 2007). The Food Guide was revised in 2002 to examine whether the guidance of health Canada was consistent with the latest science. Another revision took place in 2004 to address some of the challenges and build the strengths of the 1992 Food Guide (Katamay, Esslinger et al. 2007).

To model food intake patterns, a two step process was employed; in the first step "composite" food were created each representing a group or subgroup. In the second step, the DRI assessment methods were used to test the patterns created in step1 (Health Canada 2007). Food was then divided into 5 groups consisting of vegetable and fruits, grain products, milk and alternatives, meat and alternatives and food outside of the four food groups. Separating the population by age and gender according to the requirements of each group, food intake pattern was developed for each of the respecting DRI. Accordingly, the food guide was used to assess the dietary practices of subgroups in the population according to the recommended servings of the food groups.

Table 1 shows the final food intake recommendations by gender and age (Health Canada 2007). This Food Guide was developed according to a Canadian perspective and defines a way of eating while meeting the nutrient needs, promoting health and reducing the risk of nutrition-related chronic disease. One of the strengths of this approach is that it reviews the nutrition inadequacy knowing that any person that follows the food intake pattern has a high probability of meeting their nutrient requirements; although this

measurement does not assess nutrient adequacy it can be used as an indicator of overall diet quality. Moreover, the food intake pattern developed is based on evidence that links diet to lower risk of chronic disease. Hence, the Canadian Food Guide is a good way to describe and analyze people's eating habits because of its specific and clear grouping of food. Recently, an adapted food guide for First Nation, Inuit and Metis has been released by Health Canada (Health Canada 2007). This food guide reflects traditions and food choices of First Nations and recognizes the importance of their market and traditional foods. It is a valuable tool to promote and evaluate healthy eating and dietary practices among Aboriginal People.

2.7 Testing methods

2.7.1 Bioelectrical impedance, Tanita scale

Compared to other standard reference methods to estimate body composition, bioelectrical impedance analysis (BIA) is relatively simple and less time consuming. Leg to leg BIA was scientifically proven to be a valid alternative method to DXA for the measurement of body fat (Sung, Lau et al. 2001).

2.7.2 Questionnaires

Food frequency questionnaires give retrospective information on the patterns of food use during a longer period of time. However, this measurement method gives a less precise result and is used to assess the usual intake of food or specific classes of foods. However, a simple questionnaire takes about 15 minutes to complete, which imposes less burden on respondents than other dietary assessment methods (Gibson 2005).

The 24-hour recall is considered as a quantitative daily consumption method designed to measure the quantity of the individual foods consumed over a 1 day period. It gives us a quantitative estimation of the usual intakes of individuals. Regardless of its reliance on respondent's memory it has been validated to use in children more than 8 years old ; it has been shown that when a child reaches the age of 8, there is a rapid increase in his memory skills and his/her knowledge of names of foods which increases his/her ability to self-report food-intake (Livingstone and Robson 2000).

A repeat recall is important to limit within-subject variation. The recalls should be repeated on a sub-sample of the population on nonconsecutive days (Gibson 2005).

It is also important to note some critical points in obtaining accurate recalls such as the training of the interviewers, their ability to gather all the information needed and the respondent's accurate quantification of foods. This method may be used to estimate "absolute" intake of energy and due to its unlimited specificity regarding the type of foods and food preparations it is useful in culturally diverse populations. Conversely, this method is limited by the fact that a single day is unlikely to be representative of the usual individual intake (Institute of Medicine and Food and Nutrition Board 2005).

2.8 Prior studies

The main purpose of previous studies conducted in the James Bay region was to examine the evolution in health status of the Cree as well as assess the underlying evolving status of health determinants. In fact, the Cree communities of northern Québec have been undergoing rapid social change over the last several decades. This change is the direct result of the first James Bay Hydro Project which was followed by ongoing development such as the Eastmain-1-A Powerhouse and Rupert River Diversion hydro project known as EM-1-A project. Earlier studies mainly focused on some determinants of population health including social, environmental and personal health status (Torrie, Bobet et al. 2005). Major surveys such as the Aboriginal People Survey 1991, Santé-Québec 1991 and the Aboriginal People Survey 2001, were conducted in the 9 Cree communities. Several studies have been reported on the general trends in health status of the Cree population. However, studies covered to a much lesser extent on their nutritional status. Limitation such as under-counting, language and cross-cultural understanding and differences in some concepts of health between Québec and Cree Communities were encountered (Torrie, Bobet et al. 2005).

3. RATIONALE

In the last thirty years, the way of life of the Iiyiyiuch of northern Québec has been deeply affected by many socio-cultural and political changes along with large development projects. The hydro-electrical projects as well the mining, oil and gas

developments around the area is expected to have major environmental implication on the Cree communities that can be examined at several levels (Torrie, Bobet et al. 2005). Environmental contamination occurs through the release of methyl mercury as well as other toxicological effects into the food chain. Consequently, this can contaminate the traditional food supply and thus can change people's relationship to food sources and could disrupt Indigenous Peoples' traditional eating patterns.

The ecological system was also observed to be affected (Torrie, Bobet et al. 2005). In addition, a review article about the health of Canada's native people indicated that Indigenous Peoples; especially the Cree, showed a high risk of obesity, hypertension, diabetes mellitus which was not present in the past (MacMillan, MacMillan et al. 1996). In particular, the Iiyiyiuch of northern Québec were observed to have undergone a rapid nutritional transition according to the analysis of their health status in 2005 (Torrie, Bobet et al. 2005). Traditional food consumption along with fish eating decreased and a shift was observed through a more "southern" diet. The protective effect of traditional food has been partially lost and the increase of chronic diseases was detected; a serious spread of obesity was observed in the nine Cree communities (Torrie, Bobet et al. 2005).

Some studies in other native communities found a relationship between food intake, obesity and diabetes. Preliminary results showed that the consumption of more traditional food rich in n-3 fatty acids such as fish which have beneficial effects on HDL and triacylglycerol among Cree could be one of the factors protecting them against CVD (Dewailly, Blanchet et al. 2002). However, in a study studying the association of food consumption with diabetes and obesity in a Native Canadian Community, the consumption of more traditional bush-foods hunted from the surrounding area rich in omega3 fatty acids was associated with increased risk of obesity whereas high store-bought junk food consumption high in fat and refined sugars is associated with greater risk of diabetes (Gittelsohn, Wolever et al. 1998). One hypothesis to explain the positive association between the consumption of bush foods and the high risk of obesity was that TF are infrequently consumed in the Native Canadian population living in northern Ontario and that the consumption of these foods is no longer associated with high level of energy expenditure for most people.

Therefore, traditional food is encouraged for its protective effect with moderation. According to the results, dietary change among Indigenous Peoples in the north have led to a higher intake of energy especially from fat and refined sugar sources such as soft drinks and fast food (Kuhnlein, Receveur et al. 2004). This nutritional transition plays a major role in the development of non insulin dependant diabetes, obesity and poor quality diet which has been associated with increasing obesity and diabetes in many North American indigenous groups (Murphy, Schraer et al. 1995; Gittelsohn, Wolever et al. 1998). Although these changes are recent, they are also expected in other native population such as the Cree community of the James Bay. To guide public health interventions, a better understanding is needed about Cree youth's food behaviors and diet quality.

4. HYPOTHESIS AND OBJECTIVES

4.1 Overall objectives

The Nituuchischaayihitaa Aschii project is a multi-community project developed to give the public health department of the Cree Board of Health and Social Services more knowledge about the environmental and health issues among nine Cree Communities in James Bay. The objective of the present thesis is to describe dietary habits among Cree children and adolescents in 3 communities suffering from a high prevalence of early emerging overweight and obesity.

4.2 Specific aims and hypothesis

The primary aim of the study was to describe dietary habits and anthropometry of children in three Cree communities. Specifically, food habits were evaluated relative to Canadian guidelines, and dietary quality was further assessed through the extent to which high sugar drinks and food and high fat food contributes to energy intake. Also, the amount and frequency of traditional food consumption was evaluated. The second aim of the study was to evaluate the extent to which traditional food consumption is related to indicators of diet quality (including anthropometry) and the degree to which other dietary behaviors are related to anthropometry.

The alternative hypotheses are that

1. Diet quality will be poor relative to Canadian food group and macronutrients, and saturated fat intake guidelines; and that
2. Traditional food will be related to improved dietary quality indicators.

**Emerging Obesity and Dietary Habits Among James Bay
Cree Youth: 3 Communities**

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5. MANUSCRIPT

5.1 ABSTRACT

Objective: To describe dietary habits and extent of overweight and obesity among Cree youth in 3 communities.

Design: Dietary intake and habits were assessed by a 24-hour recall and 2 food frequency questionnaires along with clinical and health questionnaires.

Setting: James Bay, Northern Québec, Canada.

Subjects: A total of 125 youth aged 9 to 18 years.

Results: Overall 63.2% of the sample population was at risk of overweight, while 47.2% were overweight. Moreover, 81.6% of the participants fell above the cut-off value for waist circumference (85thile). Dietary intake was underreported among overweight youth, characterized by an EI: BMR ratio of (1.16±0.45). Nearly 60 % of the children consumed saturated fat above 10% of total energy. All youth had significantly lower consumption of fruit and vegetables, milk and milk products than recommended by the Canadian Food Guide for First Nations, Inuit, and Métis.

Youth consuming traditional food (TF) at least 1 time per week had significantly lower BMI percentiles ($p \leq 0.05$) than those consuming $TF < 1$ per week. Fruit and vegetable intake from the market FFQ was also significantly higher when TF was consumed weekly. However, youth in the higher TF consumption group also had a higher consumption of fats and oil and snacks (i.e., chips, nachos, popcorn, French fries), (p values ≤ 0.05).

Conclusions: Around two thirds of the Cree youth were found to suffer from excess body weight. Traditional food consumption may be related to higher physical activity and thereby help to explain the paradoxical findings of a significantly lower BMI and higher fruit and vegetable intake with higher amounts of snacks and fat among TF consumers

than infrequent TF consumers. Promotion efforts are needed to target the entire community.

5.2 INTRODUCTION

Overweight and obesity are associated with many life-threatening morbidities such as type 2 diabetes, hypercholesterolemia, hypertension, heart disease and all-cause mortality (Alpert and Powers 2005; Statistics Canada 2006). As the prevalence of obesity has been steadily increasing among children and youth, it has become a major health concern (Dehghan, Akhtar-Danesh et al. 2005; Choudhary, Donnelly et al. 2007). Early detection, prevention and treatment of obesity will avoid children from suffering morbidity complications later in life (Choudhary, Donnelly et al. 2007). According to data from the Canadian Community Health survey (CCHS), a high percentage of all Canadians are overweight or obese (Statistics Canada 2006). In particular, in view of the nutrition transition, northern communities characterized mostly by Indigenous Peoples, show the highest rates of obesity in the country; In the Canadian Community Health Survey CCHS 41% of Indigenous children aged 2 to 17 years had a BMI greater than 25, from which 21% were overweight and 20% obese, consisting of a greater prevalence than seen for other ethnic groups (Shields 2006).

Indigenous Peoples in Canada have and are undergoing a nutrition transition with decreasing traditional food and increasing market food consumption, resulting in increases in dietary fat and sugar intake (Blanchet, Dewailly et al. 2000). The resulting dietary changes have led to higher energy intakes from fat and refined carbohydrates sources such as soft drinks and snacks (Wolever, Hamad et al. 1997). This nutritional transition plays a major role in the development of type 2 diabetes mellitus, obesity and poor diet quality in many North American Indigenous communities (Murphy, Schraer et al. 1995; Gittelsohn, Wolever et al. 1998).

Dietary change appears to play a major role in the development of obesity and its related co-morbidities among Indigenous Peoples living in Canada (Gittelsohn, Wolever et al. 1998) and the U.S. (Compher 2006). The traditional diet of Pima Indians 100 years ago consisted of 70-80% carbohydrate and 8-12% fat while the current diet consists of 47% carbohydrate and 35% fat (Story, Evans et al. 1999). Pimas of Mexico, who still relied mostly on local harvests of TFs, were found to be leaner with significantly lower

body mass indices than Arizona Pima Indians suggesting that a traditional lifestyle could be protective against the development of obesity (Ravussin, Valencia et al. 1994). Moreover, several studies found that the younger generations of Indigenous Peoples consume less TF than older generations (Receveur, Boulay et al. 1997). TF contributed to only 4.5 % of the total energy intake in Dene/Métis children aged 10 to 12 years old (Nakano, Fediuk et al. 2005). In addition, the shift toward a diet composed exclusively from market food is illustrated by an increase in energy and the contribution of carbohydrate, fat and saturated fat (Receveur, Boulay et al. 1997; Nakano, Fediuk et al. 2005). Fruit and vegetables as well as grains and meat contributed to less than half of the energy intake of Dene/Métis children while 55% of energy came from fat, sweets, mixed dishes and 'extra high fat foods' (Nakano, Fediuk et al. 2005). Furthermore, overweight Cree youth (≥ 12 years) consumed less milk and milk products and fruits and vegetables than those with lower BMI (Bernard, Lavallee et al. 1995).

The traditional diet of Cree was based mainly on hunting and fishing, a diet rich in protein, moderate in fat and low in carbohydrates. The high energy requirement and intake were compensated by the Cree's traditional active lifestyles along with their extreme cold weather and at times seasonal macronutrients shortage (Gittelsohn, Wolever et al. 1998). In the last thirty years, the Iiyiyiuch of northern Québec has been deeply affected by many socio-cultural and political changes along with large development projects which are expected to have major environmental implications for Cree communities (Torrie, Bobet et al. 2005). This has led to a growing dependence on store-bought foods shipped from the south and purchased in stores along with a reduction in the importance of traditional food based on plants and animals harvested from the local environment (Kuhnlein, Receveur et al. 2004). Also, Cree were found to have a high risk of obesity, hypertension, diabetes mellitus which was not the case in the past (MacMillan, MacMillan et al. 1996).

As of 2001, 56-62% of children were estimated to be at risk of overweight in the 9 Cree Communities (Torrie, Bobet et al. 2005). However, relatively few studies evaluate eating patterns in high risk Indigenous Populations (Bernard, Lavallee et al. 1995). The

current study was undertaken to evaluate dietary habits of youth in three Cree communities of James Bay in order to guide future public health interventions.

5.3 METHODS

5.3.1 Study population and design

This study involves Cree (Iiyiyiu) youth residing in Québec on the eastern part of the James Bay area. The total population of Cree is estimated today to be around 13,000 accounting for the nine Cree Communities across the region. The five communities located along the coast are Waskaganish, Eastmain, Wemindji, Chisasibi and Whapmagoostui while the four villages located inland are Nemaska, Waswanipi, Ouje-Bougoumou and Mistissini.

The Cree call themselves Iiyiyuu which means “the people” demonstrating their deep attachment to their past and commitment to keep their tradition alive. For some thousands of years, Cree have lived in the area contained by the lakes and rivers that drain into eastern James Bay and south-eastern Hudson Bay. The Cree language is still spoken by almost everyone and is the most widely spoken native language in Canada today (Aanischaaukamikw Cree Cultural Institute).

The Nituuchischaayihitaau Aschii project is a multi-community project developed to give the public health department of the Cree Board of Health and Social Services more knowledge about the environmental and health issues among nine Cree Communities in James Bay. The objective of the present thesis is to describe dietary habits among Cree children and adolescents in 3 communities suffering from a high prevalence of early emerging overweight and obesity.

Data from three Cree communities are included in this report; Mistissini, Wemindji and Eastmain which account for 3,200, 1,267 and 550 residents respectively. Approximately 10% of each community’s residents were randomly selected from a list of the community’s inhabitants. Only Cree residents of each village were eligible to participate. Pregnant women were excluded from the study due to their special nutrient and energy needs. The current report restricted analysis to youth aged 9 to 18 years.

Overall 300, 200 and 150 participants in the respective communities were randomly selected. The selection was chosen to be representative of every age group. The sample size of 125 provides over 99% power to identify population prevalence estimates (+ or - 5%) for highly prevalent (> 15%) dietary behaviors.

5.3.2 Ethics of participatory process

The Cree Board of Health, with advice from their constituents, and McGill University, Laval University and McMaster University developed the protocol. The proposal of the study was submitted and accepted by the Research Ethics Board of McGill, Laval, and McMaster Universities as well as the Ethics Committee of the CBHSSJB.

Whereas this pilot study was conducted among all age groups, the current part of the project focused on youth aged 9 to 18 years of age. However, the participation rate included the total population due to the standard age classification in the overall project. Among the 553 who were randomly selected from the 3 communities, 352 participated in the study contributing to a 63.65% participating rate. It is important to note that the rate was higher among the 8 to 14 years old which was 75%.

5.3.3 Data collection

This study started in Mistissini during the summer of 2005 and in Wemindji and Eastmain in June and August 2007. A research team with staff from McGill University, (CINE), Laval University, McMaster University and the Cree Health Board gathered baseline information about different health and nutrition parameters. In addition, community radio and meetings helped inform the different communities about the study.

Furthermore, bilingual community members were trained and conducted the majority of interviews and recruitment of participants. The Cree interviewers were selected from each community and by the Cree Board of Health and a local coordinator. Cree interviewers who were chosen to work in the project had to be fluent in English and Cree, comfortable using a computer and have good communication skills. Two days of training preceded the field work in every community; Interviewers and recruiters were instructed about the dietary assessment techniques and were given all the information in both

English and Cree, by a pre-registered audio tape, in order to translate questions or foods for the participants.

The cross-sectional study involved the collection of a broad range of health indicators including nutritional status, dietary intake and traditional food consumption. Community consent for the project was obtained from every Band Council and they actively encouraged community members to take part in the project. The community will thus write its authorization in any report published outside the area. Separate individuals consent and ascent forms and corresponding information sheets for different age groups (0-7, 8-14, 15-17 and adults 18 and older) were prepared and signed by the participants. An additional signature from a guardian, parent or tutor of children aged 18 and under was requested.

The participants were informed about the relevance of the study, the importance of their participation as well as the tests that will be done and were given an appointment at the clinic. Dietary intake and habits were assessed by a 24-hour recall, repeat recalls on a representative subsample, and by 2 food frequency questionnaires along with clinical and health questionnaires. Anthropometric assessments including height, weight and waist circumference were further made by nurses.

Height was measured in centimeters using a graduate tape with the patient standing barefoot on hard surface. Waist was measured at the end of exhalation with the tape horizontal located between the last floating rib and the iliac crest. Waist circumference was recorded at the nearest half centimeter, the height to the nearest centimeter. We transformed anthropological measurements into body mass indices (BMI: kg/m^2). Body weight and fat percentage was determined using a bioelectrical impedance scale (Tanita) with the participant wearing light clothing.

5.3.4 Questionnaires

Dietary intake was assessed using two qualitative food frequency questionnaires (FFQ) of traditional and market food administered by bilingual Cree interviewers selected from the community itself who have received appropriate training. All the questionnaires

were checked by a dietician for quality control while field data collection was under way. The traditional questionnaire includes animals such as caribou, moose, geese and birds such as ptarmigan and fish obtained through harvesting/gathering by Cree in the past year. It takes into account seasonal variations and gives frequency of consumption of these foods per day/week/month or season. Species were verified using pictorial representations of animals in both Cree and English languages. The market food questionnaire refers to food purchased in store. It is designed to identify indicators of high fat and high sugar foods such as pastries, baked goods and sugar drinks consumption during the past month.

A 24-hour recall was also administered to all participants using graduated food models of food portion sizes (Santé Québec, Montreal, Canada). Each person was asked to describe everything they had eaten and drunk the previous day using the appropriate food model when needed. These models included a variety of shapes of different sizes to compare with real food portions. If the children found difficulty in completing the recall, their parent's help was encouraged. For a better assessment of nutrient intake, participants were insured about the confidentiality of the information given. The recall involves a 5 step data collection including a quick list, forgotten foods, details and probing, review and finally a question about vitamin and mineral supplements. Data from the 24-hour recall was used to estimate the mean distribution of usual intakes of total energy and macronutrients (Dietary Reference Intakes 2003). Each questionnaire was promptly reviewed by a research team member to ensure all questions were answered accurately.

5.3.5 Coding and data entry

The terminology "youth" refers to all participants aged 9 to 18 years, while the term "children" was used for those participants 9 to 13 years of age and "adolescents" refers to the 14 to 18 year olds.

Data of the 24-hour recall were entered to the CANDAT software and were double checked by two different people for possible mistakes. In addition, data from the food frequency questionnaires were entered in the Epi-Info program.

Body mass index (BMI) was computed by weight in kg /height in m². To evaluate obesity in the population we used the CDC guidelines recommended for children aged less than 20 years old. Children were categorized according to their BMI percentiles to three distinct groups. Children less than the 85th percentile were defined as normal weight, between the 85th and the 95th percentile as ‘at risk’ of overweight, and overweight above the 95th percentile.

To describe and provide estimation of the distribution of waist circumference (WC) among children, age and sex appropriate percentiles were used based on WC percentiles of children and adolescents from different ethnic groups combined from the Third National Health and Nutrition Examination Survey (NHANES III) (Fernandez, Redden et al. 2004). The 85th percentile was considered as a cut-off between youth with high central adiposity and those with normal waist circumference.

Body fat percent percentiles were based upon body fat references for children developed by McCarthy et al. in 2006 (McCarthy, Cole et al. 2006). The 75th percentile was used as a cut-off to categorize youth into high and normal high body fat groups.

High sugar foods were defined as those foods containing greater than 25% energy as sugar and the percent of total energy intake that these foods provide in the 24-hour recalls. This list included drinks and foods such as high sugar cereals, cookies, fruit punches and soft drinks. However, nutrient rich foods containing high sugar such as fruit and vegetables were excluded from the list of high sugar foods. High fat foods were defined as foods with greater than 40% energy as total fat and the percent of total energy that these foods provided in the 24-hour recalls. This food group included high fat baked goods, cookies, mixed meals, traditional foods as well as dressings and spreads

To calculate potential underreporting of dietary intake, we calculated the ratio of reported energy intake (EI) to basal metabolic rate (BMR) estimated by the FAO/WHO/UNU equation, using actual weight of the participants. A value below 1.5 was used in the current study to identify under-reporting.

For the examination of anthropometric and dietary correlates of TF intake, traditional food intake was categorized into two groups, representing infrequent (less than 1 time per week) and weekly consumption (at least 1 time per week).

5.3.6 Statistical analysis

Statistical analyses were run using SAS (SAS Version 8.2, SAS Institute, Cary, NC). Descriptive data were presented as means (SD) and % distribution, unless stated otherwise, of food habits as it relates to guidelines for evaluating the association of different characteristics with emerging obesity. A p value of ≤ 0.05 was used to indicate statistical significance. Comparison of characteristics of dietary habits among age groups, sexes or BMI percentiles were assessed with the use of the Student's t-tests with youth stratified into 2 age groups to compare anthropometric measurements and data from the 24-hour recall and food frequency among age groups and genders. In addition the Chi-squared test was used for categorical data to test the percentage of consumption of high fat and high sugar foods among age groups and genders. The Wilcoxon signed-rank test was used to assess differences for non-parametric data when appropriate. Finally, we calculated the rate ratios (RR) and the 95% Confidence Intervals (CI) for all potential dietary predictors of overweight. The RR was used instead of the usual Odds Ratio (OR) since the prevalence of the outcome of interest, which is overweight, is common in the study: the OR tends to overestimate the RR when the outcome is highly prevalent (Viera JUL 2008)

5.4 RESULTS

A total of 125 children aged 9 to 18 years participated in the study, representing 54, 35 and 36 youth in Mistissini, Wemindji and Eastmain, respectively. With the exception of one weight measure, all dietary and anthropometric measurements were obtained on all participants.

Subject characteristics

Overall, the study group consisted of an equal proportion of boys (n=61) and girls (n=64). Youth were separated into two age groups; 9 to 13 and 14 to 18 years of age. The mean age of participants was 13.17 ± 2.77 and the average BMI percentile was 83.45, approaching the 85th percentile for being ‘at risk of overweight’ (Table 1). The mean body fat and waist circumference percentiles approximated the 82nd and 85th percentiles respectively and did not differ by age groups. However, the mean body fat percentile (94.58) was significantly higher ($p \leq 0.005$) among girls than boys (Table 1). Overall 63.2% of the sample populations were at risk of overweight, while 47.2% were overweight. Moreover, 81.6% of the participants fell above the cut-off value for waist circumference (85th percentile). The youth in the inland community of Mistissini had a higher WC percentile than youth in the coastal communities of Wemindji and Eastmain ($p \leq 0.01$), but no differences were observed in terms of body fat and BMI percentiles between the inland and two coastal communities.

Reporting energy intake

The mean EI:BMR ratio in this study was 1.31 ± 0.62 which suggests an overall population with mild underreporting of energy. No differences in EI: BMR ratio among age group or gender was observed. However, youth having a BMI over the 85th percentile were observed to have a very low mean of EI: BMR ratio (1.16 ± 0.45) compared with their normal weight counterparts (1.567 ± 0.45) (p value ≤ 0.01), indicating serious underreporting among overweight youth.

Nutritional intake from 24-hour recall and anthropometric data

Reported energy intake did not significantly differ between age groups. However, reported energy and protein intake was significantly higher amongst boys in comparison to girls; whereas the percentage of energy coming from carbohydrate intake was significantly higher amongst girls than boys (Table 2). Intake of total fat and saturated fat was not significantly different by age or gender. Nearly 60 % of the children consumed saturated fat above the 10% of total energy.

Also, 92.8% of participants reported consuming high sugar foods, which accounted for 12.8% of total daily energy intake. Moreover, 96.8% of the participants were found to consume high fat foods which accounted for nearly 40 % of total energy intake. No significant differences were observed in consumption of high sugar and high fat foods by age or gender (Table 2).

High sugar food consumption from 24-hour recall

A significantly higher proportion of 9 to 13-year-olds (48%) than 14-18 year-olds (32%) were observed to consume ‘baked goods and cereals’ (Table 3). However, no difference by age and gender was observed in terms of the consumption of other high sugar food groups. In addition the ‘baked goods and cereal’ group contributed to the highest percentage (20%) of total energy intake followed by 15% and 12% for the ‘high sugar drinks’ and the ‘snack foods groups’ respectively for consumers of those items (Table 3).

High fat food consumption from 24-hour recall

For high fat food groups, 9 to 13 year olds were observed to consume a higher proportion of baked goods and cereals compared with the 14-18 year-olds (Table 3). Snack foods were consumed by 38% of the participants and accounted for 17% of the total daily E for consumers. The meat and fish groups, consisting of different cuts of meat, birds and fish including bacon and sausages, was consumed by nearly 45% of the youth and accounted for 18% of their total daily energy intake.

Canadian food guide recommendation

All youth, regardless of age or gender, consumed on average fewer servings of fruits and vegetables and milk and milk products than recommended by the Canadian Food Guide for First Nations, Inuit, and Métis (Table 4). The consumption of meat and alternatives exceeded the recommended amounts for all youth regardless age and sex. Furthermore, the children met the recommended intake for the grain group while adolescents had lower servings than recommended. Finally, all youth exceeded the recommendations in terms of meats and meat products consumption.

Traditional food consumption

The traditional FFQ data indicated that the consumption of TF was low. Among the most popular items were meat (moose, caribou), fish (walleye, pike) and fowl (geese, ptarmigan) (Table 5). Moose meat was the most common traditional food item eaten (an average of 2.24 days per month). When TF items were combined into 4 groups, almost all the participants (83.2%) consumed any fish less than 0.5 times per week and 65.6% of the youth consumed traditional meat less than 0.5 times per week (Table 6). Nearly half of the youth consumed at least one kind of TF on a weekly basis.

Differences between Infrequent and Weekly consumers of Traditional Food Intake

Youth who were weekly consumers of TF were similar to those who were infrequent consumers in terms of total E and macronutrient intake from the 24-hour recall (Table 7). However, youth consuming TF ≥ 1 time per week were observed to have a lower mean BMI percentile ($p \leq 0.05$) than those consuming TF less frequently. Similarly, waist circumference and body fat percentiles were found to be non-significantly lower in the group of youth consuming TF ≥ 1 time a week when compared to less than once per week. Fruit and vegetable intake from the market FFQ was also significantly higher when TF was consumed more than once a week ($p \leq 0.05$). However, youth with weekly TF consumption had a higher consumption of fats and oil and snacks (i.e., chips, nachos, popcorn, French fries), (p values ≤ 0.05). High sugar foods and groups from the market FFQ were not shown to differ among the two TF groups.

Rate Ratios and 95% CI were calculated to test the risk of overweight and of having a high waist circumference percentile relative to dietary habits among youth. Youth consuming TF less than once a week had non-significant higher rate of being at risk of overweight relative to youth consuming TF at least once per week (RR=1.12 [95 % CI, 0.86-1.47]). Also youth who consumed less than 1 fruit or vegetable servings a day had a 34% significantly higher risk of having an at risk WC percentile than youth consuming fruit or vegetables more frequently (RR=1.34 [95 % CI, 1.05-1.71]), and a non-significant higher risk of being at risk of overweight (RR=1.23 [95 % CI, 0.94-1.59]).

5.5 DISCUSSION

The main aim of the present multi-community project was to describe the dietary habits of Cree children and adolescents in 3 communities suffering from a high prevalence of early emerging overweight and obesity.

Anthropometry and dietary habits

The prevalence of overweight and at-risk of overweight and poor dietary quality is of public health concern among the 3 communities. The average BMI percentile was 83.45 (± 20.87), with 63.2% being above the 85th percentile indicating ‘‘at risk of overweight’’. In addition, the prevalence of overweight ($\text{BMI} \geq 90^{\text{th}}$ percentile) in this study population was 47%. Furthermore, a total of 82% of the participants fell above the 85th percentile cutoff for excess abdominal fat.

The estimated high proportion of at risk for overweight and overweight youth in the current study was similar to previous studies conducted among the Cree (Bernard, Lavallee et al. 1995; Torrie, Bobet et al. 2005). Around two thirds of Cree youth aged 9 to 18 years of age were found to have excess body weight similar to other studies indicating a high prevalence of overweight among Indigenous youth (Young, Dean et al. 2000; Shields 2006; Vanasse, Demers et al. 2006).

When compared with the general population, the prevalence of overweight in this study population (47%) is about four to five times that of the general Canadian population of similarly aged children (Belanger-Ducharme and Tremblay 2005), but fall within the reported rates of overweight in several other Indigenous populations (Hanley, Harris et al. 2000; Nakano, Fediuk et al. 2005). The high prevalence of overweight among the Cree is not surprising and is already well-documented. The nutrition and lifestyle transition has had a serious impact highlighted by a shift away from traditional food use, toward a market-based diet rich in carbohydrates, fat and saturated fat, as well as an increase in sedentary lifestyle (Kuhnlein and Receveur 1996).

Along with BMI percentiles, waist circumference has also emerged as an important and effective indicator for metabolic complications in children and predicts future increased health risks (Savva, Tornaritis et al. 2000; Fernandez, Redden et al. 2004). A total of 82% of the participants fell above the 85th percentile cutoff for excess abdominal fat, and all the overweight children were found to have central adiposity similar to recent findings among the Cree of one community (Downs, Marshall et al. 2008). The findings highlight the importance of using WC as a predictor for overweight related health risks.

The findings of the present study revealed no major differences in the degree of adiposity in youth by community location (coastal Eastmain, Wemindji vs. inland Mistissini). However, youth residing in Mistissini were found to have lower WC percentiles compared to their counterparts living close to Hudson Bay. This discrepancy may be due to the fact that northern communities such as Wemindji and Eastmain were considered the most directly affected by the recent hydroelectric development projects in the area. These projects often require the building and extension of all-season roads that have long existed in Mistissini but did not exist until very recently (1995) in Eastmain and Wemindji located more to the north (Torrie, Bobet et al. 2005). It is also plausible that the higher central adiposity may also be due to other factors situated within the historical context of each community and the specific projects and interventions implemented in each population group should be further studied. Two years between studies may also contribute to the differences observed.

Reporting energy intake

It is important to assess the accuracy of reported energy intake among youth prior to evaluating their eating patterns (Kersting, Sichert-Hellert et al. 1998). Overall, the mean EI:BMR ratio in this study population was 1.31 ± 0.62 , indicating a suboptimal reporting of EI. However, when underreporting was further evaluated among youth categorized into BMI percentile groups, serious underreporting was only observed among the overweight youth. Furthermore, youth with normal weight were observed to report energy intake at an acceptable level with a EI:BMR ratio of 1.56. The underreporting of E intake among the Cree youth is supported by several studies that found evidence of under reporting of

energy intake by the higher weight children and adults (Johnson-Down, O'Loughlin et al. 1997; McGloin, Livingstone et al. 2002; Baxter, Smith et al. 2006).

In addition, psychological factors such as body image as well as weight concern might be an important contributor to under-reporting of energy intake. Also, overweight individuals may not be as aware of their food intake as normal weight individuals. Many factors may occur in late childhood and adolescence that would contribute to under-reporting of EI among higher weight individuals (Fisher, Johnson et al. 2000; Scagliusi, Polacow et al. 2003).

Nutritional intake from 24-hour recall and anthropometric data

A-Energy intake

Previous research failed to show a correlation between BMI percentiles and increasing level of energy intake, highlighting the difficulty in exploring dietary habits associated with obesity (Maffeis, Talamini et al. 1998; Atkin and Davies 2000). Therefore, the study results should be interpreted with caution.

Similar to previous findings, total energy intake was greater for boys than for girls in the current study (Livingstone, Prentice et al. 1992; Guillaume, Lapidus et al. 1998; Troiano, Briefel et al. 2000). The lack of differences in energy intake by age group could be partially explained by the higher under-reporting in the 14-18 year olds (EI: BMR = 1.2 ± 0.6) compared with the younger children (EI: BMR = 1.4 ± 0.6). Similarly, Livingstone et al. found a divergence between energy intake and TEE measured by doubly labeled water as age increased (Livingstone, Prentice et al. 1992); mean energy intake obtained from self weighted dietary records was significantly lower than corresponding energy expenditure in both the 12-15 and the 18-year-old groups. These results were related to the parents controlling the youngest children's food intake. Therefore, these children end up reporting more accurately their intake compared to the adolescents who have in contrast unstructured eating patterns and a high lack of compliance to record their food intakes.

However, results from a diet history from the same study showed superiority in overcoming age-related bias in energy reporting. In contrast, Troiano et al. have reported contradicting findings, as total energy intake was found to increase with age in a 2-19 years olds in the United States (Troiano, Briefel et al. 2000). Yet, in our present study, a 24-hour recall was conducted with the use of graduated food models for better estimation of portion sizes. In addition the parents were present when needed during the interview to help the children recall their food accurately. However, it must be taken into consideration that all methods used to measure energy intake are imprecise and have limitations that may easily yield inaccurate results.

Nevertheless, when compared to other studies on dietary intake of similarly aged youth, the reported energy intake of Cree youth was similar and sometimes higher. Indigenous children (8 to 15 years) in northern Alberta reported mean energy intake of 1750 and 1079 Kcal for boys and girls respectively (Wein, Gee et al. 1993). In addition, Mohawk students aged 10 to 12 years old reported energy intake of 2212 kcal for the girls and 2202 kcal for the boys (Limenez 2000).

Moreover, when compared to the nutrient recommendations by age for children (DRI), reported daily energy consumed by the Cree youth was higher than the recommended energy intake level, regardless of gender and age. These recommendations suggest a mean daily calories intake of 1800 for girls 9 to 13 years old, 2000 for boys 9-13, 2000 for girls 14-18 and 2300 for boys 14-18 ((IOM) 1999-2002). Thus the similarities in EI between 9-13 and 14-18 years olds was unexpected, but may be partly due to the higher under-reporting of energy among adolescents. In particular, childhood is a key time for children to develop healthy eating patterns, but childhood is especially challenging due to the social context within which children live and the availability and food choices made at home, relatives, neighbors, and daycare (Birch and Fisher 1998). Furthermore, since 70% of overweight children tend to become obese adults (Cheng 2007), it is of major importance to find ways to re-direct the children toward healthier food choices.

Poor dietary habits together with low physical activity among children observed in previous Cree studies (Ng, Marshall et al. 2006; Downs, Marshall et al. 2008), help explain the high prevalence of overweight in the three communities evaluated.

B- Macronutrient intake

Macronutrient intakes were calculated as a percent of total energy intake. Percentages of energy from carbohydrate were higher among girls than boys whereas protein intake was higher among the boys compared to the girls. Moreover, percentages of fat and saturated fat were high representing respectively 35.21% and 11.73% of total energy intake. In addition, nearly 60% of the children and adolescents consumed more than 10% energy from saturated fat.

A comparison between these results and previous studies showed conflicting results, with boys consuming higher energy from carbohydrates (CHO) than girls. In addition, all children had CHO intakes below the 50% Acceptable Macronutrient Distribution Range (AMDR) (Guillaume, Lapidus et al. 1998). However, a recent study conducted among Dene/Metis and Yukon children showed higher CHO intake in the girl group compared with the boys in the November-January Season (Nakano, Fediuk et al. 2005).

Protein intake followed similar trends observed in other work and was significantly higher in the boys compared to the girls (Guillaume, Lapidus et al. 1998; Nakano, Fediuk et al. 2005). However, mean percentage of energy from protein was 15% for the whole population and fell within the AMDR of 10-30% for protein.

The mean percentage of total energy from fat among the Cree (35.21%) is within the AMDR, suggesting a consumption of 25 to 35% of total energy from fat, but it is still higher than the recommendations for the boys and the 14-18 group as well as superior to previous findings (Gillis, Kennedy et al. 2002). On the other hand, further research found similar high fat intake among the same age groups (Troiano, Briefel et al. 2000; McGloin, Livingstone et al. 2002). It is important to note the high energy intake from fat among the Cree youth since several studies suggested that high fat intake may play a role in the

development of obesity (Tucker, Seljaas et al. 1997; Guillaume, Lapidus et al. 1998; Hanley, Harris et al. 2000).

In addition, the observation that children have a high saturated fat intake concurs with previous research highlighting the growing dependence on market foods rich in saturated fats (Guillaume, Lapidus et al. 1998; Troiano, Briefel et al. 2000).

High-sugar foods and high-fat food consumption from the 24 -hour recall

Overall, 92.8% of participants reported consuming high sugar foods, which accounted for 12.8% of the youth's total daily energy intake. Moreover, 96.8% of the participants were found to consume high fat foods which accounted for nearly 40 % of total energy intake. In addition, the percentage of individuals consuming high sugar foods from specific food categories revealed that the 'baked goods and cereal' group contributed to the highest percentage (20%) of consumers total energy intake followed by 15% and 12% for the 'high sugar drinks' and the 'snack foods groups', respectively. Furthermore, high fat snack foods were consumed by 38% of the participants and accounted for 17% of the total daily energy for consumers, while the meat and fish group was consumed by nearly 45% of the youth and accounted for 18% of their daily energy intake.

The excessive intake of high sugar and fat foods was previously observed in a Dene/Métis study, where the use of fat- and sugar-rich foods was of special interest (Nakano, Fediuk et al. 2005). The fat and sugar groups contained respectively more than 40% of energy from fat and sugar respectively and were identified as 3 separate groups (sweets, fats and mixed dishes). The MFs in addition to those 3 groups contributed to more than 50% of total energy intake among the children. Similarly to the current findings, over half of the total energy intake derived from fat, sweets, mixed dishes and other high energy items.

As part of the nutrition transition, sugar was found to be the most commonly mentioned market food in the 24-hour recalls of adults from the Canadian Arctic (Kuhnlein, Receveur et al. 2004). In particular sweets contributed to 20% of the energy intake in Dene/Métis and Yukon children's diet (Nakano, Fediuk et al. 2005). In addition,

these drinks contributed to a displacement of food considered as primary sources of nutrients such as milk, fruit and vegetables (French, Lin et al. 2003; Lillegaard, Loken et al. 2007). The reduced consumption of these foods is cause of concern because they contain nutrients such as calcium, folate, magnesium, vitamin A, and other micronutrients needed for growing children (Harnack, Stang et al. 1999). Thus, the pattern of the consumption of these drinks by youth can have a strong relationship with their overall nutritional status (Forshee and Storey 2003). Most importantly, results from cross-sectional studies on children and adolescents found a significant association between the sugar-sweetened beverage intake and overweight, suggesting that the increase of high sugar consumptions put the Cree youth at high risk of excess weight gain (Troiano, Briefel et al. 2000; Giammattei, Blix et al. 2003; Sanigorski, Bell et al. 2007).

Increased fat intake along with previous high-sugar intake reveals a pattern of increase intake of snacks, soft and fruit drinks as well as meats among Cree youth. Similarly, fat-rich foods along with mixed dishes high in fat contributed to 35% of total energy intake for Dene/Métis and Yukon children (Nakano, Fediuk et al. 2005). There is prior evidence stating that energy derived from fat is less satiating and may be more efficiently used for fat storage (Gibson 1996). It has also been stated that the most important factor that increases eating in children aged 6 to 9, when having a high density meal, is the meal's effect on changing the eating behaviors of the subjects by increasing the subsequent consumption of the same kinds of foods (DJ and Rogers 1998). Interestingly, this study was one of the first to present consumption of high sugar and fat foods from specific food categories in order to have a better picture of the sugar and fat contribution to total EI which will undoubtedly affect obesity. In summary, energy dense foods that are also high in sugar and fat were found to contribute an important percentage of energy intake among Cree youth thus raising concerns that they may displace higher quality nutrient dense food items in the diet.

Canadian food guide recommendations for Inuit, Métis and First Nations

In the present study, the diet of the youth was poor compared to recommendations made by Canada's Food Guide for First Nations, Inuit, and Métis. Participants had significantly lower mean fruit and vegetable intake as well as milk and milk products.

Furthermore, the children met the recommended intake for the grain group while adolescents had lower servings than recommended. Finally, all youth exceeded the recommendations in terms of meats and meat products consumption.

The low consumption of the vegetables and fruit group along with the milk and milk products group indicates a potential for low intakes of calcium and other vital nutrients. In a previous study conducted among the same population in 1993 (Bernard, Lavallee et al. 1995), the diet of Cree children was good in relation to the Canadian Food Guide; the younger 9-to-11 year youth met or exceeded the mean number of servings consumed for the food groups, while the older youth (≥ 12 years) had low intake of milk/milk products and fruit/vegetables. The findings were attributed to the positive impact of community programs among the youngest group, such as the school milk program. It is important to note that the percentage of at risk/overweight youth was lower (38%) than the proportions observed in the present study, but may be partially due to the higher cut-off for at risk children (90% percentile). This increase in overweight and poor dietary behaviors suggest that the nutrition transition among the Cree (Torrie, Bobet et al. 2005) is continuing with serious consequences for youth. These findings further stress the need to implement dietary and physical activity interventions in at-risk Cree communities.

It was observed among 5 years old young girls, that an increase in fruit and vegetable consumption is associated with higher micronutrients and lower dietary fat intakes (Fisher, Mitchell et al. 2002). In addition, an inverse relationship was found between fruit and vegetable consumption and high-fat/high-sugar foods over a 1 year intervention (Epstein, Gordy et al. 2001). Moreover, fruit consumption was found to have a significant negative relationship with BMI among children and adolescents (Lin and Morrison 2002). Therefore, Cree youth should absolutely be encouraged to increase their consumption of fruit and vegetables which will additionally displace other high-energy low-nutrient foods from their diet.

Furthermore, the relationship between calcium intake and weight is not yet established. Although adolescents, mostly girls, were found to avoid dairy products due to concerns about weight gain, a follow up of non-obese 8 to 12 years old girls failed to find a positive relationship between dairy food intake and weight gain (Phillips, Bandini et al.

2003). Also, increased dairy consumption was found to have a strong inverse association with the incidence of insulin resistance among overweight adults (≥ 18 years) and may reduce the risk of type 2 diabetes and cardiovascular disease (Pereira, Jacobs et al. 2002). Thus, calcium and vitamin D might pose a problem to Cree youth and further interventions should also focus on the increase of milk and milk products in their diet.

Traditional food consumption

The degree of traditional food consumption was evaluated according to the TFFQ and other diet quality indicators from the 24-hour recall. Overall, TF consumption was shown to be low. However, among the most popular items consumed were meat (moose, caribou), fish (walleye, pike) and fowl (geese, ptarmigan). While a variety of TF within fish, meats and fowls were consumed by the Cree, most species were limited in use frequency to 0.2-1.7 d/month. In addition, almost all youth (83.2%) consumed fish less than 0.5 times per week.

The TF food use was higher among Dene/Métis children than in the current Cree population, as among Dene/Metis children moose, caribou, and fish were found to be the most heavily consumed items accounting for 70%, 15% and 10%, to total energy intake from TF, respectively (Nakano, Fediuk et al. 2005). The higher TF use among communities situated further north was previously noted in the literature (Receveur, Boulay et al. 1997). The very low TF use by Cree children and adolescents was supported by previous research showing that children are consuming less TF than adults (Receveur, Boulay et al. 1997; Blanchet, Dewailly et al. 2000; Nakano, Fediuk et al. 2005). Similarly, fish consumption was found to be low in Dene/Metis and Yukon children, where most TF energy came from land animals. While caribou consumption was reported in 28% of the recalls, only 2.5% of the children reported eating whitefish. The low intake of fish may be related to the concern of elders and indigenous leaders about contamination of the water resources which changes fish behaviors and water flow as well as the mercury level in the environment which was considered as major threat to the TF quality (Torrie, Bobet et al. 2005). However, even fish species, low in methylmercury, are not consumed suggesting that advisories discouraged all fish consumption.

Increasing TF intake among Cree youth would enhance their diet quality.

In communities in the 3 territories, TF contributed to increased intake in essential nutrients. When comparing days with TF to days without TF, TF intake was found to be associated with higher consumption of vitamin D, vitamin E, riboflavin, vitamin B6, iron, and other important nutrients (Receveur, Boulay et al. 1997; Kuhnlein, Receveur et al. 2004; Nakano, Fediuk et al. 2005). Furthermore, TF use, even at level as low as 5% of energy, contributed to a higher intake of several essential nutrients among children (Nakano, Fediuk et al. 2005).

Comparing youth in terms of traditional food use further illustrates how other dietary indicators and anthropometric measures are related to TF intake and affected by the nutrition transition. Youth consuming TF weekly had lower BMI percentiles ($p \leq 0.05$), and a non-significantly lower waist circumference and body fat percentile and a higher fruit and vegetables intake than youth consuming TF infrequently ($p \leq 0.05$). Surprisingly, Cree youth with weekly TF consumption also had a higher consumption of fat, oil and snacks (i.e., chips, nachos, popcorn, French fries), (p values ≤ 0.05).

The current results, indicating no differences in term of energy intake and macronutrients between the low and higher TF groups, conflict with data from Dene/Metis adults, where the shift away from TF was associated with an increase in absolute energy intake, carbohydrate, fat and saturated fat intake (Receveur, Boulay et al. 1997). Nonetheless, only protein intake was significantly higher among youth without TF while fat and saturated fat were comparable among both groups (Nakano, Fediuk et al. 2005). Unexpected results were found among Arctic Indigenous people, where days with TF had significantly higher total energy ($p \leq 0.01$) and percentage of energy from protein (Kuhnlein, Receveur et al. 2004). It is therefore no surprise that in the present study we cam across no differences among energy from macronutrient intake since the whole population was shown to have a poor diet quality characterized by the intake of high fat, saturated fat as well as high-sugar and fat foods. In addition, the overall low consumption of TF may explain the slightly higher, but not significantly different protein intake among youth in the higher TF group.

Even though energy intake was unchanged with TF consumption, Cree youth with higher TF intake were significantly leaner than their counterparts characterized by lower BMI percentiles, waist circumference and body fat percentages. Because energy intake was not different among both groups, energy expenditure may have been greater among youth consuming TF. This important finding further stresses the importance of TF intake, even if consumed at low levels and in addition to MFs.

It is important to note that to date only few studies have looked at the relationship between BMI and TF consumption since research focused more on the association of TF with obesity, diabetes, glucose intolerance, cardiovascular disease and dietary quality indicators. In addition, the association between TF consumption and BMI or waist circumference should be interpreted with caution considering the long-term and the multi-causal aspect of body weight. A study conducted of Yukon First Nations and Inuit categorized participants according to their BMIs and found that the percentage of energy from TF intake did not differ between BMI categories (Kuhnlein, Receveur et al. 2004). Conversely, waist circumference was shown to be negatively correlated with pedometer steps count in a very recent article. In addition the odds ratio for central adiposity for children meeting step recommendations for a healthy body weight was 0.45 (Downs, Marshall et al. 2008).

While, in the present study no information about physical activity was evaluated, previous studies conducted among the Cree and in other Native communities have found low physical activity levels in children (Ng, Marshall et al. 2006; Downs, Marshall et al. 2008). In addition, literature has shown that Native adults also maintained much of their traditional subsistence patterns including intense physical activity in extreme conditions (Gittelsohn, Wolever et al. 1998).

One explanation for the association between TF intake and lower BMI is possibly that children consuming TF may be more active. Future research should evaluate the relationship between TF use, physical activity and BMI.

In addition, the method of preparation of food was found to be associated in a previous study with an increased risk of diabetes. A positive association was also found between the choice of fat added during the preparation of foods and a twofold risk of higher level of glucose intolerance. In the setting of the study, the cooking method of TF

was also considered as a factor that led to the positive relationship found between TF consumption and obesity. The data highlight the underlying complexities of the inter-relationships observed between TF consumption and adiposity measures and warrant careful consideration of multiple factors in future research.

Furthermore, since the 24-hour recall is a method designed to measure the quantity of the individual foods consumed over a 1 day period, it is limited by the fact that a single day is unlikely to be representative of the usual intake of individuals (Institute of Medicine and Food and Nutrition Board 2005). In view of this limitation, the frequency of consumption of items from the MFFQ was further compared with high and low TF intake.

Moreover, since fruit and vegetable consumption is higher when TF is consumed, the low TF intake associated with low fruit and vegetables consumption may create a twofold concern; since the overall consumption of TFs nutritionally equivalent to the fruit/vegetables group (organs, eggs and wild plants) was rarely mentioned in the recalls, the contribution of those specific foods in the diet is hypothesized to be even lower when TF use is low. These results, along with the lower BMI percentile found among the highest TF consumers, suggest that an increased TF intake would lead to dietary improvement among the Cree youth. This suggestion was supported with a previous study where Dene/Métis and Yukon children had higher intakes of meat/alternatives and grains when TF was not consumed (Nakano, Fediuk et al. 2005). Although fruit and vegetables were not found to be associated with TF intake, overall, when children consumed TF, less market meat, fat meat and grains were also consumed. Thus, the replacement of energy from TF resulted in general in less nutrient dense diets.

However, the association of higher TF consumption with fat, oil and snacks intake (p values ≤ 0.05) was unexpected. It concurs with the findings among Arctic Indigenous People, where days without TF had significantly higher percentage of energy intake (Kuhnlein, Receveur et al. 2004). The positive association between high consumption of TFs and snacks from the MFFQ is surprising, but explainable. Since nowadays fewer people go hunting, the consumption of TFs is infrequent and has been further associated

to a social mechanism; TFs are mostly consumed at community feasts, which occur frequently throughout the year and were a wide variety of other foods rich in fat are served (Gittelsohn, Wolever et al. 1998).

A possible interpretation of the results is that youth consuming TF more frequently may also be more active; those youth consuming TFs at least once a week, are most probably consuming those foods at home. Therefore, they most likely come from families who still go fishing or hunting and have kept a part of a traditional lifestyle. In addition, the traditional diet of Cree was based mainly on hunting and fishing, which requires more physical activity (Gittelsohn, Wolever et al. 1998) and more time spent out on the land (Kuhnlein and Receveur 1996).

6. CONCLUSION

6.1 6.1 Summary of the results

In summary, the Nituuchischaayihitaa Aschii project described dietary habits of Cree youth, including TF and MF use, and the prevalence of adiposity. We were able to identify main food groups and patterns in eating behaviors among the Cree youth residing in 3 different communities in northern Quebec. Around two thirds of the Cree youth were found to suffer from excess body weight as a result of dietary and lifestyle transitions that are also having an impact on Indigenous Peoples throughout the world. While our data show that overweight youth underestimated their energy intake, there is no evidence that under-reporting affected any specific food category. The study indicates a high degree of intake of energy dense food items, which are also rich in sugar and fat, among youth. All youth, regardless of sex and age, consumed higher total energy, fat and saturated fat intake than current recommendations. Furthermore, the low fruit and vegetable intake along with low milk and milk products and low TF consumption raises concerns about insufficient nutrient intake among the Cree. However, direct quantification of nutrient intakes was beyond the scope of the thesis.

Finally, weekly intake of TF was found to be associated with lower BMI percentiles and higher fruit and vegetable intake. Paradoxically, TF use was also associated with higher reported intake of snacks, oil and fat; perhaps indicating that youth consuming TF on a weekly basis are more active than youth consuming TF on a more infrequent basis.

6.2 Significance and limitations of current findings, and future research

First and foremost, this study was one of the first multi-community projects to describe dietary habits of Cree youth and to relate dietary behaviors, including TF and MF use to adiposity. In addition, the setting of the study, the food frequency method, in combination with the 24-hour recalls provides a combined means of determining usual intake of the Cree. It is also important to note that the accuracy in estimating energy intake was tested among the youth to check for plausible and implausible reporters of EI. Moreover, although some studies were limited to self-reported data, anthropometrics in the current study were measured by nurses in a clinic. Furthermore, it is important to

highlight that this survey was successfully conducted with partnership of the communities and the contribution of Cree interviewers and recruiters selected from each community who helped in the data collection. Finally, it is hoped that the project will build awareness and capacity to effectively deal with the obesity epidemic in Cree communities, in addition to being of value to other communities afflicted by “globesity”. In particular, descriptive data on diet quality among youth collected in high-risk Cree communities will help guide intervention and health promotion campaigns specific to Cree needs. Furthermore, the assessments will potentially serve as baseline data for future evaluation of health promotion campaigns.

On the other hand it is important to underline the limitations of the current study in order to make recommendations for future work. Primarily, the cross-sectional design of this study makes it impossible to draw any conclusion regarding cause or effect relationships. Clearly, further research of a longitudinal design is required, with this study serving as baseline information. Furthermore, the CANDAT database, used to estimate the average daily macronutrient composition of the diet of study participant, is incomplete for sugar and saturated fat intake. Therefore, the results for intake of these two items are likely underreported. This limitation combined with underreporting likely means that participants may be consuming much higher intakes of sugar and saturated fat. In addition, while some demographic characteristics of the youth were available it is hoped that future research will include more information about the participant’s parents (mother and father’s BMI, education, level of schooling and income). In addition it is suggested that some future work could study more in depth the participants eating patterns by using repeated recalls and diet history to measure nutritional intake. As well, using a longitudinal design might help to see the emerging obesity by comparing people’s BMI over time. Finally, future research will benefit from assessments of physical activity along with dietary habits. Pedometers are now included in the surveys being conducted in the remaining Cree communities which will provide opportunities for an improved assessment of the context of emerging obesity among Cree youth.

6.3 Recommendations for community

Developing interactive ways to improve food knowledge and healthy food choices and simultaneously promoting Cree culture will provide a powerful strategy for promoting the health of future generations of Cree.

In particular, recommendations include:

- Promotion of TF use and the many activities associated with TF harvests
- Approaches to reduce the intake of energy dense and nutrient poor food should be combined with strategies to improve access to better quality MF. At the same time, programs should be developed, so that food lower in fat, sugar and energy would be available and easily accessible in the communities' stores and schools. In addition measures to limit marketing of fast food to Youth should be implemented.
- Along with youth education, programs about TF protection should be implemented within the communities, since it is a critical point for TF accessibility.
- Youth should be encouraged to increase intakes of fruit and vegetables as well as low-fat milk and milk products.
- Replacing fruit juices and high sugar beverages by water and the consumption of raw fruit and vegetables could be an effective strategy for improving nutrient quality and reducing excess energy intake.
- Increasing physical activity should be promoted and accessibility of enjoyable physical activities at school should be emphasized. (MacMillan, MacMillan et al. 1996)

Table1. Summary of demographic characteristics¹ by gender and age, Cree youth of 3 communities.

	Age group				Gender					
	9-13 (n = 68)		14-18 (n=57)		Girls(n=64)		Boys (n=61)		Total (n=125)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Height (cm)	155.6	(10.7)	170.8**	(6.8)	159.3	(9.6)	165.9*	(13.1)	162.5	(11.9)
Weight (kg)	60.4	(20.2)	79.4**	(20.1)	67.5	(23.1)	70.5	(21.4)	68.9	(22.2)
BMI percentiles	84.6	(20.9)	82.0	(20.9)	83.9	(20.5)	83.0	(21.4)	83.4	(20.9)
WC percentile	87.9	(17.3)	81.3	(21.7)	87.6	(16.6)	82.0	(22.2)	84.9	(19.6)
Body fat percentile	81.7	(30.6)	83.5	(25.7)	94.6	(28.0)	84.2**	(38.8)	82.5	(28.4)
% at risk of overweight	67.6		57.9		60.9		65.6		63.2	
% overweight	45.6		61.4		54.7		39.3		47.2	
% at risk for WC	83.8		79.0		84.4		78.7		81.6	

¹Data are shown as mean and St Dev or %

*p < 0.05, t-test

** p < 0.01, t-test

Table2. Past day macronutrient and high sugar and high fat food intake by age group and gender, Cree youth of 3 communities

	Age category				Gender				Total	
	9-13 (n=68)		14-18 (n=57)		Girls (n=64)		Boys (n=61)		(n=125)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Energy (kcalories)	2208.6	(933.0)	2223.2	(1103.8)	1995	(824.9)	2446.8*	(1135.1)	2215.2	(1010.3)
% protein	15.1	(7.1)	15.7	(7.1)	14.0	(5.6)	16.9*	(8.1)	15.4	(7.1)
% carbohydrates	51.6	(12.4)	48.3	(14.8)	52.4	(12.9)	47.6*	(14.0)	50.1	(13.6)
% fat	33.9	(9.7)	36.7	(10.7)	34.2	(9.9)	36.3	(10.5)	35.2	(10.2)
% saturated fat	11.7	(5.2)	11.7	(5.1)	11.8	(5.2)	11.7	(5.0)	11.7	(5.1)
% sugar	16.8	(11.9)	13.8	(11.4)	16.0	(11.5)	14.8	(12.0)	14.4	(11.7)
% saturated fat >10%	57.3		61.4		56.2		62.3		59.2	
% consumed HSF	95.6		89.5		95.3		90.2		92.8	
% E from HSF among consumers.	13.7		11.7		13.7		11.9		12.8	
% consumed HFF	98.5		94.7		96.9		96.7		96.8	
% E from HFF among consumers.	38.8		40.1		39.9		38.7		39.3	

¹Data are shown as mean and St Dev or %

* p < 0.05, t-test ** p < 0.01, t-test

E = energy

HSF = High Sugar Foods

HFF = High Fat Foods

% protein, carbohydrates, fat, sat fat, sugar = % of Energy from those nutrients.

Table 3. Prevalence and percentage energy in the past day from high sugar (>25% total sugars) and high fat (>40 % total fat) food by type of food, age and gender, Cree youth 3 communities.

	Age		Gender		Total
	9-13(n=68)	14-18(n=57)	Girls(n=64)	Boys(n=61)	(n=125)
	%	%	%	%	%
% consuming high sugar food groups #					
Baked goods and cereals	48.5	31.6*	40.6	41.0	40.8
Dressings/sauces/spread	29.4	38.6	26.6	41.0	33.6
High sugar drinks including soft drinks	66.2	57.9	62.5	62.3	62.4
Snack foods	32.3	38.6	40.6	29.5	35.2
% of energy by group					
Baked goods and cereals	20.7	20.7	20.9	19.2	20.1
Dressings/sauces/spreads	4.7	7.1	6.1	4.7	5.3
High sugar drinks including soft drinks	16.7	12.3	14.6	5.1	14.8
Snack foods	14.9	11.5	12.3	11.2	11.8
% consuming high fat food groups #					
Baked goods	9.6	7.02*	17.2	8.2	12.8
fast/mixed foods	22.1	29.8	25.0	26.3	25.6
meat/fish	42.6	49.1	45.3	45.9	45.6
snack foods	44.1	31.6	40.6	36.1	38.4
% of energy by group					
baked goods	12.2	14.9	12.8	12.9	12.8
fast/mixed foods	26.0	29.7	31.3	24.7	28.0
meat/fish	21.2	14.8	15.6	20.6	18.1
snack foods	17.6	17.0	17.7	17.1	17.4

Data are analyzed by Wilcoxon Signed Rank test for non parametric variable

Data are analyzed by X²test

*p ≤ 0.05, ** p ≤ 0.01

Table 4. Food group daily servings relative to Canada's Food Guide To Healthy Eating for First Nations, Inuit and Métis people, Cree youth, 3 communities.

	Age category							
	Children 9-13				Adolescents 14-18			
	Boys n = 30		Girls n = 38		Boys n =31		Girls n = 26	
	Mean (SD)	Rec.	Mean (SD)	Rec.	Mean (SD)	Rec.	Mean (SD)	Rec.
Vegetables and fruit	2.95 (3.17)	5-6	2.65 (2.81)	5-6	4.65 (4.51)	7-10	2.67 (2.86)	7-8
Grain	5.77(3.08)	4-6	5.39 (3.25)	4-6	6.14 (4.46)	7-8	4.36 (2.39)	6-7
Milk products	1.31 (1.40)	2-4	1.83 (2.72)	2-4	1.63 (2.07)	3-4	1.05 (0.84)	3-4
Meat and alternatives	3.22 (2.59)	1-2	2.24 (2.43)	1-2	3.57 (3.15)	3	2.18 (2.19)	2

Rec. = Recommended number of servings from Canada's Food Guide to Healthy Eating for First Nations, Inuit and Métis.
Health Canada (2007). «Revision of Canada's Food Guide: Development of Food Intake Patterns."

Table5. Percent of youth consuming each traditional food item in the past year and frequency of consumption among consumers (days/month).

			Youth		
Food	%cons.	(days/ month)	Food	%cons.	(days/ month)
- Meats			Sturgeon	11.2	(0.22)
Moose meat cooked	84	(2.24)	Whitefish	9.6	(0.69)
Caribou meat cooked	56.8	(1.68)	Red or white sucker	9.6	(1.27)
Beaver meat	52.8	(0.80)	- Fowls		
Rabbit Meat	52	(0.82)	Geese	97.6	(1.72)
Bear meat cooked	44	(0.45)	Ptarmigan, partridge and other birds	63.2	(1.27)
Speckled trout	29.6	(1.09)	Goose gizzard	26.4	(1.57)
Smoked game animal	13.6	(0.52)	Dapplers	24.8	(0.77)
Moose liver or kidney	13.6	(0.47)	Sea ducks	12	(0.80)
- Fish			- Other TF		
Walleye	42.4	(1.08)	Wild berries	57.6	(1.37)
Pike	28.8	(0.82)	Wild berry jam	55.2	(1.27)
Smoked wild fish	24.8	(0.67)	Goose grease	48.8	(1.22)
Lake trout	23.2	(0.87)	Bear grease	15.2	(0.74)

Foods included in the table are the ones with greater than 9 individuals consuming them in the past year.

%cons = % of youth consuming each traditional food item in the past year.

Table6. Times per week participants have reported eating meats, fish or any traditional food from the FFQ, Cree youth 3 communities (n=125)

	Percent					
	0-0.5	0.5-1	1-2	2-3	3-4	more than 4
Meats	65.6%	12.0%	10.4%	2.4%	3.2%	6.4%
Any TF	25.0%	21.0%	22.6%	10.5%	3.2%	17.7%
Fish	83.2%	7.2%	4.0%	0.8%	1.6%	3.2%
Meat and Fowl	33.1%	25.0%	21.0%	7.3%	1.6%	12.1%

Data are shown as frequency of consumption of items per week and percent of individuals consuming food groups.

TF = Traditional Food

Table7. Diet quality indicators by weekly (≥ 1 per week) and infrequent traditional food intake groups (< 1 per week), Cree youth 3 communities

	TF intake			
	Infrequent		Weekly	
	Mean (SD) n=58	(SD)	Mean n=67	SD
- 24 hour recall				
kcalories	2172.3	(1064.4)	2252.4	(967.5)
% protein	15.0	(6.4)	15.8	(7.6)
% carbohydrates	48.7	(13.1)	51.3	(14.1)
% fat	36.6	(11.0)	34.0	(9.4)
% saturated fat	12.6	(5.1)	10.9	(5.0)
% sugar	17.1	(12.0)	14.1	(11.4)
- Anthropometric measures				
waist circumference percentile	87.3	(16.6)	82.8	(21.8)
body fat percentile	85.3	(12.4)	80.0	(31.4)
BMI percentiles	87.3	(14.8)	80.1*	(24.6)
- MFFQ				
Fruits and vegetables	9.1		12.1*	
Sweets	3.0		4.4	
Snacks fries, chips	6.2		7.5	
High sugar beverages	15.5		17.7	
Fats and oil	7.2		9.5*	
Snack incl. fats and oil	13.4		17.1*	
Regular soft drinks	2.3		3.9	
Fruit drinks	3.4		4.6	
Real fruit juices	7.1		6.9	

* $p \leq 0.05$ t-test or Wilcoxon Signed Ranked test²

** $p \leq 0.01$ t-test or Wilcoxon Signed Ranked test²

% protein, carbohydrates, fat, sat fat, sugar = % of Energy from those nutrients (Borruud L et al., 1997)

MFFQ = Marcket Food Frequency Questionnaire

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8. APPENDIXES

APPENDIX 1

Market Food Frequency Questionnaire

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*Let's learn about our land
Let's learn about ourselves*

This questionnaire is to be administered to persons aged 9 years or more

0. Start time

HH:MM

How often did you eat these foods in last 30 days?		
Fruits	Last 30 days	
	Frequency	D-W-M
1. Fresh fruit (apples, pears, bananas, berries, grapes, oranges, grapefruit)		
2. Canned fruit		
3. Dried fruit (raisins, dates, apricots, etc.)		
Vegetables		
4. Potatoes (instant or homemade mashed, boiled, baked – not fried)		
5. Carrots, peas or corn		
6. Salad or coleslaw		
7. Tomatoes (fresh, canned, sauce)		
Sweets		
21. Cakes, snack cakes, boudin cake, donuts, pies, pastries		
22. Cookies		
Miscellaneous		
42. Chips, crisps, cheese puffs		
43. Nacho chips with melted cheese		
44. Microwave Popcorn What is your usual choice? (select one): 1 ☐ Regular 2 ☐ Light or Low fat		
47. Poutine		
48. French fries, fried potatoes or hash browns		
49. Deep fried snacks (onion rings, cheese sticks, etc.)		

How often did you drink these beverages in last 30 days?		
Beverages	Last 30 days	
	Frequency	D-W-M
25. Soft drinks What is your usual choice? (select one): 1 ☐ Regular 2 ☐ Diet		
26. Ice tea What is your usual choice? (select one): 1 ☐ Regular 2 ☐ Diet		
27. Fruit drinks or Sports drinks (Tang, punch, Kool-Aid, Sunny D, Gatorade)		
28. Real fruit juice (100% pure, bottled or frozen)		
29. Milk What is your usual choice? (select one): 1 ☐ Whole 2 ☐ 2%, “Grand Pré” 3 ☐ 1% 4 ☐ Skim		
30. Chocolate milk		
32. Beer What is your usual choice? (select one): 1 ☐ Regular 2 ☐ Light		
33. Wine		
34. Alcohol What is your usual choice? (select one): 1 ☐ Mixed with juice or pop 2 ☐ Shooters or on ice		

How often did you use the following fats and oil (by adding them to your foods OR in your cooking and baking)?

Fats and oil	Last 30 days	
	Frequency	D-W-M
50. Butter		
51. Margarine		
52. Lard or shortening		
53. Vegetable oil		

Thank you for your collaboration!

The interview was held in:

- 1 ☐ English
- 2 ☐ Cree
- 3 ☐ Both English and Cree

Name of interviewer

Date of interview

YYYY MM DD

End time

HH MM

End of Market Food Frequency questionnaire

Traditional Food Frequency

Questionnaire



Dates for Seasons	
Fall	September 21 to December 20
Winter	December 21 to March 20
Spring	March 21 to June 20
Summer	June 21 to today

Codes for Frequency	
D	Day
W	Week
M	Month
S	Season

This questionnaire is to be asked to persons aged 9 years old or more

0. Start time

|_|_|:|_|_|
HH MM

In the past 12 months, did you eat any of the following Animals? If yes, how often did you eat these Animals for each of the following seasons?

Animals	Eaten		Fall		Winter		Spring		Summer	
	Yes	No	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S
1. Bear meat, <u>dried</u>	☐	☐								
2. Bear meat, <u>cooked</u>	☐	☐								
3. Bear <u>liver or kidney</u>	☐	☐								
4. Moose meat, <u>dried</u>	☐	☐								
5. Moose meat, <u>cooked</u>	☐	☐								
6. Moose <u>liver or kidney</u>	☐	☐								
7. Caribou meat, <u>dried</u>	☐	☐								
8. Caribou meat, <u>cooked</u>	☐	☐								
9. Caribou <u>liver or kidney</u>	☐	☐								

10. Beaver meat	☐	☐								
11. Rabbit meat	☐	☐								
12. Smoked game animal meat	☐	☐								
Any other <u>Game</u> Animals that you ate in the past 12 months? (specify on line)										
13. _____	☐	☐								
14. _____										
15. _____										
16. _____										

In the past 12 months, did you eat any of the following Fish? If yes, how often did you eat these Fish for each of the following seasons?										
Fish	Eaten		Fall		Winter		Spring		Summer	
	Yes	No	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S
17a. Speckled trout (from	☐	☐								
17b. Speckled trout (from	☐	☐								
18. Walleye	☐	☐								
19a. Whitefish (from fresh	☐	☐								
19b. Whitefish (from	☐	☐								
20. Pike	☐	☐								
21. Lake Trout	☐	☐								

22. Sturgeon	☐	☐								
23. Burbot	☐	☐								
24. Red or White Sucker	☐	☐								
25. Fish from the ocean	☐	☐								
26. Fish eggs	☐	☐								
27. <u>Smoked wild</u> fish	☐	☐								
Any other <u>Wild</u> Fish that you ate in the past 12 months? (specify species on line)										
28. _____	☐	☐								
29. _____										
Did you eat Fish liver? (specify species on line)										
30. _____	☐	☐								
31. _____										

In the past 12 months, did you eat any of the following Birds and Ducks? If yes, how often did you eat these Birds and Ducks for each of the following seasons and what is your usual portion size?										
Birds and Ducks	Eaten		Fall		Winter		Spring		Summer	
	Yes	No	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S
32. Loon or Merganser	☐	☐								
33. Geese (all types, including Brent)	☐	☐								

34. Dabblers (Mallard, American Black duck and Northern Pintail)	☐	☐							
35. Sea Ducks (Golden eye, Old Squaw and Black Scoter)	☐	☐							
36. Other Ducks	☐	☐							
37. Ptarmigan, partridge and other birds	☐	☐							
Did you eat Bird and Duck gizzards in the past 12 months? (specify species on line)									
38. _____	☐	☐							
39. _____									
40. _____									
41. _____									
Did you eat Bird and Duck livers or kidneys? (specify species on line)									
42. _____	☐	☐							
43. _____									
44. _____									
45. _____									

In the past 12 months, did you eat any Wild Berries or Wild Berry Jam? If yes, how often did you eat Wild Berries or Wild Berry Jam for each of the following seasons?

	Eaten		Fall		Winter		Spring		Summer	
	Yes	No	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S
46. Wild berries	☐	☐								
47. Wild berry jam	☐	☐								

In the past 12 months, did you use any of the following Animal Fats for spreading, dipping, baking or frying? If yes, how often did you use these Animal Fats for each of the following seasons?

Animal fats	Eaten		Fall		Winter		Spring		Summer	
	Yes	No	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S	Freq.	D-W-M-S
48. Bear grease	☐	☐								
49. Goose grease	☐	☐								
Did you use other Animal Fats for spreading, dipping, baking or frying? (specify on line)										
50. _____	☐	☐								
51. _____										

52. _____									
53. _____									

Thank you for your participation!

The interview was held in:

- 1 ☐ English
- 2 ☐ Cree
- 3 ☐ Both English and Cree

Name of interviewer

Date of interview

|_|_|_|_|_| |_|_| |_|_|
 YYYY MM DD

End time

|_|_|:|_|_|
HH MM

End of Traditional Food Frequency questionnaire

APPENDIX 3

LISTING OF FOOD

GROUPS IN CATEGORY - "HISUGAR"		
Number	Group Name	Description
1	Baby Foods	
2	Baked Goods	cakes
3	Cereal	
4	Cheese	cottage and some processed cheese
5	Dressing/Sauce/Dip/Spread	including syrups
6	Hi Sugar Drinks	fruit juice, instant coffee with sugar, lemonade, sweetened tea, fruit punch, hot chocolate, smoothie, energy drink, sports drinks
7	Ice cream	milk shakes, ice cream, ice cream desserts, ice cream bars,
8	Junk Food/Candy	chocolate bars and candy, desserts, puddings
9	misc	
10	Snack Foods	granola bars, caramel popcorn,
11	soft drinks	carbonated drinks, soda, cola, ginger-ale, dr-pepper,

Does not include alcoholic drinks, raw fruits and vegetables

APPENDIX 4

LISTING OF FOOD GROUPS IN CATEGORY - "HIFAT"

Group Number	Group name	Description
1	Baby Foods 30-40%	
2	Baby Foods 40-<50%	
3	Baby Foods >50%	
4	Baked Goods 30-40%	custard, biscuits, cakes, muffins, cookies,
5	Baked Goods 40-<50%	doughnuts, pancakes, pies, rolls, waffles,
6	Baked Goods >50%	pastry,
7	Bread and Pasta 30-40%	
8	Bread and Pasta >50%	fried bread, taco shell, Chinese noodles.
9	Cereal 40-50%	
10	Cereal 30-40%	
11	Cereal >50%	
12	Cheese 30-40%	
13	Cheese 40-<50%	
14	Cheese >50%	
15	Cream >50%	Sour, table, whipped, cereal half and half...
16	Dress/sauces/dip/spred 30-40%	
17	Dress/sauces/dip/spread 40-<50%	Gravy, salad dressings, spaghetti sauce, egg sauce, guacamole, butter and cream dressings, margarine, dips...
18	Dress/sauces/dip/spread >50%	
19	Egg 30-40%	
20	Egg 40-50%	egg dried, frozen mixtures, whole eggs...
21	Egg: >50%	
22	Fast foods: 30-40% fat	specific mixed dishes from restaurants,
23	Fast food 40-50% fat	bagel (ham, egg..), breakfast dishes, hamburgers, chicken-cheese-burgers, hot dogs, Mexican nachos, burritos, pizza, sandwiches (submarine, chicken ceaser, roast beef, fish tartar..), french-fries, hashed brown, onion rings, chicken wings, coleslaw, poutine...
24	Fast Foods: >50%	
25	Ice cream: 30-40%	
26	Ice cream: 40-<50%	Ice cream and ice cream deserts, frozen chocolates...
27	Ice cream >50% fat	
28	Junk Food: 30-40%	Frosting, candies, chocolate bars...

29	Junk Food: 40-<50%	
30	Junk Food: >50%	
31	Mixed foods: 30-40% fat	frozen meals, frozen pizza, macaroni and
32	Mixed Foods: 40-<50%	cheese, dehydrated and concentrated
33		soups, mashed potato, pie commercial,
	Mixed Foods: >50%	shepherd's pie, canned chili, meatballs
34	Misc: 30-40% fat	canned, chicken fajitas, hummus,
35	MISC: 40-50% FAT	dumplings...
36	MISC: >50% FAT	Coffee whitener, bread stuffing, vitamins,
37	Milk products: 30-40% fat	vegetable oil...
38	Milk products: 40-<50% fat	
39	Milk products: >50% fat	
40	Nuts: 30-40% fat	
41	Nuts: 40-50% fat	Peanut butter, nuts, seeds...
42	nut: >50% fat	
43	REG MEAT/FISH: 30-40% FAT	
44	REG MEAT/FISH: 40-50% FAT	Beef, chicken, duck, lamb, pork, salmon,
45	reg meat >50% fat	tuna, turkey, veal, bacon...
46	Snack Foods: 30-40% fat	
47	Snack Foods: 40-<50% fat	Granola bars, rice bars, crackers, chips,
48	Snack Foods: >50% fat	popcorn...
49	Soups: 30-40% fat	
50	Soups: 40-50% fat	
51	Soups: >50% fat	
52	TRADITIONAL FOOD: 30-40% FAT	
53	TRADITIONAL FOOD: 40-50% FAT	Bannock, and traditional meats and cuts;
54	Traditional food: >50% fat	goose, moose, wild duck...
55	YOGOURT: 30-40% FAT	
56	Yogurt: >50% fat	

NB does not include vitamin supplements, vegetables, herbs or spices

2. Interview

You and your child will also be asked to respond to questions about your child's lifestyle, health and usual eating habits. You and your child will be asked what your child has eaten in the past day. This part will take about two hours. Later, on another day, some parents and children will be again asked to tell what the child has eaten. The questions related to diet will be administered to children aged 9 years old and over

It's your choice

You can decide whether you want your child to be in this study or not. And even if you agree for your child to be in the study, you can change your mind later if you do not want your child to continue. What you decide will not have any effect on the health care that you or your child receives.

Benefits of the study

If you allow your child to take part in this study, you will be helping the Cree Health Board, and your Chief and Council, to know if contaminants are causing health problems in your community. They will also know more about how healthy children are, and how health care could be improved. Once we have the results of your child's medical tests, we can send them to your local clinic or to a doctor that you choose. You will get a letter telling you if your child's results are normal or not. It will tell you if there are problems that you should discuss with a doctor or nurse. We recommend that you consult your clinic if any of your child's results are abnormal.

If you decide to allow your child to be part of the study, we will give you or your child \$20 to thank you and your child for the time giving up. If your child is one of the people who is asked to do a second interview about diet, you or your child will receive an extra \$10.

Risks of the study

We do not think that being in the study will cause your child any harm. The tests do not hurt. But when your child gives blood samples, he or she might develop a light bruise where the needle goes in. Also, you and your child might feel tired after answering the interview questions.

What will be done with your child's blood, toenails, urine and hair samples

Some of your child's samples will be sent to the laboratory at Chisasibi Hospital and others will be sent to the Quebec National Public Health Institute (INSPQ) in Quebec City. Your child's samples will be tested to find out about heart, contaminants in your child's body, and things in your child's diet that protect his or her health. Together, these results will tell about the state of your child's health. The results will be used in the study. Your child's blood and urine samples will be kept frozen for the Cree Health Board in a -80°C freezer in the laboratory of Dr. Éric Dewailly (CHUQ-CHUL), for 15 years. That way they will still be there later if the Cree Health Board needs to test your child's blood and urine for something new. But no new tests will be done on your child's samples unless you sign a paper agreeing to them.

How we will keep your information private

None of the information that you and your child provide for this study will be made public. Your child's results and samples will be labelled with a number, not your child's name. There will be strict rules about who can see the "Master List" that matches names and study numbers. The Master List will be destroyed at the same time as all samples.

How you can find out about the results of the study

We will prepare reports to tell people in the community what the study found out. These reports will describe the results for the community as a whole. Your child's name will not appear in any report. You can ask to have a copy of the report mailed to you when it is ready.

Who is doing the study:

This study is being done by the Public Health Department of the Cree Health Board. Partners in the study are:

- The Chief and Council of your community and the communities already visited
- the Quebec National Institute of Public Health
- Laval University Hospital (CHUQ-CHUL)
- McMaster University
- McGill University

The money for the study comes from the new Mercury Agreement (2001), which funds the Health Board to make sure that people are protected from mercury and other contaminants. The money is coming through Niskamoon Corporation.

The study has been approved by the Research Ethics Committees of Laval University Hospital (CHUQ-CHUL) and McGill University, and shared with that of McMaster University; as well as by the Research Committee of the Cree Board of Health and Social Services.

For more information:

If you have any questions about the project, you can contact:

Ms. Jill Torrie Permanent Secretary of the Research Committee	Cree Board of Health and Social Services (514) 861-2352 (ext. 231) in Montreal or (514) 953-8283
Ms. Suzanne Côté Field coordinator and nurse	Public Health Research Unit, Laval University (418) 656-4141, ext. 46536 or (418) 563-0113 (Québec City)
Dr. Éric Dewailly Principal researcher	National Quebec Public Health Institute Professor, Laval University (418) 656-4142, ext. 46518 (Québec City)
Professor Evert Nieboer Principal researcher	Professor, McMaster University (905) 525-9140 ext. 22048 (Hamilton)
Dr Grace Egeland Principal researcher	Professor, McGill University (514) 398-8642 (Montreal)

If you have any concerns about your participation, questions or complaints, you can call or write to:

The Cree Nation representative to the Cree Board of Health and Social Services
c/o Office of the Chief of your Cree Nation

or

Ms. Ann-Marie Awashish, Commissioner of Complaints (reporting to the Board of Directors)
Cree Board of Health and Social Services of James Bay
1-(866) 923-2624

Moreover, if you have questions concerning your rights as a subject of research, you can contact the Director of Professional Services of CHUQ-CHUL at the following number; 418 691-5521.

CONSENT FORM TO PARTICIPATE IN NITUUCHISHAAYIHTITAAU ISTCHEE
(8-14 years old)

I have read and understand what is involved in the study. I know that I can choose whether or not to have my child be in the study. I agree to have my children to participate in the Nituuchischaayihitaa: Multi-Community Environment and Health Study in Iiyiyu Istchee.

Yes ☐ No ☐

I would like the Cree Health Board to send my child's results of his/her clinical tests to the local clinic (or to the doctor of my choice) to be placed in his/her file. I and my child will receive a letter telling if the results are normal or not, and if I and my child should talk to a doctor about them.

Yes ☐ No ☐

The doctor of my choice (if other than a doctor at my local clinic) is: Name

Address _____

Other choices (You do not need to agree to any of these to be in the study)

I agree to allow a research nurse to review my child's medical file to find out about my child's health.

Yes ☐ No ☐

I agree that the researchers can contact me for follow-up tests and for other analyses not mentioned above.

Yes ☐ No ☐

I would like to receive a short report of the study's results.

Yes ☐ No ☐

Name of participant Signature Date yy/mm/dd

Name of parent or tutor
For participants under 18 years Signature Date yy/mm/dd

Name of witness Signature Date yy/mm/dd

Name of principal investigator or
his/her designated
representative

Signature

Date yy/mm/dd

APPENDIX 6



McGill

Faculty of Medicine
3655 Promenade Sir William Osler
Montreal, QC H3G 1Y6

Faculté de médecine
3655, Promenade Sir William Osler
Montréal, QC, H3G 1Y6

Fax/Télécopieur: (514) 398-3595

03 April 2007.

Dr. Grace Egeland
School of Dietetics and Human Nutrition
MacDonald Campus
21,111 Lakeshore
Ste-Anne-de-Bellevue QC H9X 3V9

RE: IRB Study Number A06-B23-05A

Dear Dr. Egeland,

Our office has received consent forms for ethics review for the above-referenced study entitled, *Chichaschiinuu: A Multi-Community Environment and Health Study in Iiyiyiu Aschii (Pilot Phase of a Seven-Year Project)*.

The documents were reviewed and full Board approval was provided on April 02, 2007 for the following:

- Modified Information Sheet and Consent Form (0-7 years old): Wemindji, Summer 2007 (dated February 12, 2007);
- Modified Information and Consent Form (8-14 years old): Wemindji, Spring/Summer 2007 (dated February 12, 2007).

Please note: the investigator is responsible for ensuring that all documents approved by this IRB are reported to and meet the standards in effect at the institution where subject recruitment occurs and/or where study data is collected. The investigator must contact the individual Research Ethics Offices in order to fulfil this obligation. The investigator risks having the study's data invalidated and research funds frozen if there is a failure to comply.

Sincerely,

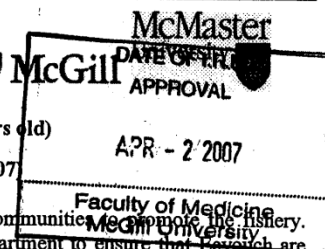
J. Lawrence Hutchison, MD
Co-chair
Institutional Review Board

Cc: A06-B23-05A

**Ninichschanihittani ; Muth Community Environment and Health Study in
Dylyin Aschii**



Conseil Crée de la santé et des services sociaux de la Baie James
Cree Board of Health and Social Services of James Bay



Information Sheet and Consent Form (8-14 years old)

(Wemindji, spring/summer 2007)

The new Mercury Agreement (2001) provides money to the communities to improve the fishery. The Agreement also provides money for the Public Health Department to ensure that Eeyouch are protected from mercury and other contaminants in the environment. This research project has been developed to give the Chief and Council of the Cree Nation of Wemindji and the Public Health Department of the Cree Board of Health and Social Services (referred to as the Cree Health Board (CHB)) more knowledge about environment-and-health issues in Wemindji. This study is being financed by Niskamoon Corporation.

Purpose and who participate:

The study will gather information to understand whether Eeyouch:

- have been exposed to heavy metals, PCBs and other contaminants;
- are healthy;
- and the relationship between health, contaminants and the kind of food people are eating

This study will be conducted in the Cree Nation of Wemindji during summer 2007. All communities will be visited over a 7-year period. Two hundred (200) people in Wemindji, will be invited to participate. Pregnant women will not be invited to do so because they participate in a regular monitoring programme as part of the Maternal and Infant Health Programme.

What your child will be asked to do:

The first part of the study with the nurse will take about 30 minutes. The nurse will

- a. Take a fasting blood sample (about 1 tablespoon).
- b. Measure your child's weight, height, waist and hip circumference, and your sitting height.
- c. Measure how much muscle, fat and water are in your child's body (to do this you stand on a machine that looks like a bathroom scale).
- d. Take your child's blood pressure.
- e. Take a toenail sample to test for arsenic and selenium (a mineral found in the environment).
- f. Take a small hair sample (about the size of a pen) to test for mercury and arsenic.
- g. Ask you and your child some questions about his or her health.

Secondly, during a face-to-face interview of approximately 2 hours, an interviewer will ask you or your child questions about your child's lifestyle, health, and eating habits. You and your child will also be asked to tell what your child have eaten during the past day and some will be invited to make an appointment later to repeat this questionnaire only. The questions related to diet will be administered to children aged 9 years old and over.

What will be done with your child's blood, toenails and hair samples:

Consent form 8-14 years old (spring/summer 2007)		Page 1 of 4
Participant's initials	Witness' initials	



CHUG
CENTRE HOSPITALIER
UNIVERSITAIRE DE QUÉBEC





McGill

Faculty of Medicine
3655 Promenade Sir William Osler
Montreal, QC H3G 1Y6

Faculté de médecine
3655, Promenade Sir William Osler
Montréal, QC, H3G 1Y6

Fax/Télécopieur: (514) 398-3595

12 June 2006.

Dr. Grace Egeland
School of Dietetics and Human Nutrition
Macdonald Campus
21,111 Lakeshore Road
Ste-Anne-de-Bellevue, Quebec H9X 3V9

RE : IRB Study Number A06-B23-05A

Dear Dr. Egeland,

We have received your application for continuing review of the above-referenced study entitled, "Chichaschiinuu: A multi-community environment and health study in liiyiu Aschii (Pilot Phase of a Seven-Year Project)".

The progress report was reviewed and we are pleased to inform you that full board ethics re-approval for the study was provided on **June 12, 2006**. The renewed ethics certificate is valid until **June 11, 2007**. The certification of approval is enclosed.

Please note: a review of all research involving human subjects is required on an annual basis and in accordance with the date the initial ethics approval. If there are any modifications to the study or if any un-anticipated developments occur prior to the next annual review please inform the IRB promptly.

Sincerely,

Celeste Johnston, RN., D.Ed.
Co-Chair
Institutional Review Board

cc: A04-M34-03A

Conseil Cri de la santé et des services sociaux de la Baie James
σ ∩ d 7^a b 7 ∙ Δ f Δ ∙ ◁ Δ^a ◁ a a b f C b σ ∩^u
Cree Board of Health and Social Services of James Bay

CBHSSJB #01/013/04

**SUBJECT: Support for Proposal:
“Exposure and Baseline Health
Assessments of the Iyiyuuch of
Eeyou Istchee in Relation to the
Environmental Impacts of
Mercury and Other
Contaminants”**

**The Board of Directors of the Cree Board
of
Health and Social Services of James Bay
having met in Montreal, Quebec on this
20th day of April 2004.**

**Health and Social Services of James Bay
having met in Montreal, Quebec on this
20th day of April 2004.**

WHEREAS the Mercury Agreement will disperse \$22 million to promote Eeyou fisheries which may expose Iyiyuuch to higher levels of mercury;

WHEREAS this gives the Cree Board of Health and Social Services of James Bay additional responsibilities for health research and surveillance as a result of this;

WHEREAS the Eeyou Nemess Corporation disperse a large fund dedicated to assist the Cree Board of Health and Social Services of James Bay carry out these additional responsibilities for health and environmental studies and surveillance;

WHEREAS the Public Health Department and McMaster University carried out a consultation with each of the communities to determine the environmental-health concerns and the interest of the communities in a Ouje-Bougoumou type of study;

WHEREAS the above partners have developed a comprehensive proposal for establishing a baseline study of mercury and other contaminants and general health status;

WHEREAS this project also proposes to partner with “Atlantis” - a complete mobile laboratory of the National Institute of Public Health of Quebec- so that communities can become involved in seeing how testing is done and in having the opportunity to carry out their own environmental testing with immediate results;

ACTION:
Carried unanimously

BE IT RESOLVED:

THAT the Board of Directors strongly supports this initiative and strongly recommends it to the Eeyou Nameess Corporation to assure its financing so that the first community can be visited this summer;

THAT the Research Committee ensures that the study receives all of the necessary ethical approvals and agreements and is carried out to the highest standards.

**Certified copy of resolution
adopted on:**

Corporate Secretary

APPENDIX 8

COUNCIL OF THE CREE NATION OF MISTISSINI
ISAAC SHECAPIO SR. ADMINISTRATION BUILDING
187 MAIN STREET, MISTISSINI (QUÉBEC) GOW 1C0



TEL.: (418) 923-3461 / FAX: (418) 923-3111
E-Mail: legislative@nation.mistissini.qc.ca
administration@nation.mistissini.qc.ca

January 25, 2005



Dr. Yv Bonnier Viger
Physician, Special in Community Health
Public Health Administration of the James
Bay Cree Territory
Cree Board of Health and Social Services of
James Bay
BP 1086, Chisasibi, Qc J0M 1E0

Dear Dr. Viger:

Enclosed, you will find a copy of resolution no. 2005-12A pertaining to the
*"Approval of the Environment Health Contaminants Program: Chichaschiinuu
Multi-Community Environment and Health Longitudinal Study in Iiyiyiu Aschii"*
duly approved and adopted by the Council of the Cree Nation of Mistissini on
January 24, 2005.

I trust this is to your satisfaction.

Sincerely yours,

Nellie Petawabano
Band/Corporate Secretary

Cc: Council of the Cree Nation of Mistissini

Encls.



RES. NO. CCNM **2005-12A**

PROPOSED BY:

Kathleen J. Wootton

SECONDED BY:

Alfred Coonishish

ACTION:

Carried

SUBJECT: **APPROVAL OF THE ENVIRONMENT
HEALTH CONTAMINANTS PROGRAM:
CHICHASCHIINUU MULTI-COMMUNITY
ENVIRONMENT AND HEALTH
LONGITUDINAL STUDY IN IYIYIIU
ASCHII**

WHEREAS, the Environment Health Contaminants Program: Chichaschinuu Multi-Community Environment and Health Longitudinal Study Iiyiliu Aschii of the CBHSSJB has been presented to the Council of the Cree Nation of Mistissini on January 24, 2005;

WHEREAS, the Council of the Cree Nation of Mistissini considers that this program and, in particular the Chichaschinuu project may have a positive impact on the community.

BE IT RESOLVED:

THAT, the Council of the Cree Nation of Mistissini supports the project proposal to be submitted to Niskamoon Corporation for funding;

THAT, the Council of the Cree Nation of Mistissini provides a suitable land for the temporary installation of the Atlantis laboratory;

THAT, the Management of the Council of the Cree Nation of Mistissini is to designate one person within the administration to ensure harmonious link and communications between the project, the Council, the administration and the community;

THAT, the Director General is hereby mandated to do all things deemed necessary to give effect to the foregoing.

Certified copy of a
resolution adopted on

January 24, 2005


Nellie Petawabano
Band/Corporate Secretary

APPENDIX 9

July 15, 2008

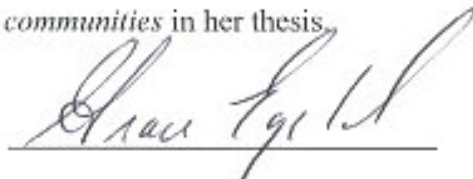
To whom it may concern:

The purpose of the present letter is to confirm that the co-author (Grace Egeland) agrees that the candidate Cynthia Bou Khalil includes the manuscript entitled *Emerging Obesity and Dietary Habits among James Bay Cree Youth: 3 communities* in her thesis.

The candidate's roles in this study included collecting part of the data among Cree Youth residing in Northern Quebec, supervising the nutritional interviews, entering the data and conducting the analysis. The candidate wrote the manuscript under the guidance of the co-author and made modifications to it in response to her comments.

Cynthia Bou Khalil

I, the co-author, agree that the candidate, Cynthia Bou Khalil, include the manuscript entitled *Emerging Obesity and Dietary Habits among James Bay Cree Youth: 3 communities* in her thesis.

A handwritten signature in black ink, appearing to read 'Grace Egeland', is written over a horizontal line.

Grace Egeland, Ph.D.