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Assessing dietary intake in a population undergoing a rapid transition in diet and lifestyle: the Arctic Inuit in Nunavut, Canada

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The aims of the present study were to (1) characterise the diets of adult Inuit; (2) highlight foods for a nutritional and lifestyle intervention programme; (3) develop a quantitative FFQ (QFFQ) to evaluate the programme and monitor changes in dietary intake in this population over time. A dietary survey using single 24-h dietary recalls was conducted among Inuit aged between 19 and 87 years in two communities in Nunavut, Canada. Eighty-seven subjects completed the recalls (response rate was approximately 73 %). The mean energy intake for men and women was 9530 and 6939 kJ, respectively. The intakes of dietary fibre and the majority of vitamins and minerals (especially vitamins A, D, and E, total folate and Ca) were far below the recommendations. Traditional foods contributed 40 and 42 %, respectively, to protein and Fe intakes. Non-nutrient-dense store-bought foods were consumed much more frequently than the nutrient-dense traditional foods. Foods high in fat and sugar were highlighted, and will be replaced by healthier, more nutrient-dense alternatives to address the dietary inadequacies for the nutritional intervention programme. A 154-item QFFQ was developed and pilot tested in the Arctic Inuit. The present study highlighted foods to be targeted for a nutritional and lifestyle intervention programme not previously undertaken in this population. This QFFQ is culturally appropriate and specific for evaluating the effectiveness of the programme, as well as monitoring nutritional transition in this population.

Dietary assessment: Food and nutrients: Inuit: Nunavut

Inuit are indigenous peoples residing in Arctic regions of Alaska, Greenland and Canada. In Canada, Inuit live in Nunavut and the Northwest Territories, Northern Quebec and Northern Labrador. In the past, Inuit were hunter-gatherers with seasonal patterns of food consumption. Traditional foods, defined as those harvested from the local environment, contributed largely to dietary intake and were vital to nutrition, health and food security. Traditional foods played an important role in social, cultural and economic aspects of Inuit life[1–3].

For the past 50 years, indigenous people worldwide have been in the process of changing from a traditional diet to one centred primarily on manufactured and imported foods[4,5]. Although locally harvested foods (mainly protein based such as fish, caribou and marine mammals) are still highly valued among aboriginal peoples for maintaining health and cultural identity, foods imported into the Arctic have replaced some traditional foods in the diet[3,6–9]. Sweetened beverages and chips contribute significant calories in all age groups[10,11]. There is a great concern that this rapid dietary shift will have a significant impact on the nutritional and health status of Inuit and lead to an increasing prevalence of CVD, cancer and diabetes[4,5,12–15].

In Nunavut, an Inuit self-governed territory of northern Canada, 28 % of the population is overweight and 20 % obese[8,16]. Nearly, 60 % of adult Nunavut residents reported that they were physically inactive[16]. Although there are a variety of risk factors for obesity and diabetes mellitus among Inuit[9,17], dietary change plays an important role, and there is an urgent need for a nutritional intervention programme to prevent these diseases[18,19]. In the Canadian Arctic, Inuit communities are isolated with most foods coming from one or two grocery stores or through hunting or fishing. The complete lack of roads makes the communities accessible only by air. The majority of foods arrive on a barge once a year during a short window of time when the ice melt permits this access. The grocery stores are, therefore, an essential focal point for a nutritional intervention, as they govern food availability and cost. Programmes in grocery stores have the potential to impact point-of-purchase decision making regarding household food choices[20].

Abbreviation: QFFQ, quantitative FFQ.

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The Government of Nunavut's Department of Health and Social Services (DHSS) has long recognised the need for a nutritional intervention programme to improve dietary intake and reduce the risk of chronic disease; however, little information is available on the current Inuit diet in terms of food, nutrient and food group intakes. Without accurate knowledge of dietary intake, it is difficult to determine which foods and nutrients should be targeted by an intervention programme. Furthermore, any intervention programme developed would need to be evaluated for its effectiveness.

Evaluating a nutritional intervention aimed at improving dietary adequacy requires a comprehensive dietary instrument specifically developed for the population at risk. Quantitative FFQ (QFFQ) have advantages over other dietary assessment methods, such as short-term recalls and dietary records, because they are relatively inexpensive and can measure long-term dietary intake, especially for large population samples[21–23]. QFFQ also allow researchers to track dietary changes over time in a population, such as Inuit, who are undergoing a rapid transition in diet and lifestyle. To the best of our knowledge, no such detailed, population-specific dietary instrument has been developed for Inuit adults, particularly where individual portion size is assessed for all foods consumed (i.e. both traditional and store-bought).

The aims of the present study were to (1) characterise the diets of adult Inuit in Nunavut; (2) highlight foods and nutrients to target for the nutritional intervention programme; (3) develop a QFFQ that would evaluate the programme and monitor nutritional transition over time. Working with DHSS, grocery stores, and based on the input of community focus groups, the research team sought to identify alternative healthier foods that the stores could stock, that were acceptable to the community and that the DHSS programmes could promote long term in a sustainable nutritional intervention to reduce risk of chronic disease and to improve dietary adequacy.

Materials and methods

Setting

The study took place in two communities in Nunavut. *Nunavut*, meaning 'our land' in the Inuktitut language, is one of the three territories in northern Canada. It spans two million square kilometres of land and has twenty-seven communities with populations ranging from 180 to 6000. Nunavut has the youngest population in Canada, with a median age of 22 years; 53 % of the population is under 24 years old. Approximately 85 % of the population in Nunavut is Inuit[24]. Nunavut is located above the tree line with little or no plant-based foods occurring in the wild for most of the year. Therefore, the majority of foods are either harvested wildlife or marine life, or store-bought foods that have been carried in by air or barge.

Community 1. Community 1 has a population of 1500 and is a regional administrative centre of the government of Nunavut[24]. This community has two grocery stores (the Northern Store and the Arctic Co-op), a 'quick stop' that offers takeout foods and one restaurant in the local hotel. A meat-processing plant is located in the community, which processes musk ox and fish products for local purchase and export to southern markets. The rate of unemployment in community 1 is 10 %[24].

Community 2. Community 2 has a population of 800[24]. It also has a Northern Store and an Arctic Co-op store. The rate of unemployment in community 2 is high, at 30 %[24]. The main employers are the Government of Nunavut, the Hamlet of community 2 and the grocery stores.

These two communities were selected because they represent a larger regional administrative centre and a smaller, more traditional community that relies on traditional foods.

Respondent selection for 24-h dietary recalls

Respondents who were Inuit, aged 19 years and over, and who had lived in the community for at least 6 months were eligible for the dietary recalls. Pregnant and breastfeeding women were excluded.

Using housing maps, the communities were divided into five zones: North; South; East; West; Central areas. This stratification ensured that those closest to the land, to the sea and to the grocery stores were included. Within each zone, houses were chosen randomly. Both the communities cover a very small area, and the houses are all relatively close together (within a 0·5 square mile).

The interviewers visited houses that they had preselected from the maps. Interviews were immediately conducted if the respondents agreed. Otherwise, an appointment was set up to visit the respondents at a later date. If the respondents refused to be interviewed, the next closest house was selected. Before starting the interview, the interviewers explained the project in detail and obtained written consent. If a respondent was unavailable (after up to five contact attempts at different times of the day and on at least two different days of the week), the next person on the list was contacted. If a potential participant had died or had moved out of the community, the household next door was selected. To obtain the maximum diversity in diet within the community, only one person per household was selected, as it is likely that people within a household eat similar foods. An attempt was made to stratify the sample based on age and sex to ensure that the respondents represent all those who reside in the communities. Men and women were selected from each age decade.

24-h Dietary recall collection

Two interviewers who had been trained by the first author (S. S.) for 1 week collected 24-h dietary recall data with at least one observed practice session, including complete 24-h recall on a community member. A standard manual of procedures was developed and strictly followed by the interviewers.

A single 24-h dietary recall was collected for each participant. The interviewers systematically sought and recorded information about foods and beverages consumed during the preceding 24-h period. The time of consumption and the type of food or drink consumed, such as meat type or brand name, were recorded on the recall form, as well as the source of foods or beverages and any additions such as lard on dried meat, butter on bread or sugar in tea and coffee. A range of three-dimensional food models[25] was carefully selected with the help of local staff, which represented

different portion sizes of commonly consumed foods, particularly for meat. In addition, bowls, cups, plates and other household utensils familiar to the population were obtained. Packets of store-bought foods were also obtained, such as potato chips and chocolate bars, so the participants could more easily relate their portion to those routinely available in the local stores. The participants were free to report multiple servings, or proportions of servings such as half of each model, household utensil or standard unit, such as a slice of bread. Models were also made to represent local foods, where no such model was available commercially. An additional list of questions was included to prompt for easily forgotten foods, such as dried meats, fats, sweets and snacks.

All interviews in community 1 were conducted in English except for a few with older respondents who only spoke their native language; in these situations, a local translator was used. In community 2, almost all interviews were conducted in the local language (Inuktitut), although the interviewer, who was bilingual, recorded in English.

The interviewers collected 24-h recalls on different days of the week and the weekend.

Portion weights. To derive weights from portion sizes that respondents reported consuming in the 24-h recalls, a trained local project coordinator weighed portions for all reported foods. For example, ten pieces of raw caribou (as consumed) were weighed, and an average weight was calculated. Weights were also obtained for all household units for each food item recorded, such as taking the average of ten pot spoons of caribou stew. All food weights were obtained using electronic Salter Aquatronic kitchen scales[26].

Data analyses

The recalls were coded, entered and analysed using Nutribase Clinical Nutrition Manager v. 5.18[27]. Nutribase Clinical is a computerised dietary database and analysis program that has a research quality nutrient database analysing 121 nutrients, using nutrient data from the Canadian food composition tables. To determine the major food sources of energy and select macro- and micronutrients, and to highlight which foods to be targeted by a nutritional intervention programme, the percentage contribution for similar foods was combined, such as different types of soft drinks and chips. Statistical Analysis Systems (SAS Institute, Cary, NC, USA)[28] was used for descriptive statistical analysis of the dietary intake and manipulation of the data.

Development of the draft quantitative FFQ

Foods and drink items reported in the 24-h recalls were tabulated, and any item (including both store-bought and traditional foods) that was consumed more than once by any respondent was included in the draft QFFQ, except for foods very low in energy and nutrients, such as condiments and spices.

Foods and/or drink items that were not reported, but that would be promoted as part of the intervention, such as low fat spreads and low sugar drinks, were added to the draft QFFQ to track changes in consumption pre- and post-intervention. For example, to reduce fat consumption, baked chips may be recommended to replace fried chips, so these were added to the draft QFFQ. Additional fruits and vegetables that may be targeted for promotion were also included, even though these foods were not reported in the recalls. To determine whether foods had been forgotten because of seasonality, particularly traditional foods, we included blank lines under each food group on the draft QFFQ, where participants could list other foods and/or beverages that they had consumed during the previous 12 months.

Similar foods (e.g. different kinds of cookies) were grouped together under one 'cookie' category, and all foods were listed under the appropriate category, such as breads, cereals, fruits, vegetables, and dairy. The food categories were ordered according to the culture and dietary habits of this population based on the advice and input of the Inuit staff (A. B.) and advisors.

To assess the portion size, three-dimensional food models, locally appropriate household utensils (e.g. bowls and mugs) and standard units (e.g. teaspoon and can) were assigned for each line item listed on the QFFQ based on the portion size information reported in the 24-h recalls and discussion with local Inuit staff and advisors.

A manual of procedures was developed for the administration of the draft QFFQ, and all the staff were trained and certified.

Pilot testing and refining the draft quantitative FFQ. The draft QFFQ was pilot tested and interviewer-administered in twenty randomly selected subjects in each community, 3 months after collecting the initial dietary recalls. A focus group discussion was undertaken with local staff and residents to list all traditional foods such as birds, sea mammals, eggs, berries and meats that may be consumed at any time during the year. All these traditional foods were included on the draft QFFQ and were asked about during the pilot study to help participants remember foods consumed in other seasons. Food models were refined with the input of Inuit staff.

The QFFQ is culturally appropriate, as input from local Inuit was included in all aspects of QFFQ development such as: (1) inclusions of traditional foods and the order of the animals consumed; (2) selecting appropriate food models to assess amount consumed that best represent the animals, e.g. polar bear meat; (3) ordering of the foods, e.g. including all kinds of caribou together in the QFFQ; (4) having traditional foods listed before store-bought snack items; (5) local terminology for local foods was also used, e.g. muktuk for seal fat.

Institutional review board approval was obtained from the Committee on Human Studies at the University of Hawaii, and the Office of Human Research Ethics at the University of North Carolina at Chapel Hill. The present study was also approved by the Nunavut Research Institute in Nunavut.

Results

In community 1, eight outright refusals were received to take part in the study; in community 2, there were no refusals. In addition, twenty-five individuals were not at home at the time of their scheduled appointment. The response rate overall was approximately 73 %. In total, eighty-seven complete recalls were obtained from forty-seven participants from community 1 and forty people from community 2. The mean age of men and women was 45 and 49 years, respectively. Twenty-six men (62 %) and twenty-seven women (60 %) reported smoking; seventeen men (40 %) and ten women

(22 %) were employed. Four recalls were excluded as outliers, as the energy intakes were above 20 900 (*n* 3) or below 2090 kJ (*n* 1).

Nutrient intake

Table 1 presents the mean and median energy; macro- and micronutrient intakes; the percentage energy provided by total fat, carbohydrate and protein; for comparison, the dietary reference intakes. The percentage of energy provided by total fat and protein is similar for men and women; however, men have a lower percentage of energy provided by carbohydrate than women due to differences in alcohol intake. The percentage of energy provided by protein is high at approximately 21 and 20 % in men and women, respectively. The mean percentage of energy provided by alcohol is 2·2 % for men and zero for women (data not shown).

Mean daily intake of dietary fibre was 9 and 8 g for men and women, respectively, and much lower than the recommended adequate intake (38 g for men and 25 g for women). Low mean daily intakes of vitamin A, vitamin E and total folate were observed in both men and women compared to the RDA. Mean daily intake of vitamin D was much lower than the recommended adequate intake 90 IU for men and 85 IU for women *v.* the recommended 200 IU. Mean daily Ca intake in both men (467 mg) and women (327 mg) was lower than the recommended adequate intake (1000 mg). Inuit women had a lower mean daily intake of Fe, while Inuit men had much higher intake of Fe compared to the RDA, which was attributable to greater consumption of traditional foods (red meat) in men.

The estimated average requirement is the average daily nutrient intake level estimated to meet the requirement of half of the healthy individuals in a particular life stage and sex group. To use these reference values correctly, more than 1 day's intake is recommended. However, to illustrate how low the intakes are, 75–100 % of Inuit men and women (in the age groups of 19–50 years and >50 years old) did not meet the estimated average requirement of the intakes of vitamins A, E, D and total folate and Mg. Up to 35 % of women did not meet the recommendations for Fe and up to 83 % for Zn. For both men and women, up to 67, 33 and

Table 1. Daily energy and nutrient intake in adult Inuit in Nunavut
(Mean values, standard deviations and their median values)

	Men (*n* 39)				Women (*n* 44)			
	Mean	SD	Median	DRI*	Mean	SD	Median	DRI*
Age (years)	45	17	41	–	50	18	50	–
Energy (kJ)	9530	4565	9444	9204†	6939	3268	6359	7533†
Energy from fat (%)	30	11	30	20–35‡	29	9	30	20–35‡
Energy from carbohydrate (%)	47	13	49	45–65‡	51	15	54	45–65‡
Energy from protein (%)	21	9	19	10–35‡	20	11	16	10–35‡
Fat (g)	77	51	66	–	55	34	42	–
Saturated fat (g)	24	15	20	–	18	13	14	–
Protein (g)	105	67	86	–	77	49	67	–
Carbohydrate (g)	271	154	232	–	214	120	204	–
Sugars (g)	142	98	118	<25 % of energy	105	85	81	<25 % of energy
Dietary fibre (g)	9	6	9	38§	8	6	6	25§
Monounsaturated fat (g)	20	16	16	–	13	11	10	–
Polyunsaturated fat (g)	8	6	6	–	6	5	5	–
n-3 Fatty acid (g)	0·6	1·0	0·3	–	0·9	1·4	0·3	–
n-6 Fatty acid (g)	3·3	3·2	2·0	–	3·2	3·3	2·2	–
Cholesterol (mg)	394	331	373	As low as possible	220	214	150	As low as possible
Vitamin A (μg-RE)	217	709	26	900‖	94	201	13	700‖
Vitamin A (IU)	1949	2597	959	–	1569	2,360	464	–
Thiamine (mg)	2·0	1·6	1·4	1·2‖	1·3	1·1	1·2	1·1‖
Riboflavin (mg)	2·9	2·0	2·2	1·3‖	1·8	1·5	1·4	1·1‖
Niacin (mg)	27	20	23	16‖	18	15	15	14‖
Vitamin B_6 (mg)	1·6	1·8	0·9	1·3‖	0·8	0·7	0·6	1·3‖
Vitamin B_{12} (μg)	40	86	17	2·4‖	15	32	2·3	2·4‖
Vitamin C (mg)	136	164	56	90‖	124	190	29	75‖
Vitamin D (IU)	90	160	13	200§¶	85	225	8	200§¶
Vitamin E (mg)**	1·0	1·1	0·7	15‖**	1·2	1·2	0·7	15‖**
Total folate (μg)	200	128	178	400‖	180	126	163	400‖
Ca (mg)	467	339	418	1000§	327	354	206	1000§
Fe (mg)	20	19	14	8‖	12	7	10	18‖
Zn (mg)	10	8	8	11‖	6	6	5	8‖

RE, retinol equivalent[38].
* The recommendation of dietary reference intakes (DRI) is presented in this table using adequate intake (AI) and RDA for men and women aged between 31and 50 years[38].
† Estimated amounts of calories needed to maintain energy balance for men and women aged between 31 and 50 years at the level of very low physical activity–sedentary level[38].
‡ Acceptable macronutrient distribution ranges (AMDR)[38].
§ AI[38].
‖ RDA[38].
¶ As cholecalciferol. In the absence of adequate exposure to sunlight[38].
** As α-tocopherol[38].

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Table 2. Consumption of traditional and most frequently reported foods in adult Inuit in Nunavut (*n* 87)

Traditional foods	Respondents (%)	Most frequently reported foods	Respondents (%)
Caribou	32	Coffee	70
Trout	21	Bread, white	68
Arctic char	14	Sugar or honey	68
Caribou soup or stew	8	Sweetened drinks or juices	67
Polar bear	5	Tea	57
Muktuk	3	Butter or margarine	51
Bearded seal	2	Coffee creamer/Coffee-mate	43
Caribou fat or seal fat	2	Chips	33
Arctic char chowder	1	Soda/soft drinks, regular	29
Trout soup	1	Eggs	23

43 % did not meet the recommendations for thiamine, riboflavin and niacin, respectively, and 91–100 % did not meet the adequate intake level for Ca and dietary fibre (data not shown).

Frequency of consumption of traditional v. *store-bought foods*

The most frequently reported traditional foods were caribou, trout and Arctic char (Table 2). Non-nutrient-dense store-bought foods were consumed much more frequently than the nutrient-dense traditional foods. The most frequently reported food items were all store bought, including coffee, white bread, sugar, juice, tea, butter or margarine, coffee creamer, chips and soft drinks, which were reported by between 29 and 70 % of respondents at least once per day. Mean daily intake of fruits and vegetables was very low (data not shown).

Food sources

Tables 3 and 4 present the ten major food sources of energy, total fat, carbohydrate, sugar, protein, dietary fibre, vitamin A and vitamin C. The greatest contributors to energy were sweetened drinks, sugar added to tea and coffee and soft drinks, which together provided approximately 19 % of total energy intake. The top ten contributors to total energy intake were mostly non-nutrient dense. In relation to total fat intake, sausages and lunch meats, chips, pizza, and butter and margarine contributed 25 % of the total fat in the diet, while traditional foods including seal fat, trout, and caribou meat dishes contributed approximately 14 %. Sweetened juices and drinks, including soft drinks, provided over 30 % of carbohydrates in the local diet. Almost 73 % of sugar intake came from sweetened drinks, sugar itself and soft drinks. The major sources of protein included caribou, pork, trout, Arctic char, pizza, eggs, white bread, seal, polar bear and sausages and lunch meats. Taken together, these foods provided 63 % of the total protein intake. Foods low in fibre but consumed in large amounts contributed the most dietary fibre to the diet, with chips providing 8 %. The major source of vitamin A was seal fat, contributing approximately 35 %; eggs contributed 18 %; vegetables provided approximately 12 %. Approximately 86 % of the vitamin A intake was provided by the top ten foods. Vitamin C was mostly provided by sweetened juices or drinks (82 %). Fig. 1 shows the contribution of traditional foods to energy and selected nutrients, including total fat, saturated fat, protein, vitamin A and Fe.

Development of the quantitative FFQ

The final QFFQ contains 154 items: breads and cereals, 12; meat, fish and poultry, 67; dairy, 13; fruit, 13; vegetables, 20; desserts and snacks, 14; beverages, 12; alcohol, 3. Eight frequency categories were listed on the QFFQ, which range

Table 3. The ten major food sources of energy and selected nutrients in adult Inuit in Nunavut

Foods	Contribution to energy (%)	Foods	Contribution to protein (%)	Foods	Contribution to total fat (%)	Foods	Contribution to carbohydrate (%)
Sweetened juices/ drinks	11·8	Caribou, any kind	18·0	Sausages, lunch meats	7·1	Sweetened juices/ drinks	24·1
Caribou, any kind	5·0	Pork chops/ribs	13·1	Chips	6·9	Sugar	8·4
Bread, white	4·5	Trout, any kind	8·2	Pork chops/ribs	6·9	Bread, white	6·8
Sugar	4·1	Arctic char, any kind	6·9	Butter, margarine	5·6	Soda/soft drinks, regular	6·5
Bannock, fried	4·1	Pizza	3·8	Pizza	5·4	Bannock, fried	5·5
Pizza	3·9	Eggs (chicken)	3·5	Seal fat	5·1	Pizza	3·2
Chips	3·7	Bread, white	2·6	Eggs (chicken)	4·9	Chips	3·1
Soda/soft drinks, regular	2·9	Seal, any kind	2·4	Trout, any kind	3·4	Pilot biscuit	2·3
Trout, any kind	2·6	Polar bear, any kind	2·4	Caribou, any kind	3·3	Cereal, ready-to-eat	2·1
Sausages, lunch meats	2·3	Sausages, lunch meats	2·1	Bannock, fried	3·1	French fries, hash browns	1·9
Total	44·9	Total	63·0	Total	51·7	Total	63·9

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Table 4. The ten major food sources of selected nutrients in adult Inuit in Nunavut

Foods	Contribution to sugar (%)	Foods	Contribution to dietary fibre (%)	Foods	Contribution to vitamin A (%)	Foods	Contribution to vitamin C (%)
Sweetened juices/ drinks	44·1	Chips	8·2	Seal fat	34·9	Sweetened juices/ drinks	82·1
Sugar	16·9	Bread, white	7·4	Eggs (chicken)	18·0	Mixed fruit, fresh or frozen	4·7
Soda/soft drinks, regular	12·4	French fries, hash browns	6·4	Mixed vegetables, canned or frozen	12·4	Stir-fry vegetables and/or meat dishes	1·5
Candies, chocolate (bar)	4·2	Bannock, fried	6·4	Evaporated milk, low fat or non-fat	4·2	Chips	1·0
Fruit salad, canned	2·9	Pizza	5·5	Chicken soup, any kind	3·9	Evaporated milk, low fat or non-fat	0·8
Cereal, ready-to-eat	1·4	Beef and pasta entree	4·3	Milk, skim	3·3	Orange, raw	0·7
Bread, white	1·2	Bread, wheat	4·2	Butter, margarine	3·0	Muffin, any kind	0·7
Muffin, any kind	1·1	Stir-fry vegetables and/or meat dishes	3·6	Trout, any kind	2·7	French fries, hash browns	0·7
Ice cream	0·8	Oatmeal porridge	3·5	Shrimp, cooked	2·0	Mixed vegetables, canned or frozen	0·7
Cookies, any kind	0·7	Candy, chocolate	2·7	Cheesecake	1·8	Banana, raw	0·7
Total	85·7	Total	52·2	Total	86·2	Total	93·6

from 'once in the last 30 d' to '2 times a day or more' (Appendix 1). Additional questions included supplement use and adherence to special diets, such as weight-loss or diabetic diets.

Discussion

The present study has presented the food and nutrient intakes, the food sources of selected nutrients and the development of a culturally appropriate QFFQ for the Inuit population in Nunavut. In addition, the present study has highlighted nutrients of concern for dietary inadequacy, as well as foods that can be targeted in the intervention programme due to their contribution to fat, energy and sugar intakes.

The findings in the present study show a trend in diet transition similar to those in other studies of Inuit adults; in those studies, adults consumed store-bought foods high in sugar and fat and of a much lower nutrient density than traditional foods[14]. The most commonly consumed foods in the present study were store-bought foods such as coffee, white bread, sugar and/or honey, sweetened juices and/or drinks, margarine and/or butter and chips. These food choices highlight the need for a nutritional intervention programme that focuses on store-bought foods and on foods not being frequently consumed because of lack of availability, such as fruits and vegetables. Other dietary studies of indigenous North Americans have shown that this shift in diet results in decreased intake of many micronutrients[15,29–45]. Frequently, consuming

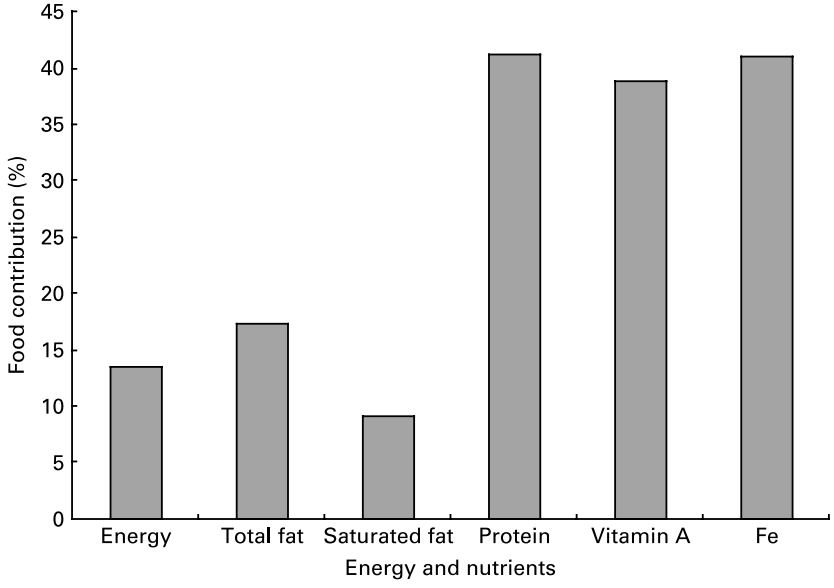

Fig. 1. Percentage contribution of traditional foods to energy and selected nutrient intake in adult Inuit in Nunavut.

high-sugar, low-fibre and high-fat foods has been associated with increasing risk for diabetes in other indigenous populations in Canada[18]. Decreased protein and increased carbohydrate intakes have also been observed among Alaska Natives and other indigenous Canadians[6,10,46,47], a trend that has been highlighted as a risk for many chronic diseases[48,49].

The mean daily intake of many vitamins and minerals was low in both men and women compared to the RDA. Women of child-bearing age were the least likely to meet the estimated average requirement, and few of the adults in the present study were able to meet the recommended adequate intakes for Ca, vitamin D and dietary fibre (data not shown). Traditional foods are still an important source of essential nutrients, in spite of the fact that less nutrient-dense store-bought foods are consumed more frequently. For example, traditional foods including caribou, Arctic char, trout and whale contributed significantly to protein (41·3 %) and Fe (41·2 %) intakes in the present study. Blanchet *et al.* [42] reported that traditional foods made similar (approximately 40 %) contributions to protein and Fe intakes among Nunavik Inuit women[42]. Traditional foods have also been shown to improve glucose tolerance, insulin secretion and insulin receptor sensitivity, thereby reducing the risk of diabetes mellitus and CVD[5,6,8–10,13,33,50–59].

There is a serious shortage of studies characterising current dietary intakes in high-risk populations upon which nutritional interventions can be based. One objective of the present study was to describe the food and nutrient intakes and the major food sources of energy and selected macro- and micronutrients in this population; these dietary data could help the researchers to develop a nutritional intervention specifically designed to meet local needs.

The present study made several observations: (1) this population rarely consumed fruits and vegetables; (2) the major sources of sugar intake in this population were soft drinks and other sweetened beverages and sugar added to tea or coffee; (3) foods contributing the most to energy and fat intakes were mainly store bought (explaining why these popular and frequently consumed foods are significant sources of many nutrients).

The dietary data are being used to help develop an integrated, multilevel and multi-institutional intervention strategy called Healthy Foods North, which aims to reduce dietary and lifestyle-related risk factors for chronic disease in Inuit populations. Diet-based components of the intervention are based on identifying and promoting affordable and acceptable healthier alternatives to the foods that contributed the greatest amount of energy, fat and sugar to the existing diet. Because of the low intakes of many micronutrients, the programme will also promote more nutrient-dense foods, such as unsweetened fruit juice and high-fibre and fortified cereals, and will provide instructions in cooking methods that will result in greater consumption of healthier, nutrient-dense foods. The intervention will also provide alternatives to high-fat chips and pizza; for example, low-fat baked chips and home-made pizza. The primary goals of the intervention are to improve dietary adequacy by increasing knowledge, self-efficacy and attitudes about healthier dietary behaviours, as well as improving availability of healthful food choices at the community level. The research team is partnering with the grocery stores to improve food availability and knowledge about some non-traditional foods, such as fruits and vegetables. The selection of foods for the intervention was based not only on results from the 24-h recall analysis, but also from in-depth interviews conducted with community members, through community workshops, and with input from interested parties, such as the Government of Nunavut, the DHSS and the Regional Inuit Association. This process has been successfully used in other environmental nutritional interventions with indigenous North Americans[60,61].

Development of a locally appropriate dietary assessment instrument is crucial for accurately assessing diet in subcultural groups[62]. QFFQ measure usual intake, an advantage over other dietary assessment methods such as short-term recalls and diet records[23]. Obtaining an appropriate food list for a unique population is the most crucial step in the process of developing a QFFQ. The QFFQ was developed and locally adapted by involving Inuit staff in the instrument's development, selecting food models to assess portion size, and ordering the food list during the workshops and pilot testing.

The QFFQ will be used as part of the evaluation for the Healthy Foods North trial because it allows the researchers to track changes in consumption of both the promoted foods and also less healthful foods. This instrument assesses common food choices and eating patterns from the entire diet, making it a comprehensive dietary assessment tool that evaluates overall dietary intake in terms of food, nutrient and food group intakes, as well as amounts and frequency of each food consumed. As in other studies, portion sizes for the QFFQ were assessed using appropriate three-dimensional food models so that the participants could visualise and estimate their usual amount consumed[63–66]. The QFFQ will be used to monitor nutritional transition in this population.

The present study is not without limitation. The sample included the main food preparer/shopper because they are likely the greatest influence on dietary intake in the home. However, they may not be representative of all people in the communities. The 24-h dietary recall was chosen to determine the food and drink items that were consumed for inclusion on a QFFQ. The recalls may not have included all food and drink items. However, local Inuit staff added any additional foods that may have been omitted due to seasonality and furthermore, the pilot testing did provide an additional opportunity to list any other foods not reported on the recalls. The food and nutrient intake estimates were obtained from a single 24-h recall, which might not reflect the usual intake in this population. However, multiple recalls would have substantially increased the cost of the study and increased subject burden. The QFFQ was developed based on the data collected in two communities in Nunavut. The sample may not be representative of all Inuit in Canada, and the QFFQ developed might not be appropriate for Inuit populations in other communities. On the other hand, the sampling frame was stratified by sex and age group to ensure a representative sample, and that the range of foods consumed was captured and included. QFFQ are limited and may over- or under-report nutritional intake. However, the QFFQ in the present study is being used to assess the changes in food intake from pre- to post-intervention. Therefore, any bias in the QFFQ in over- or under-reporting would be consistent during pre- and post-intervention. In addition, the validation of the QFFQ with three 24-h dietary recalls is currently underway.

The primary shopper/food preparer was chosen because (1) they prepare foods for the family; (2) the Healthy Foods

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North programme was developed to influence food purchasing and food preparation habits, as this would in turn influence the household food consumption and habits. The primary shopper/food preparer was the main subject for the intervention activities, such as shelf displays and taste tests in the store; (3) this sampling method was used in our other similar projects and thus provides comparative data[63–65].

In conclusion, an urgent need has been highlighted for a nutritional intervention programme aimed at improving dietary adequacy and reducing the risk of chronic disease in this Inuit population undergoing a rapid transition in diet. Specific foods have been selected for the intervention based partially on the results from 24-h recalls. There is a need to encourage the consumption of available nutrient-dense traditional foods as well as healthier store-bought foods.

The final QFFQ provides a comprehensive tool for assessing overall dietary intake and will be used to evaluate the effectiveness of the diet and lifestyle intervention programme, as well as to track dietary changes over time. This is the first time a QFFQ including all foods (traditional and store bought) has been developed from a representative population sample for Inuit.

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Appendix

Table S1. Food and drink items listed on the final quantitative FFQ developed for adult Inuit in Nunavut

Category	Food items
Breads, cereals (12)	Bannock, fried; Bannock, baked; white bread including toast, sandwiches, rolls and bagels; whole-wheat bread; pancakes or waffles including Eggo waffles; butter or margarine; peanut butter; jam or marmalade; home-made porridge; Quaker oats or porridge in a package; sweet cereals including Frosted Flakes or Honey Nut Cheerios; low-sugar cereals like Corn Flakes, Rice Krispies, Cheerios;
Meats, fish, poultry (67)	Caribou, boiled, baked or roast; caribou, raw; caribou, dried; caribou, fried (not including stir fry); caribou, aged; caribou fat, hard; polar bear, boiled; beef steak (not including stir fry); beef hamburgers; meat pie; sloppy joe; pork or beef ribs; pork chops; pork roast; seal liver; seal cooked; seal fat, fermented or fresh, hard; seal fat, fermented, liquid; seal raw, not including liver; muktuk; musk ox, fat; musk ox, boiled; musk ox, fried; bone marrow, any; any heart, any kidney; any liver, not including seal; any stomach, any intestine, specify animal; chicken nuggets or popcorn chicken; chicken wings; chicken leg fried including KFC; chicken leg baked, boiled or roasted; chicken breast fried including KFC; chicken breast baked, boiled or roasted; goose, baked, boiled or roasted; ptarmigan; bologna, salami; klik or other canned meat; beef or musk ox jerky; pepperoni sticks; ham; hot dogs, wieners or sausages; bacon, fried; char, raw; trout, raw; char, smoked; char, boiled; trout, boiled; char, dried; trout, dried; white fish, raw; white fish, dried; fish, battered and/or fried; fish, baked; fish head, small; fish head, medium; fish head, large; shrimp; oysters; baby clams, whole, canned in water or oysters; caribou soup or stew; caribou, stir fried; beef stew home-made or canned; beef, stir fried; any soup with beef, ham, chicken, duck or goose; mushroom or vegetable soup; char or clam chowder or any fish soup;
Dairy (13)	Milk, 1 % or skim; milk, 2 %; whole milk; milk, Carnation, cream, half and half or Carnation cream; Coffee-mate; eggs, chicken or duck; goose eggs; swan eggs; hard cheese including Kraft cheese slices; cream cheese, any; yogurt; milkshake or hot chocolate; soya milk;
Fruits (13)	Dried fruits including raisins; apple; orange; banana; mango; grapes; strawberries; kiwi; peaches and nectarines; blueberries, raspberries, blackberries, any other; any fruit or fruit cocktail canned in syrup; fruit salad fresh; fruit, frozen (including peaches, strawberries and blueberries);
Vegetables (20)	Hash browns or potato patties or French fries; potato salad; baked potato or boiled potato; mashed potato including instant; gravy, any; Corn on the cob; maize; carrot eaten alone; tomatoes canned; frozen vegetables, any including mixed; vegetables canned any; fresh vegetables; salad in a sandwich; salad in a bowl; salad dressing including mayo and dips; pizza; noodles; spaghetti with ground beef or ground musk ox, or beef ravioli; macaroni and cheese or Kraft dinner; rice, any
Desserts, snacks (14)	Ice cream any kind; any cake or muffin; pie, blueberry, apple, cherry; cheesecake or similar; chocolate bar, any kind; potato chips; Pilot biscuits any kind; crackers including Cream Crackers, Premium Plus; crackers including Ritz, Wheat Thins or sesame snacks; cookies including Oreos, Oatmeal; hard candy, any; cashews or other nuts including sunflower seeds; popcorn; granola bars
Beverages (12)	Juice sweetened, any kind (with added sugar); Does it have vitamin C added?; sugar-free juices like sugar-free Crystal Lite and sugar-free Koolaid; juice unsweetened; tomato or vegetable juice; pop, regular; pop, diet; tea, any hot tea; coffee; water; artificial sweetener; sugar or honey
Alcohol (3)	Liquor including rum, whisky, vodka or gin; beer or coolers, any kind; wine, any

Table S2. Sample page of the quantitative FFQ developed for adult Inuit in Nunavut

How often during the last 30 d did you USUALLY eat the following foods and how much do you USUALLY eat at one time?	Usual portion size	Never	Once in the last 30 d	2–3 times in last 30 d	Once a week	2–3 times a week	4–6 times a week	Once a day	2 times a day or more
			1 time	2–3 times	4 times	8–12 times	12–24 times	30 times	31 + times
Breads									
Bannock, fried	FF*	1	2	3	4	5	6	7	8
Bannock, baked	FF	1	2	3	4	5	6	7	8
White bread including toast, sandwiches, rolls and bagels	Slice	1	2	3	4	5	6	7	8
Whole-wheat bread	Slice	1	2	3	4	5	6	7	8
Pancakes or waffles including Eggo waffles	#	1	2	3	4	5	6	7	8
Butter or margarine	N	1	2	3	4	5	6	7	8
Peanut butter	N	1	2	3	4	5	6	7	8
Jam or marmalade	N	1	2	3	4	5	6	7	8
Cereal: I am going to ask you about different kinds of cereals. This is DRY cereal before you add milk									
Home-made porridge	SS	1	2	3	4	5	6	7	8
Quaker oats or porridge in a package	pkg	1	2	3	4	5	6	7	8
Sweet cereals including Frosted Flakes or Honey Nut Cheerios	SS	1	2	3	4	5	6	7	8
Low-sugar cereals like Corn Flakes, Rice Krispies, Cheerios	SS	1	2	3	4	5	6	7	8
Meats, poultry, fish (not including meats in soups, stews or stir fries) Remember to praise respondents!									
Caribou, boiled, baked or roast	ZZ	1	2	3	4	5	6	7	8
Caribou, raw	ZZ	1	2	3	4	5	6	7	8
Caribou, dried	ZZ	1	2	3	4	5	6	7	8
Caribou, fried (not including stir fry)	K	1	2	3	4	5	6	7	8
Caribou aged	ZZ	1	2	3	4	5	6	7	8
Caribou fat, hard	Q	1	2	3	4	5	6	7	8
Polar bear, boiled	ZZ	1	2	3	4	5	6	7	8
Beef steak (not including stir fry)	ZZ	1	2	3	4	5	6	7	8
Beef hamburgers	M	1	2	3	4	5	6	7	8
Meat pie	BB	1	2	3	4	5	6	7	8
Sloppy Joe	VV	1	2	3	4	5	6	7	8
Pork or beef ribs	4″	1	2	3	4	5	6	7	8
Pork chops	U	1	2	3	4	5	6	7	8
Pork roast	K	1	2	3	4	5	6	7	8
Seal liver	ZZ	1	2	3	4	5	6	7	8
Seal cooked	ZZ	1	2	3	4	5	6	7	8
Seal fat, fermented or fresh, hard	N	1	2	3	4	5	6	7	8
Seal fat, fermented, liquid	Tsp	1	2	3	4	5	6	7	8
Seal raw, not including liver	ZZ	1	2	3	4	5	6	7	8
Muktuk	E	1	2	3	4	5	6	7	8

*These letters represent different food models.