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RESEARCH PAPER

Nutrient intakes, major food sources and dietary inadequacies of Inuit adults living in three remote communities in Nunavut, Canada

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Abstract

Background: Inuit in Nunavut, Canada, are currently undergoing a nutritional transition that may contribute to an increased prevalence of chronic disease. Information is lacking about the extent to which contemporary Inuit diets are meeting current dietary recommendations.
Methods: A culturally appropriate quantitative food frequency questionnaire (QFFQ) developed and validated for Inuit in Nunavut, Canada, was used to assess food and nutrient intake in a cross-sectional sample of adults.
Results: Participants included 175 women and 36 men with mean (SD) ages of 42.4 (13.2) and 42.1 (15.0) years, respectively. The response rate for those who completed the study was 79% with 208 QFFQs included for analysis. Reported mean daily energy intakes were: men 15 171 kJ (3626 kcal); women 11 593 kJ (2771 kcal). Dietary inadequacy was expressed as the percentage of participants reporting intakes below the sex- and age-specific estimated average requirements (EARs). For nutrients without EARs, adequate intakes were used. Energy and sodium intakes exceeded the recommendations. Less than 10% of participants met recommendations for dietary fibre intake. Vitamin E intakes were below EARs for $\geq$97% of participants, whereas >20% reported inadequate vitamin A, folate and magnesium intakes. Among women, >50% reported inadequate calcium and vitamin D intakes. Non-nutrient-dense foods contributed 30% of energy, 73% of sugars and 22% of fat. Traditional foods contributed 56% of protein and 49% of iron.
Conclusions: The present study demonstrates a relatively high prevalence of inadequate nutrient intakes among Inuit. The results may be used to monitor the nutrition transition among Inuit, evaluate nutritional interventions, and inform public health policy decision-making.

Introduction

Inuit are an indigenous people comprising 85% of the population of Nunavut, a Canadian territory located mostly above the Arctic Circle (Statistics Canada, 2007a). Inuit have survived the extreme environmental challenges of the circumpolar habitat for thousands of years on a diet comprised entirely of nutrient-dense animal products, wild plants and berries (Graburn & Strong, 1973; Kuhnlein *et al.*, 2001). These traditional foods contain high levels of many essential vitamins and minerals, fatty acids and protein (Kuhnlein *et al.*, 2002), and their consumption may have contributed to the historically low rates of diabetes, cardiovascular diseases and certain cancers observed among Inuit populations (Bjerregaard *et al.*, 2004). High levels of physical activity, an inherent

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component of the nomadic hunter-gatherer lifestyle of Inuit, likely further inhibited prevalence of such chronic diseases (Adler *et al.*, 1996).

Similar to other indigenous populations worldwide, over approximately the last 50 years, Inuit have come under increasing pressure to leave behind their traditional way of life and acculturate to the values of Western society (Shephard & Røde, 1996; Kirmayer *et al.*, 2003; Mead *et al.*, 2010). Settlement into permanent communities and the introduction of store-bought processed foods imported by air or barge from Southern Canada have led to a significant reduction in the consumption of nutrient-dense traditional foods (Boult, 2004). Furthermore, an increased reliance on motorised transportation has reduced overall physical activity (Curtis *et al.*, 2005). This rapid dietary transition, characterised by an increased reliance on store-bought foods and a reduced adherence to the traditional Inuit diet (Erber *et al.*, 2010; Hopping *et al.*, 2010a), has given rise to serious concerns as it may lead to inadequate intakes of essential nutrients and coincides with an increasing prevalence of chronic disease and associated risk factors, including obesity (Hopping *et al.*, 2010b) and diabetes (Young, 1996). Obesity rates in Nunavut increased from 23% in 1992 to 37% in 2004 (Anctil, 2008). Inuit have disproportionately higher rates of cancer compared to southern Canadians, including the highest incidence of salivary gland and lung cancers in the world and one of the highest rates of nasopharangeal cancer (Circumpolar Inuit Cancer Review Working Group *et al.*, 2008). Age-standardised rates of cancer mortality (per 100 000 people) in 2007 were 340 in Nunavut compared to 166 for the general Canadian population (Public Health Agency of Canada, 2011). In addition, age-standardised mortality rates for diseases of the circulatory system (per 100 000 people) in 2000–2004 were 249 in Nunavut compared to 192 for the general Canadian population (Public Health Agency of Canada, 2011). Overall life expectancy in Inuit-inhabited areas is more than 12 years lower than the Canadian average (Wilkins *et al.*, 2008). These high rates of chronic disease prevalence, coupled with the remoteness of the communities, place the healthcare system of Nunavut under serious pressure as a result of the high cost of health service delivery (Sharma, 2010).

Investigating the possibility of a link between dietary and chronic disease trends among Inuit populations requires a comprehensive assessment of dietary quality (Whiting & Mackenzie, 1998). Various methods are used to determine dietary quality in a population, including 24-h recalls, food diaries, biochemical analysis and measuring dietary diversity (Cade *et al.*, 2002; Torheim *et al.*, 2004). Quantitative food frequency questionnaires (QFFQs) are more easily administered with large populations and can assess diet over a longer period of time, although they contain a finite amount of foods and are therefore traditionally unsuitable for measuring true nutrient intake. However, communities in the Canadian Arctic are isolated and have relatively restricted access to store-bought foods. Although traditional foods are still an important part of the current Inuit diet, many communities now obtain the majority of foods from one or two stores that import a limited selection of mainly nonperishable processed goods (Sharma, 2010). The availability of a relatively limited variety of foods makes capturing the total diet using a QFFQ much more feasible among Inuit than in other populations. A culturally appropriate QFFQ is therefore an ideal dietary assessment instrument for use with isolated Inuit populations.

The present study aimed to analyse the diets of Inuit adult participants in the Healthy Foods North nutritional and physical activity intervention programme using a previously developed and validated QFFQ (Pakseresht & Sharma, 2010; Sharma *et al.*, 2010). Nutrient intakes were quantified and compared with current dietary recommendations to determine the dietary adequacy of the population, as well as to determine the primary foods contributing to energy and selected nutrients.

Materials and methods

Setting and population

The setting and population for the present study have been described previously (Sharma, 2010). Briefly, this cross-sectional study took place in three isolated communities in Nunavut, Canada, with Inuit adults ($\geq$19 years of age) from randomly selected households. The study communities are relatively young, with a median age of approximately 20 years (Statistics Canada, 2007b).

Quantitative food frequency questionnaire development

Because food availability, accessibility and preferences can vary greatly between settings, research with ethnic/racial minority, multi-ethnic or culturally distinct populations requires that food frequency questionnaires be developed specifically for that population to accurately capture the local diet and locally-available foods (Sharma, 2011). Development of the QFFQ used in the present study has been described previously (Sharma *et al.*, 2010). In brief, using an established methodology (Sharma, 2011), single 24-h recalls collected from Inuit participants in Nunavut were used to develop a culturally relevant QFFQ that was designed to assess usual dietary intake over the previous 30 days. Key stakeholders and community members provided input at all stages of development. A final 150-item QFFQ was developed and validated using multiple 24-h

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recalls and was found to have an overall deattenuated Spearman's rho of 0.57 (Pakseresht & Sharma, 2010).

Data collection

Standard procedures for data collection were developed by the Principal Investigator (SS) and strictly followed. Data collectors, comprising research assistants from the Principal Investigator's team and members of the three Nunavut communities, were trained by the Principal Investigator for five days and certified to ensure all data were comparable. To minimise inter-coder variability, each data collector was required to interview the Principal Investigator as a subject to demonstrate that they could elicit the same (and correct) responses to both the demographic and dietary intake questions on the questionnaire before being deemed sufficiently skilled to proceed. The trained interviewers administered 211 QFFQs between July and October of 2008. Local translators, who received prior training by the investigators to ensure standardisation, were available to accommodate participants who were not comfortable completing the interviews in English and preferred to use Inuktitut. Participants were asked how frequently during the past 30 days they consumed each of 150 food items. Eight frequency categories allowed participants to report the frequencies of consumption as: 'Never'; 'one time/month'; 'two to three times/month'; 'one time/week'; 'two to three times/week'; 'four to six times/week'; 'one time/day' and 'two or more times/day'.

Portion sizes were estimated using locally available utensils, commercially available food models (NASCO, Fort Atkinson, WI, USA) and models designed locally to represent traditional foods.

Institutional Review Board approval was obtained from the Office of Human Research Ethics at the University of North Carolina at Chapel Hill and the Committee on Human Studies at the University of Hawaii. The Nunavut Research Institute licensed the study. Participants provided their written informed consent prior to participation and were compensated for their time with gift cards (CAD$25) for use at local grocery stores.

Statistical analysis

Dietary analysis was conducted for each participant by converting reported frequencies into mean daily frequencies of consumption (ranging from 0 to 2 times per day), multiplied by reported portion sizes (g) to obtain mean daily consumption of each food item on the QFFQ. Daily nutrient intake was calculated using a food composition table (FCT) developed using the Canadian food composition database in NUTRIBASE CLINICAL NUTRITION MANAGER, version 7.17 (CyberSoft Inc., Phoenix, AZ, USA) and a Food Frequency Questionnaire Analysis Program in STATA (FFQAPIS), a data analysis program created using STATA, version 10 (StataCorp., College Station, TX, USA). FFQAPIS combines three datasets (FCT, QFFQ and portion weight data) to compute the quantity of daily food and nutrient intake, as well as the primary food sources of energy and selected nutrients. The FFQAPIS has no limitation for analysis in terms of sample size or the number of food items in a QFFQ.

The top 10 food sources for energy and selected nutrients were calculated using 19 food groups, including store-bought, non-nutrient-dense foods (NNDF) and traditional foods (TF). NNDF included food items such as margarine, pop and potato chips, whereas TF included animal products obtained from the land (caribou, muskox), sea (seal, fish) and sky (goose, ptarmigan).

The mean, median, and SD of daily energy and nutrient intakes were calculated for all participants and are presented for comparison with the recommended dietary allowances (RDAs) and adequate intake (AI) (in the absence of RDAs) for men and women aged 31–50 years [Institute of Medicine of the National Academies (IOM), 2005]. Dietary adequacy was assessed using the sex-specific estimated average requirements (EARs) for age groups 19–30, 31–50, 51–70 and >70 years. Because of the small sample size of several subgroups, data are presented as single categories ($\geq$19 years) for both sexes. For nutrients without EARs (dietary fibre, vitamin D and calcium), AIs were used for comparison as recommended. The percentages of participants reporting an intake below the EARs and AIs were determined for selected nutrients.

Participants who reported extreme energy intake [<2092 kJ (<500 kcal) or >20 920 kJ (>5000 kcal), n = 3] were excluded from the analysis. All analyses were stratified by sex. Data were analysed using SAS, version 9.1 (SAS Institute, Inc., Cary, NC, USA).

Results

The overall response rate for the three communities was 79% for a total sample of 211 participants. After exclusion of three participants with extreme energy intake, 208 QFFQs were included in the analysis. The mean (SD) ages for both men (n = 36) and women (n = 172) were 42.1 (15.0) and 42.4 (13.2) years respectively.

Nutrient intake

Men reported an average energy intake of 15 171 kJ (3626 kcal), whereas women had a mean intake of 11 593 kJ (2771 kcal) (Table 1). Macronutrient distributions were very similar between men and women, although men

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Table 1 Energy and selected nutrient intake among Inuit men and women in Nunavut

	Men (n = 36)			Women (n = 172)		
	Mean (SD)	Median	DRI*	Mean	Median	DRI*
Age (years)	42.1 (15.0)	39.5	–	42.4 (13.2)	41.0	–
Energy kJ [kcal]	15 171 (6137) [3626 (1467)]	3480	2200[†]	11 593 (5246) [2771 (1254)]	2561	1800[†]
% of energy from protein	22 (6.9)	22	10–35[‡]	24 (8.1)	23	10–35[‡]
% of energy from carbohydrates	47 (9.4)	46	45–65[‡]	47 (9.6)	47	45–65[‡]
% of energy from fat	31 (5.3)	30	20–35[‡]	28 (5.0)	28	20–35[‡]
Protein (g)	195.3 (92.4)	195.7	–	163.0 (97.1)	145.7	–
Carbohydrate (g)	421 (186.8)	395.5	–	326 (169.9)	308.3	–
Sugars (g)	214.8 (133.7)	170.9	<25% of energy*	161.0 (116.3)	149.3	<25% of energy*
Dietary fibre (g)	18.2 (8.6)	14.4	38[§]	13.6 (6.7)	13.1	25[§]
Fat (g)	124.3 (58.3)	117.6	–	87.0 (41.0)	82.1	–
Saturated fat (g)	43.4 (21.9)	40.7	<10% of energy[¶]	30.3 (14.8)	28.2	<10% of energy[¶]
Monounsaturated fat (g)	43.8 (20.6)	43.0	–	30.0 (14.1)	27.6	–
Polyunsaturated fat (g)	18.7 (8.6)	17.5	–	13.3 (6.4)	12.0	–
Omega-3 fatty acid (g)	2.1 (1.3)	1.8	–	1.6 (1.2)	1.3	–
Omega-6 fatty acid (g)	14.3 (7.6)	12.6	–	9.6 (5.1)	9.1	–
Cholesterol (mg)	652 (404.3)	488.1	As low as possible	474 (339.4)	402.6	As low as possible
Vitamin A (μg RAE**)	869 (525.2)	737.8	900[††]	1071 (1466.9)	740.1	700[††]
Thiamin (mg)	2.7 (1.0)	2.7	1.2[††]	2.2 (1.0)	2.0	1.1[††]
Riboflavin (mg)	4.8 (2.1)	4.6	1.3[††]	3.9 (2.1)	3.5	1.1[††]
Niacin (mg)	47.5 (25.2)	45.5	16[††]	34.3 (17.4)	30.8	14[††]
Pantothenic acid (mg)	11.5 (5.4)	10.5	5[§]	9.5 (5.8)	8.4	5[§]
Vitamin B_6 (mg)	2.8 (1.4)	2.6	1.3[††]	2.0 (1.0)	1.9	1.3[††]
Total folate (μg)	482 (176.6)	464.0	400[††]	389 (174.1)	365.8	400[††]
Vitamin B_{12} (μg)	17.0 (12.1)	12.7	2.4[††]	16.5 (14.9)	12.8	2.4[††]
Vitamin C (mg)	207 (162.7)	165.2	90[††]	183 (131.9)	149.7	75[††]
Vitamin D (μg)[‡‡]	7.4 (6.2)	5.9	5[§]	5.0 (4.5)	3.6	5[§]
Vitamin E (mg)[§§]	5.3 (2.7)	5.0	15[††]	4.0 (2.5)	3.6	15[††]
Iron (mg)	31.6 (12.8)	29.8	8[††]	28.0 (16.9)	24.8	18[††]
Calcium (mg)	1275 (670.8)	1167.8	1000[§]	1110 (644.7)	991.9	1000[§]
Magnesium (mg)	448 (169.8)	471.7	420[††]	370 (158.3)	352.3	320[††]
Potassium (g)	4.9 (2.0)	4.6	4.7[§]	4.0 (1.9)	3.9	4.7[§]
Sodium (g)	5.1 (2.1)	5.0	1.5[§]	3.9 (2.2)	3.5	1.5[§]

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Table 1 (Continued)

	Men (n = 36)			Women (n = 172)		
	Mean (SD)	Median	DRI*	Mean	Median	DRI*
Selenium (μg)	180 (92.5)	160.9	55††	169 (184.8)	131.7	55††
Zinc (mg)	22.8 (10.0)	22.4	11††	20.0 (13.1)	17.8	8††

*The dietary reference intakes (DRI) are presented in this table using adequate intake (AI), recommended dietary allowance (RDA) for men and women aged 31–50 year, acceptable macronutrient distribution ranges (AMDR) and Recommendation on saturated fat intake by Joint World Health Organization (WHO)/Food and Agriculture Organization (FAO) (IOM, 2005; Joint WHO/FAO Expert Consultation, 2003).

†Estimated amounts of calories needed to maintain energy balance for men and women aged between 31–50 years at the level of very low physical activity-sedentary level.

‡AMDR.

§AI.

¶Recommendation on saturated fat intake by Joint WHO/FAO.

**Retinol activity equivalent.

††RDA.

‡‡As cholecalciferol. In the absence of adequate exposure to sunlight.

§§As α-tocopherol.

obtained a slightly higher percentage of energy from fat (31% versus 28%). Carbohydrates provided 47% of energy for both men and women, approximately 50% of which was from sugar. Protein intake was adequate, providing 22% of energy for men and 24% of energy for women.

Dietary fibre recommendations were unmet by 100% of men and 92% of women (Table 2). Almost half of men and 69% of women reported vitamin D intakes below the AI. Vitamin E intakes were below the EARs for $\geq$97% of men and women. The EARs for total folate were unmet by 22% of men and 35% of women. Calcium intakes were below the recommendations for 39% of men and 53% of women. The dietary reference intakes for magnesium and vitamins A, B_6 and C were each met by $\geq$61% of participants, and intakes of thiamin, riboflavin, niacin, B_{12}, iron, and zinc were each adequate for $\geq$92% of participants.

Food sources of energy and selected nutrients

Both TF and NNDF contributed significantly to dietary intake, providing 21% and 30% of energy, respectively (Table 3). TF contributed 56% of protein intake, whereas NNDF contributed 22% of fat, 50% of carbohydrates and 73% of sugar intake. TF were the primary contributors to iron intake (49%). Dairy products provided 31% of calcium, followed by white breads (25%) and NNDF (20%). Fruits and vegetables were the first and fourth greatest contributors to dietary fibre, respectively, together comprising 27% of total intake.

Discussion

Traditionally, Inuit have experienced relatively low rates of chronic noncommunicable diseases; however, increasing acculturation in recent decades has caused profound changes to the Inuit diet and lifestyle, which are giving rise to serious public health concerns. The present study has reported data from a culturally relevant QFFQ assessing dietary adequacy of Inuit men and women from three communities in Nunavut, Canada. Although macronutrient intake fell within the acceptable macronutrient distribution ranges, total energy intake was high. Although sugar intake met the recommendation of contributing <25% of total energy, energy intake itself was far in excess of the recommendations, with sugar provided approximately 39% and 36% of the amount of energy recommended for men and women, respectively. Sugar comprised half of all carbohydrates, and NNDF accounted for almost 75% of sugar intake, providing more than four times as much sugar as fruits and dairy combined. These results are comparable to those obtained

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Table 2 Percentage of Inuit men and women below the dietary reference intakes (DRIs)

Nutrients	Men (%) ≥ 19 year (*n* = 36)	DRI	Women (%) ≥ 19 year (*n* = 172)	DRI
Dietary fibre (g)*	100	30	92	21
Vitamin A (μg RAE†)‡	39	625	24	500
Vitamin C (mg)‡	14	75	19	60
Vitamin D (μg)*,§	47	10	69	10
Vitamin E (mg)‡,¶	97	12	98	12
Thiamin (mg)‡	0	1.0	6	0.9
Riboflavin (mg)‡	0	1.1	0	0.9
Niacin (mg)‡	0	12	2	11
Vitamin B_6 (mg)‡	3	1.1	19	1.1
Total folate (μg DFE**)‡	22	320	35	320
Vitamin B_{12} (μg)‡	0	2.0	2	2.0
Calcium (mg)*	39	800	53	800
Magnesium (mg)‡	33	350	26	265
Iron (mg)‡	0	6	4	8.1
Zinc (mg)‡	8	9.4	8	6.8

*Adequate intake used for comparison.
†Retinol activity equivalent.
‡Estimated average requirement used for comparison.
§As cholecalciferol in the absence of adequate exposure to sunlight.
¶As α-tocopherol.
**Dietary folate equivalent.

from multiple 24-h dietary recalls in the same population (Hopping *et al.*, 2010c), suggesting that NNDF consumption may be contributing to increased dietary energy density among Inuit.

Dietary fibre intake was far below recommendations, most likely as a result of an infrequent consumption of fruits, vegetables, and whole grains, as revealed previously in this population (Hopping *et al.*, 2010a). The difficulty of transporting perishable foods, such as fruits and vegetables, to remote Arctic communities greatly inflates prices and reduces quality, in turn reducing consumer acceptability and consumption (Chan *et al.*, 2006). Additionally, the relatively recent exposure of Inuit populations to manufactured foods and the lack of nutritional education in Northern communities have not provided Inuit with the information necessary for informed dietary decision-making.

The present study identified a number of additional micronutrient inadequacies that could negatively impact the health of this population. Of particular concern is the finding that 31% of women of childbearing age (19–50 years) did not meet the EAR for folate (data not shown), which may increase the risk of neural tube defects (IOM, 2005). The finding that 53% and 69% of all women did not meet recommendations for calcium and vitamin D, respectively, suggests an additional health risk because inadequate levels of these nutrients are associated with an increased risk of osteoporosis (IOM, 2005).

Traditional foods were the main contributors of protein and iron, an outcome consistent with other studies (Kuhnlein *et al.*, 1996; Hopping *et al.*, 2010c; Sharma *et al.*, 2010). This result emphasises the importance of maintaining traditional food consumption in the Arctic, specifically for women of childbearing age who are at increased risk for iron deficiency (Berti *et al.*, 2008; Simpson *et al.*, 2011). The fact that white breads contributed 25% of calcium intake is probably explained by high consumption of bannock, a type of traditional bread prepared with monocalcium phosphate baking powder, and the fact that many participants did not consume adequate calcium. Although NNDF contributed 20% of calcium and 15% of fibre, they were also the greatest contributors to energy and sugar intake and the second greatest contributors to fat intake.

The results of the present study appear to further support the hypothesis that Inuit are undergoing a nutritional transition towards a dietary pattern associated with an increased risk of chronic disease. The data reported here show mean energy intakes of 15 171 kJ (3626 kcal) for men and 11 593 kJ (2771 kcal) for women, as compared with data from 1998 and 1999 (Kuhnlein *et al.*, 2004) indicating a sex-adjusted mean energy intake of 8129 kJ (1943 kcal). Similar increases appear to have occurred when comparing data for sodium, sugar and saturated fat. The use of different dietary assessment instruments may be responsible for some of the heterogeneity of these findings, although recent data obtained from multiple 24-h recalls (Hopping *et al.*, 2010c) also show greater energy intake compared to previous data.

The present study has several limitations. Men were under-represented in the sample as a result of the fact that the household members targeted were those primarily responsible for making decisions regarding food purchase and preparation, most of whom were women. The generalisability of the results to other Inuit communities is also limited. There could have been response bias resulting from the use of an interviewer-administered QFFQ and recall bias, which is a characteristic limitation of FFQs. The higher energy and nutrient intakes observed in the present study compared to those observed in a smaller and slightly different population based on multiple 24-h recalls (Hopping *et al.*, 2010c) suggest a tendency for the QFFQ to overestimate intakes. Moreover, the validation study for the QFFQ (Pakseresht & Sharma, 2010) showed relatively modest correlation coefficients in the nutrients analysed. Thus, these results need to be interpreted with caution, and the suitability of this tool

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Table 3 Top 10 food sources of energy and selected nutrients among Inuit in Nunavut (*n* = 208)

Foods	% contribution to energy	Foods	% contribution to protein	Foods	% contribution to fat	Foods	% contribution to carbohydrates
NNDF*	30.0	Land TF†	32.7	Beef and pork	22.7	NNDF*	50.0
Land TF†	11.7	Sea TF‡	23.0	NNDF*	21.7	White breads	10.8
Beef and pork	10.9	Beef and Pork	13.5	Dairy	11.1	Fruits	7.6
Sea TF‡	8.9	Dairy	6.8	Sea TF‡	9.9	Noodles	6.0
White breads	7.6	Chicken/ turkey	6.2	Land TF†	8.4	Cereals	3.7
Dairy	6.6	NNDF*	4.2	White breads	6.3	Dairy	3.7
Noodles	5.1	White breads	3.2	Noodles	5.5	Rice	3.1
Fruits	3.4	Noodles	3.0	Chicken/ turkey	4.9	Beef and pork	2.4
Chicken/ turkey	3.2	Other starches	1.2	Nuts	2.8	Vegetables	2.2
Cereals	2.1	Cereals	0.9	Other starches	2.3	Land TF†	2.1
Total	89.5		94.7		95.6		91.6

Foods	% contribution to sugar	Foods	% contribution to fibre	Foods	% contribution to calcium	Foods	% contribution to iron
NNDF*	73.3	Fruits	18.1	Dairy	31.2	Land TF†	39.4
Fruits	11.3	NNDF*	15.2	White breads	24.6	Sea TF‡	9.9
Dairy	6.3	White breads	11.4	NNDF*	20.0	White breads	9.5
Wheat breads	1.8	Vegetables	9.2	Noodles	4.7	NNDF*	8.9
Cereals	1.6	Wheat breads	7.4	Sea TF‡	3.4	Beef and pork	7.4
Vegetables	1.2	Cereals	7.2	Beef and pork	2.3	Cereals	7.0
White breads	1.1	Noodles	6.4	Land TF†	2.3	Noodles	4.2
Beef and pork	1.0	Beef and pork	6.2	Other starches	2.1	Dairy	2.1
Noodles	0.8	Land TF[2]	5.3	Fruits	1.8	Wheat breads	1.7
Unclassified foods	0.4	Potatoes	3.0	Unclassified foods	1.8	Vegetables	1.7
Total	98.8		89.4		94.2		91.8

*Non-nutrient-dense foods, including pop, chips, sweetened juice, margarine, coffee creamer, fried potatoes, and desserts.
†Land traditional foods, including caribou, muskox and polar bear.
‡Sea traditional foods, including seal, muktuk, Arctic char, trout and white fish.
NNDF, non-nutrient-dense food; TF, traditional food.

for estimating the prevalence of inadequate nutrient intakes in this population requires further study. Further limitations include the fact that reported values for selected micronutrients may underestimate actual intake because nutrient database values for some vitamins are limited (United States Department of Agriculture, 2008). Additionally, the study period spanned summer and autumn only, and therefore does not account for the seasonal availability of foods.

Despite these limitations, the results of the present study have important implications for public health in Nunavut, and are valuable for informing government policy development and health promotion programming. Chronic diseases create significant financial consequences in Canada: nationally, cardiovascular disease cost CAN$20.6 billion in 1998, whereas, in 2002, cancer and diabetes cost CAN $17.9 billion and CAN$9.9 billion, respectively (Ohinmaa *et al.*, 2004; Patra *et al.*, 2007). These figures are particu-

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larly worrisome in the context of Nunavut's young population because chronic disease prevalence will likely increase as the population ages. Nutritional education and dietary interventions targeting the nutritional excesses and deficiencies identified in the present study could be an effective method for reducing the financial and personal burden of chronic disease in the territory.

At a broader level, the findings are also relevant for many other indigenous populations in transition around the world because they may allow researchers to anticipate and devise strategies that counteract the likely nutritional consequences of moving from traditional societies to a more modern way of life.

In conclusion, these data represent the first comprehensive evaluation of Inuit dietary adequacy over a 30-day period using a validated population-specific QFFQ. The results indicate high energy intakes, although several nutrients are being consumed below the recommended levels. These data may serve as a baseline for monitoring future dietary changes within this population. The results can be used by public health policy makers and community nutrition health workers to improve health outcomes among the Inuit by identifying, encouraging and promoting the consumption of more nutrient-dense foods in these and other Canadian Arctic communities.

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Conflicts of interest, sources of funding and authorship

The authors declare that there are no conflicts of interest. The study was supported by the American Diabetes Association Clinical Research award (1-08-CR-57), Department of Health and Social Services (HSS) of the Government of Nunavut, and Health Canada.SS developed the design of the study. BNH reviewed the literature, performed data analyses and drafted the manuscript. CR oversaw all field activities. TS contributed to the reviewing and editing of the manuscript. All authors were responsible for data interpretation, critically reviewed the manuscript, and have approved the final version submitted for publication.

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