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RESEARCH PAPER

Traditional food patterns are associated with better diet quality and improved dietary adequacy in Aboriginal peoples in the Northwest Territories, Canada

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Abstract

Background: Traditionally, the Arctic diet has been derived entirely from locally harvested animal and plant species; however, in recent decades, imported foods purchased from grocery stores have become widely available. The present study aimed to examine Inuvialuit, traditional or nontraditional dietary patterns; nutrient density of the diet; dietary adequacy; and main food sources of energy and selected nutrient intakes.
Methods: This cross-sectional study used a culturally appropriate quantitative food frequency questionnaire to assess diet. Traditional and nontraditional eaters were classified as those consuming more or less than 300 g of traditional food daily. Nutrient densities per 4184 kJ (1000 kcal) were determined. Dietary adequacy was determined by comparing participants' nutrient intakes with the Dietary Reference Intakes.
Results: The diet of nontraditional eaters contained, on average, a lower density of protein, niacin, vitamin B_{12}, iron, selenium, zinc, omega-3 fatty acids ($P \leq 0.0001$), vitamin B_6, potassium, thiamin, pantothenic acid ($P \leq 0.001$), riboflavin and magnesium ($P \leq 0.05$). Inadequate nutrient intake was more common among nontraditional eaters for calcium, folate, vitamin C, zinc, thiamin, pantothenic acid, vitamin K, magnesium, potassium and sodium. Non-nutrient-dense foods (i.e. high fat and high sugar foods) contributed to energy intake in both groups, more so among nontraditional eaters (45% versus 33%). Traditional foods accounted for 3.3% and 20.7% of total energy intake among nontraditional and traditional eaters, respectively.
Conclusions: Diet quality and dietary adequacy were better among Inuvialuit who consumed more traditional foods. The promotion of traditional foods should be incorporated in dietary interventions for this population.

Introduction

A number of social and environmental factors have led to major changes in the food environment of Aboriginal Arctic populations (Kuhnlein & Receveur, 1996; Willows, 2005; Loring & Gerlach, 2009). Traditionally, the Arctic diet was derived entirely from locally harvested animal and plant species; however, in recent decades, imported foods purchased from grocery stores have become widely available (Sharma, 2010).

Prior research indicates that store-bought foods used most frequently in Arctic communities are of low nutritional quality, which negatively affects overall diet quality (Erber *et al.*, 2010b; Hopping *et al.*, 2010). Studies on dietary intake among Canadian Aboriginal populations of the Arctic region have revealed low nutrient intakes and excessive fat and sugar intakes (Sharma *et al.*, 2009, 2010; Erber *et al.*, 2010c; Hopping *et al.*, 2010).

The shifting dietary trends among Arctic populations are of concern because they are associated with increasing obesity and chronic disease risk (Jorgensen *et al.*, 2002; Kuhnlein *et al.*, 2004; Friborg & Melbye, 2008). Among Inuvialuit, an Inuit population that resides predominately in the Northwest Territories (NWT) of Canada, the prevalence of overweight/obesity rose from 55% to 63% from 2003 to 2008 compared to 51% among non-Inuit Canadians (Northwest Territories Health & Social Services, 2005). Chronic disease rates were previously low among Inuit populations (Bjerregaard *et al.*, 2004; Deering *et al.*, 2009); however, a recent study showed that 23% of Inuvialuit adults self-reported having at least one chronic disease (hypertension, heart disease, diabetes and/or cancer) (Erber *et al.*, 2010a). From 2005 to 2007, the leading causes of death in the NWT were cancers and cardiovascular diseases (Northwest Territories Health & Social Services, 2005). This has implications on the quality of life and longevity of the Inuvialuit living in the NWT (Hopping *et al.*, 2010).

Strategies to improve diet in an effort to reduce chronic disease risk are needed among Inuvialuit populations. A well-defined knowledge of the foods that contribute significantly to diet quality in this population will aid in the development of targeted interventions. Research on a number of Arctic populations has shown that the consumption of traditional food items (often meat or fish) is associated with higher nutrient intakes compared to when they are not consumed (Risica *et al.*, 2005; Kuhnlein & Receveur, 2007), although this has not specifically been examined among Inuvialuit. The present study aimed to examine whether Inuvialuit who consume a greater amount of traditional foods have better diet quality and dietary adequacy than those who consume fewer traditional foods.

Materials and methods

Setting

This cross-sectional study took place in three remote communities in the NWT, Canada. The NWT (population: 43 759; 51.7% males: 48.3% females) is located between the territories of Yukon and Nunavut (Northwest Territories Health & Social Services, 2005). It has an area over one million square kilometres and 33 geographically dispersed communities (Northwest Territories Health & Social Services, 2005). Almost half of the population (46%) lives in the capital city, Yellowknife; another quarter (22%) lives in regional centres (Inuvik, Hay River and Fort Smith) and the remaining population is spread amongst 28 remote communities, which range in size from 70 to 1300 residents (Northwest Territories Health & Social Services, 2005).

The three participating communities were identified as representative of varying levels of population size and socioeconomic status. Community populations range from 400 to 3500 people, 40–90% of whom identify as Inuvialuit. The median age of Inuvialuit ranges from 24 to 26 years, unemployment is 35–60% and median household income is C$33 000–64 000 (Sharma, 2010). Each of these communities has two or three food stores that obtain food primarily through shipments from the South via airplane year-round, via road or ice road for parts of the year for two communities, and via barge once per year when the ice melts. Because of high transportation and storage costs, the price of food is elevated compared to prices in southern Canada (Indian & Northern Affairs Canada, 2008). Food is also obtained, to varying degrees, by traditional means (e.g. hunting, fishing).

Data collection

The study protocol has been described previously (Sharma *et al.*, 2010). In brief, study participants were randomly selected using up-to-date community housing maps. This method ensured sampling from areas with varied proximities to food stores. One resident per household was recruited. This was the person who was responsible for shopping and food preparation, most commonly a woman. The sampling excluded residents <19 years (children) and pregnant/lactating women as a result of their different nutritional requirements and possible changes in dietary habits. A signed informed consent form was obtained from each study participant. Response rates in the three communities were 65–85%.

Dietary data were collected between July 2007 and July 2008 using a culturally appropriate quantitative food frequency questionnaire (QFFQ), previously developed to assess dietary intake in the Inuvialuit over a previous 30-day period (Sharma *et al.*, 2009). For this questionnaire, three-dimensional food models (NASCO Company, Fort Atkinson, WI, USA), household units (e.g. bowls, mugs and spoons), standard units and local food packages were carefully chosen with input from local communities to best estimate the weight per portion of foods and beverages consumed. The 142-item QFFQ included most foods/beverages consumed in these communities, including foods available in stores, traditional foods not available in stores and those that vary between seasons. In total, these comprised 12 breads and cereals; 41 meats, including traditional land, sea and sky foods; seven soups or stews; 13 fish; 11 dairy products; two sugar and sweetener; 11 fruit; 11 vegetables; four starchy products; 15 desserts and snacks; 12 beverages, including alcoholic drinks; and three other foods including mayonnaise, stuffing and gravy. Traditional meats/poultry include caribou, seal, muskox, goose and ptarmigan. Traditional fish includes Arctic char and trout (Sharma *et al.*, 2009). The QFFQ was previously validated against repeated 24-h recalls collected in the same population and the two methods indicated a relatively good agreement proportion (same or adjacent quartiles) of 77% for energy and macronutrients, 86% for sugar and 76% for micronutrients. This high agreement indicated that the QFFQ was a valid tool to assess diet in this population (Pakseresht & Sharma, 2010).

Data were collected by community staff trained by the Principal Investigator in administration of the QFFQ. Participants were asked to report the frequency of consumption over a 30-day period choosing from eight categories which ranged from 'never' to '2 or more times per day.' Interviewers and interpreters fluent in the local language were used for participants whose primary language was not English. Data collectors interviewed participants in their homes and most interviews were conducted in English.

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 Ethics Committee of the Beaufort Delta Health and Social Services Authority also approved this project and the Aurora Research Institute in the NWT provided a research licence. Participants were remunerated for their time with $C25 gift cards for use at the local stores.

Statistical analysis

Data were analysed using SAS, version 9.1 (SAS Institute, Inc., Cary, NC, USA). All dietary data from QFFQs were coded and analysed using NUTRIBASE CLINICAL NUTRITION MANAGER, Version 9 (Cybersoft Inc., Phoenix, AZ, USA), a computerised dietary database using the Canadian food composition tables.

The mean (SD), median of daily energy and selected nutrient intakes were calculated for all participants. Twelve participants who reported extreme daily energy intake, defined as <2000 or >20000 kJ (<500 or >5000 kcal), were excluded from the analysis. Traditional and nontraditional eaters were classified as those consuming more or less than 300 g of traditional food daily, respectively, based on the median intake of the entire study population.

To compare the diet of traditional eaters with nontraditional eaters, nutrient densities per 1000 kcal were determined by dividing each participant's daily nutrient intake by their energy intake, multiplied by 4184. Because nutrient densities were not normally distributed after log transformation, the nonparametric Wilcoxon rank sum test was used to determine statistically significant differences in nutrient densities between traditional eaters and nontraditional eaters. All analyses were stratified by traditional/nontraditional eating patterns. All tests and *P*-values were two-sided and $\alpha = 0.05$ was considered statistically significant.

Dietary Reference Intakes (DRIs) were used to assess adequacy of nutrient intakes. Intakes were compared with the gender-specific Estimated Average Requirements (EARs) for the age groups 19–30, 31–50, 51–70 and >70 years (Joint WHO/FAO Expert Consultation, 2003; Institute of Medicine of the National Academies, 2005). If the EAR was not available, for dietary fibre, vitamin D, pantothenic acid, potassium, sodium and calcium, the Adequate Intake (AI) was used instead. The number and percentage of participants not meeting the EAR/AI were determined for selected nutrients by gender and traditional/nontraditional eaters.

Results

The study sample included 218 participants (172 women and 46 men). The mean (SD) quantity of traditional foods consumed per day was 306.6 (306.7) g. One hundred and thirty-three participants were classified as nontraditional eaters and 85 participants were classified as traditional eaters. Table 1 presents the mean (SD) energy and selected nutrient intakes of Inuvialuit men and women classified as traditional or nontraditional eaters. DRIs are also presented for reference purposes. Mean energy and saturated fat intakes exceeded recommended levels in all groups. By contrast, mean dietary fibre and vitamin E intakes were lower than recommended levels. Among women nontraditional eaters and in all men (traditional and nontraditional eaters), mean vitamin A, magnesium and potassium intakes were below recommended levels. For women nontraditional eaters, folate and iron were also below the Recommended Dietary Allowance (RDA). Traditional eaters consumed a more favourable omega 6 to omega 3 fatty acid ratio than nontraditional eaters (approximately 7 : 1 versus 10 : 1 for both men and women).

Table 2 presents the nutrient density of the diet per 1000 kcal of traditional and nontraditional eaters. The diet of traditional eaters contained, on average, higher densities of protein, omega-3 fatty acids, niacin, vitamin B_{12}, iron, selenium, zinc, ($P \leq 0.0001$), vitamin B_6, potassium, thiamin, pantothenic acid ($P \leq 0.001$), riboflavin and magnesium ($P \leq 0.05$). By contrast, the diet of nontraditional eaters contained a greater density of carbohydrate, sugar ($P \leq 0.0001$), vitamin A, ($P \leq 0.001$), dietary fibre, saturated fat, calcium and total folate ($P \leq 0.05$).

Table 1 Mean (SD) energy and selected nutrient intakes among Inuvialuit men and women (n = 218) by traditional food consumption status

	Women					Men				
	Nontraditional eaters (n = 104)		Traditional eaters (n = 68)			Nontraditional eaters (n = 29)		Traditional eaters (n = 17)		
	Mean	(SD)	Mean	(SD)	DRI*	Mean	(SD)	Mean	(SD)	DRI*
Age (years)	45.0	(14.8)	44.0	(12.3)	–	41.9	(15.3)	44.8	(11.0)	–
Energy (kJ)[¶¶]	10 493	(5263)	15 365	(5208)	7531[†]	12 381	(5747)	13 911	(5668)	9205[†]
% Energy from protein	15.1	(4.1)	22.1	(6.3)	10–35[‡]	14.7	(3.0)	21.6	(5.1)	10–35[‡]
% Energy from CHO	52.1	(8.0)	43.2	(8.4)	45–65[‡]	51.3	(7.5)	42.8	(6.1)	45–65[‡]
% Energy from fat	32.1	(6.0)	32.0	(5.1)	20–35[‡]	32.2	(5.1)	32.9	(5.3)	20–35[‡]
Protein (g)	90.4	(43.9)	196.5	(70.2)	–	105.8	(46.7)	178.7	(94.6)	–
CHO (g)	329.4	(178.3)	403.0	(173.6)	–	377.0	(172.1)	352.9	(142.9)	–
Sugars (g)	172.8	(117.9)	189.8	(93.9)	<25% of energy*	188.6	(92.6)	170.7	(85.5)	<25% of energy*
Dietary fibre (g)	15.7	(9.2)	21.1	(11.2)	25[§]	17.1	(9.4)	15.7	(7.0)	38[§]
Fat (g)	90.5	(52.0)	131.9	(52.6)	–	107.1	(53.8)	119.5	(44.1)	–
Saturated fat (g)	30.2	(16.0)	42.0	(18.1)	<10% of energy[¶]	35.8	(18.2)	38.9	(14.8)	<10% of energy[¶]
Monounsaturated fat (g)	32.5	(18.8)	48.6	(19.2)	–	39.0	(19.8)	44.9	(16.7)	–
Polyunsaturated fat (g)	15.0	(11.9)	21.6	(9.0)	–	16.1	(8.0)	18.5	(7.8)	–
Omega-3 fatty acid (g)	1.5	(0.9)	3.0	(1.3)	–	1.6	(0.6)	2.4	(1.2)	–
Omega-6 fatty acid (g)	14.9	(15.5)	19.2	(8.9)	–	16.1	(9.9)	16.4	(6.7)	–
Cholesterol (mg)	330.4	(178.4)	580.4	(257.5)	As low as possible	396.9	(171.7)	570.2	(286.4)	As low as possible
Vitamin A (μg RAE**)	656.1	(348.6)	838.0	(437.5)	700[††]	673.8	(342.0)	658.5	(302.7)	900[††]
Thiamin (mg)	1.9	(1.2)	3.1	(1.4)	1.1[††]	2.0	(0.9)	2.8	(1.1)	1.2[††]
Riboflavin (mg)	3.3	(1.7)	5.1	(2.1)	1.1[††]	3.4	(1.4)	5.1	(2.4)	1.3[††]
Niacin (mg)	28.0	(17.5)	48.8	(20.2)	14[††]	31.6	(13.4)	44.6	(13.6)	16[††]
Pantothenic acid (mg)	8.1	(3.8)	13.6	(5.7)	5[§]	8.4	(3.5)	13.7	(7.6)	5[§]
Vitamin B_6 (mg)	2.2	(1.7)	3.4	(1.5)	1.3[††]	2.4	(1.2)	2.8	(0.9)	1.3[††]
Total folate (μg)	391.5	(181.7)	539.6	(257.8)	400[††]	454.5	(208.6)	516.9	(269.2)	400[††]
Vitamin B_{12} (μg)	8.7	(6.1)	22.6	(12.0)	2.4[††]	8.9	(4.2)	19.6	(7.3)	2.4[††]
Iron (mg)	16.5	(7.5)	36.8	(14.4)	18[††]	18.7	(8.17)	34.2	(21.5)	8[††]
Vitamin C (mg)	159.5	(159.0)	201.9	(138.1)	75[††]	210.9	(156.6)	164.2	(103.5)	90[††]
Vitamin D (μg)[‡‡]	5.7	(5.1)	8.8	(6.0)	5[§]	6.1	(3.2)	6.8	(4.4)	5[§]
Vitamin E (mg)[§§]	4.0	(2.1)	6.2	(2.6)	15[††]	4.3	(2.1)	6.1	(2.8)	15[††]
Calcium (mg)	1092	(599.5)	1464	(847.0)	1000[§]	1273	(644.5)	1314	(836.8)	1000[§]
Magnesium (mg)	295.3	(134.3)	456.1	(152.3)	320[††]	317.3	(147.8)	408.1	(189.6)	420[††]
Potassium (g)	3.2	(1.5)	5.0	(1.7)	4.7[§]	3.3	(1.4)	4.6	(2.4)	4.7[§]
Sodium (g)	3.7	(2.0)	6.0	(2.5)	1.5[§]	4.3	(2.3)	5.7	(3.8)	1.5[§]

Table 1 *(Continued)*

	Women					Men				
	Nontraditional eaters (n = 104)		Traditional eaters (n = 68)			Nontraditional eaters (n = 29)		Traditional eaters (n = 17)		
	Mean	(SD)	Mean	(SD)	DRI*	Mean	(SD)	Mean	(SD)	DRI*
Selenium (μg)	112.0	(57.4)	241.7	(145.1)	55††	133.9	(64.4)	201.9	(98.3)	55††
Zinc (mg)	13.4	(7.2)	27.7	(11.2)	8††	15.3	(7.1)	25.4	(10.5)	11††

CHO, carbohydrate; DRI, Dietary Reference Intake; RAE, Retinol Activity Equivalent.
*DRIs are presented in this table using Adequate Intake (AI), Recommended Dietary Allowance (RDA) for men and women aged 31–50 years, Acceptable Macronutrient Distribution Range (AMDR) and Recommendation on saturated fat intake by Joint WHO/FAO.
†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.
‡AMDR.
§AI.
¶Recommendation on saturated fat intake by Joint WHO/FAO.
**RAE.
††RDA.
‡‡As cholecalciferol. In the absence of adequate exposure to sunlight.
§§As α-tocopherol.
¶¶1 kJ = 0.24 kcal.

Table 2 Mean (SD) nutrient density per 4184 kJ of selected nutrients among Inuvialuit traditional versus nontraditional eaters (n = 218)

	Nontraditional eaters (n = 133)		Traditional eaters (n = 85)	
	Mean	(SD)	Mean	(SD)
Protein (g)	37.49*	(9.73)	55.06*	(15.04)
Carbohydrate (g)	129.87*	(19.71)	107.67*	(19.91)
Sugars (g)	67.96*	(26.58)	51.12*	(16.76)
Dietary fibre (g)	6.20‡	(2.11)	5.44‡	(1.72)
Fat (g)	35.64	(6.47)	35.78	(5.67)
Saturated fat (g)	12.12‡	(2.49)	11.44‡	(2.33)
Monounsaturated fat (g)	12.95	(2.60)	13.27	(2.19)
Polyunsaturated fat (g)	5.68	(1.93)	5.79	(1.40)
Omega-3 fatty acid (g)	0.60*	(0.22)	0.81*	(0.31)
Omega-6 fatty acid (g)	5.42	(2.65)	5.11	(1.48)
Cholesterol (mg)	140.90†	(56.71)	162.88†	(49.74)
Vitamin A (μg RAE)	271.80†	(119.87)	226.93†	(94.15)
Thiamin (mg)	0.75†	(0.25)	0.84†	(0.22)
Riboflavin (mg)	1.38‡	(0.77)	1.43‡	(0.43)
Niacin (mg)	11.27*	(3.26)	13.46*	(2.95)
Pantothenic acid (mg)	3.48†	(2.39)	3.86†	(1.39)
Vitamin B_6 (mg)	0.85†	(0.28)	0.93†	(0.24)
Total folate (μg)	165.93‡	(63.61)	148.56‡	(41.94)
Vitamin B_{12} (μg)	3.49*	(1.57)	6.32*	(2.70)
Iron (mg)	6.87*	(2.04)	10.28*	(3.08)
Vitamin C (mg)	65.30	(47.56)	53.29	(29.28)
Vitamin D (μg)§	2.37	(1.72)	2.56	(2.56)
Vitamin E (mg)¶	1.64	(0.56)	1.72	(0.49)
Calcium (mg)	448.64‡	(162.71)	391.01‡	(122.89)
Magnesium (mg)	123.68‡	(52.55)	126.34‡	(24.13)
Potassium (g)	1.33†	(0.71)	1.41†	(0.35)
Sodium (g)	1.49	(0.55)	1.66	(0.58)
Selenium (μg)	51.38*	(22.72)	67.78*	(40.75)
Zinc (mg)	5.48*	(1.49)	7.75*	(2.28)

RAE, retinol activity equivalent.
*Significantly different, $P \leq 0.0001$.
†Significantly different, $P \leq 0.001$.
‡Significantly different, $P \leq 0.05$.
§As cholecalciferol. In the absence of adequate exposure to sunlight.
¶As α-tocopherol.

The percentage of participants that did not meet selected nutrient DRIs for their respective age group and gender, grouped by traditional and nontraditional eaters, is presented in Table 3. For all nutrients examined, a greater percentage of nontraditional eaters were below the EAR/AI. The most dramatic differences were seen for calcium, folate, vitamin D, magnesium and potassium (more than a 20% point difference), dietary fibre, vitamin B_6, vitamin C, zinc and pantothenic acid (more than a 10% point difference). Regardless of whether traditional or nontraditional eaters, dietary fibre, calcium, vitamin D, vitamin E, and potassium intakes were below recommended levels in more than one-third of participants.

The percentage contributions of the top food sources of energy and selected nutrient intakes for traditional

Table 3 Percentage of Inuvialuit adult nontraditional and traditional eaters below the dietary reference intakes*

Nutrients	Nontraditional eaters (*n* = 133)	Traditional eaters (*n* = 85)
Dietary fibre†	89.5	76.5
Calcium†	58.6	35.3
Total folate (DFE)	41.4	21.2
Vitamin A (RAE)‡,¶	39.8	30.6
Vitamin B_6‡	19.5	2.4
Vitamin C‡	25.6	12.9
Vitamin D†,§	65.4	43.5
Vitamin E§,¶	98.5	97.6
Iron‡	6.8	0.0
Zinc‡	16.5	0.0
Thiamin‡	10.5	2.4
Riboflavin‡	0.8	0.0
Niacin†	5.3	0.0
Pantothenic acid†	18.8	2.4
Vitamin B_{12}‡	0.8	0.0
Magnesium‡	49.6	14.1
Potassium†	85.7	51.8
Sodium†	6.8	0.0
Selenium‡	4.5	0.0

DFE, Dietary Folate Equivalent; RAE, Retinol Activity Equivalent.
*Institute of Medicine (2005).
†Adequate Intake used for comparison.
‡Estimated average requirement used for comparison.
§As cholecalciferol in the absence of adequate exposure to sun.
¶As α-tocopherol.

eaters (Table 4) and nontraditional eaters (Table 5) are presented. As seen in Table 4, among traditional eaters, foods classified as non-nutrient-dense (includes: butter, jam, ice cream, any cake, muffin, pie, chocolate bar, potato chips, french fries, biscuits, crackers, cookies, candies, pop corn, coffee-mate, artificial sweetener, sugar, honey and salad dressing) were the single largest source of total energy intake (33%). These foods were those with high fat/energy content and/or a relatively low nutrient density, not considered as traditional foods, or classified in other food groups such as fruit or vegetables, (i.e. soft drinks, butter/margarine, nondairy coffee whitener, hash browns/french fries). Energy contribution of non-nutrient-dense foods was followed by traditional land foods (13%). Traditional land, sky and sea foods were the main contributors of protein (56%) and iron (56%) among traditional eaters; however, non-nutrient-dense foods accounted for the largest portions of fat (35%), carbohydrate (50%), sugar (71%) and fibre (23%) intakes.

Among nontraditional eaters (Table 5), non-nutrient-dense foods contributed more to energy intake compared to traditional eaters (45% versus 33%) and traditional foods (land, sea, sky) contributed much less (approximately 3% versus 21%). Also, among nontraditional eaters, non-nutrient-dense foods were the main contributors to fat (44%), carbohydrate (57%), sugar (76%) and fibre (29%).

Discussion

The results of the present study support the growing body of evidence indicating that the nutrition transition occurring in the Arctic negatively impacts diet quality (Kuhnlein *et al.*, 2004, 2008). In the present study of Inuvialuit in the NWT, traditional versus nontraditional eating patterns appeared to have a considerable effect on the macro- and micronutrient composition of the diet. Overall, the reported total energy intake of those who were 'traditional eaters' was higher. There was a pronounced disparity in energy intake for women consuming traditional foods compared to women with a less traditional diet. The reason for this discrepancy can be largely attributed to the higher consumption of foods rich in protein and fat for women eating a more traditional diet. This trend was much less pronounced for men, although diets with higher levels of protein and fat also contributed to a higher energy intake in traditional eaters compared to nontraditional eaters. It is important to note that men were under-represented in the present study and therefore these results may not be representative of the general male Inuvialuit population. It is possible that a larger sample size would have been required to better examine how differences in macronutrients contribute to the total energy intake among gender categories. The diet of those who were 'traditional eaters' contained a greater density of protein, several B-vitamins, a number of essential minerals and a more favourable omega 6 to omega 3 fatty acid ratio. These essential nutrients are important in maintaining healthy human functioning and their absence in sufficient quantities may predispose an individual to poor health. A lower consumption of traditional foods was associated with a diet with a more dense composition of carbohydrate, saturated fat and sugar. The diet of nontraditional eaters was more densely composed of several nutrients, including dietary fibre, calcium, folate and vitamin A. More traditional eaters met the recommended adequate intake levels of these nutrients than nontraditional eaters. Indeed, those who consumed more traditional foods achieved better dietary adequacy for all nutrients examined.

Nontraditional eaters, on average, consumed very low amounts of traditional foods (approximately 3% of total energy). This is remarkable when considering that, only 150 years ago, prior to exposure to other cultures, these populations consumed the majority of their energy from these local food sources (Pauktuutit Inuit Women of Canada, 2006). Carbohydrates, which were once very low in the animal protein-rich traditional diet, contributed to

Table 4 Percentage contributions of the top 10 food sources of energy and selected nutrients among Inuvialuit traditional eaters

Foods	Energy	Foods	Protein	Foods	Fat	Foods	CHO
Non-nutrient-dense foods	33.0	Traditional land foods	38.1	Non-nutrient-dense foods	34.7	Non-nutrient-dense foods	49.8
Traditional land foods	13.1	Traditional sea foods	13.1	Beef and pork	18.4	White breads	14.6
White breads	9.5	Beef and pork	12.8	Traditional land foods	9.0	Fruits	8.4
Beef and pork	9.3	Dairy	6.6	Dairy	8.5	Dairy	3.6
Dairy	5.7	Non-nutrient-dense foods	6.0	White breads	6.8	Cereals	3.4
Traditional sea foods	4.8	Traditional sky foods	5.0	Traditional sea foods	5.4	Traditional land foods	3.4
Alcoholic beverages	4.6	White breads	4.2	Traditional sky foods	5.3	Beef and pork	1.9
Fruits	3.5	Chicken/turkey	3.7	Chicken/turkey	2.9	Wheat breads	1.9
Traditional sky foods	2.8	Soups and stews	3.3	Nuts	2.3	Rice	1.8
Soups and stews	2.1	Seafood	1.4	Soups and stews	2.0	Soups and stews	1.8
Total	88.4		94.2		95.3		90.6

Foods	Sugar	Foods	Fibre	Foods	Calcium	Foods	Iron
Non-nutrient-dense foods	71.0	Non-nutrient-dense foods	23.2	White breads	31.4	Traditional land foods	44.7
Fruits	13.6	Fruits	15.3	Dairy	27.6	White breads	10.8
Dairy	6.6	White breads	13.7	Non-nutrient-dense foods	20.3	Non-nutrient-dense foods	8.8
Cereals	1.8	Traditional land foods	7.0	Traditional land foods	3.2	Traditional sea foods	6.1
Wheat breads	1.8	Vegetables	6.3	Beef and pork	2.6	Beef and pork	5.8
Vegetables	0.8	Cereals	6.1	Traditional sea foods	2.5	Cereals	5.4
White breads	0.7	Wheat breads	5.7	Fruits	1.9	Traditional sky foods	5.2
Alcoholic beverages	0.7	Soups and stews	5.6	Cereals	1.6	Soups and stews	2.4
Beef and pork	0.6	Potatoes	4.4	Seafood	1.5	Dairy	1.7
Traditional land foods	0.6	Beef and pork	2.4	Noodles	1.2	Wheat breads	1.5
Total	98.2		89.7		93.8		92.4

CHO, carbohydrate.

Table 5 Percentage contributions of the top 10 food sources of energy and selected nutrients among Inuvialuit nontraditional eaters

Foods	Energy	Foods	Protein	Foods	Fat	Foods	CHO
Non-nutrient-dense foods	45.0	Beef and pork	20.6	Non-nutrient-dense foods	44.1	Non-nutrient-dense foods	57.2
Beef and pork	9.6	Dairy	15.0	Beef and pork	17.4	White breads	11.8
White breads	8.7	Traditional land foods	13.1	Dairy	12.8	Fruits	6.1
Dairy	8.6	Non-nutrient-dense foods	12.6	White breads	5.0	Dairy	4.4
Traditional land foods	3.3	White breads	6.5	Chicken/turkey	3.8	Cereals	2.9
Alcoholic beverages	3.1	Chicken/turkey	6.4	Traditional sky foods	2.4	Wheat breads	2.9
Fruits	3.1	Traditional sea foods	6.3	Traditional land foods	2.3	Beef and pork	1.7
Chicken/turkey	2.4	Soups and stews	3.6	Traditional sea foods	2.1	Rice	1.7
Wheat breads	2.0	Traditional sky foods	3.5	Nuts	1.8	Potatoes	1.7
Cereals	1.8	Wheat breads	2.3	Soups and stews	1.5	Noodles	1.6
Total	87.6	Total	89.9	Total	93.2	Total	92.0

Foods	Sugar	Foods	Fibre	Foods	Calcium	Foods	Iron
Non-nutrient-dense foods	75.7	Non-nutrient-dense foods	28.7	Dairy	39.2	Non-nutrient-dense foods	19.3
Fruits	8.8	White breads	13.0	Non-nutrient-dense foods	25.6	Traditional land foods	16.1
Dairy	7.4	Fruits	12.3	White breads	17.8	White breads	15.7
Wheat breads	2.4	Wheat breads	9.3	Beef and pork	2.6	Beef and pork	10.2
Cereals	1.4	Vegetables	6.9	Fruits	2.1	Cereals	8.6
Vegetables	0.8	Cereals	5.6	Noodles	1.6	Wheat breads	4.2
Alcoholic beverages	0.7	Potatoes	4.7	Cereals	1.4	Traditional sky foods	3.7
White breads	0.7	Soups and stews	3.7	Wheat breads	1.4	Dairy	3.5
Beef and pork	0.6	Beef and pork	2.8	Seafood	1.4	Soups and stews	2.7
Noodles	0.5	Noodles	2.7	Vegetables	1.0	Traditional sea foods	2.4
Total	99.0	Total	89.7	Total	94.1	Total	86.4

CHO, carbohydrate.

approximately 40% of energy intake among traditional eaters and more than 50% of energy intake in nontraditional eaters. It was observed that non-nutrient-dense foods constituted a greater portion of the nontraditional eaters' diet, although these foods were also a mainstay in the diet among traditional eaters. Similarly, although inadequate nutrient intakes were more prevalent among nontraditional eaters, they were also notably present among traditional eaters, suggesting that the effects of the nutrition transition are widespread in these communities.

These findings highlight the nutritional benefits of a traditional subsistence diet among Inuvialuit in the NWT. In addition to their important contributions to diet quality (Kuhnlein & Receveur, 2007), these foods promote physical activity through hunting and fishing, as well as other procurement and preparation activities (Redwood *et al.*, 2008), which, in addition to diet, is another important factor for preventing obesity and chronic disease. Public health strategies to improve nutrition in Inuvialuit communities should incorporate the promotion of the traditional diet. However, when promoting the use of these foods, it should be noted that concerns have been raised in recent years among Arctic populations regarding the increasing contamination of air and water resources that may affect traditional food quality (Armitage *et al.*, 2011; Hargreaves *et al.*, 2011). Furthermore, traditional food availability may be threatened by climate change, which is predicted to affect animal survival and migratory patterns (Duerden, 2004; Guyot *et al.*, 2006). Also, the modern subsistence hunter now faces the increased costs associated with these activities as a result of the use of motorised vehicles and fuel costs, as well as the use of freezers and other preservation technologies (Loring & Gerlach, 2009).

If traditional foods are replaced in the diet with store-bought foods, they should be foods of high nutrient density (i.e. vegetables, fruit and whole grains) to ensure the maintenance of diet quality. However, remote Arctic communities face barriers to the consumption of these foods as well. Store-bought foods are shipped in from provinces in southern Canada, greatly increasing food prices (Joint WHO/FAO Expert Consultation, 2003; Institute of Medicine of the National Academies, 2005; Pauktuutit Inuit Women of Canada, 2006; Indian & Northern Affairs Canada, 2008; Kuhnlein *et al.*, 2008; Pakseresht & Sharma, 2010). A recent study of Inuvialuit showed that those with lower socioeconomic status were less likely to consume fruit and vegetables (Erber *et al.*, 2010b). Furthermore, the quality and variety of perishable items is often affected by shipping and extreme Arctic temperatures (Pauktuutit Inuit Women of Canada, 2006). Strategies that creatively assist Inuvialuit communities in overcoming the many obstacles to healthy eating are urgently needed.

The present study was not without limitations. Men were under-represented in the present sample and therefore the results may not be generalisable to the general male Inuvialuit population; however, this was because household members who primarily make decisions regarding food purchase and preparation were targeted for the subsequent intervention programme and the vast majority of these were female. The Canadian food composition tables were used for the analysis of all data and foods that are fortified are accounted for in terms of nutrient content in the composition tables. However, we are unable to account for the bioavailability of the nutrients in those fortified foods; for example, iron compared to the bioavailability of nutrients, such as iron, naturally occurring in red meats.

Conclusions

Diet quality and dietary adequacy were better among Inuvialuit adults who consume more traditional foods. Efforts for improving dietary adequacy in this population should emphasise the use of traditional foods, as well as the improved availability of and access to store-bought foods of high nutritional quality.

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Conflict of interests, source of funding and authorship

The authors declare that they have no conflict of interests.

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TS and FK participated in the drafting of the manuscript and edited the manuscript. SES conducted the data analysis and the interpretation of the results. DND interpreted the results and participated in the drafting of the manuscript. AC conducted a critical review and participated in the drafting of the manuscript. SS conceived the study and critically reviewed the manuscript. All authors read and approved the final manuscript submitted for publication.

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