ORIGINAL RESEARCH ARTICLE

Dietary quality and adequacy among Aboriginal alcohol consumers in the Northwest Territories, Canada

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Objectives: The present study aimed to assess dietary adequacy and quality among Inuvialuit alcohol consumers and non-consumers in the Northwest Territories (NWT), Canada.
Study design: Cross-sectional study.
Methods: A validated quantitative food frequency questionnaire was administered to individuals (n = 216) of randomly selected households in 3 NWT communities to capture dietary intake and alcohol consumption over a 30-day recall period. The daily energy and nutrient intake, dietary adequacy and the top food sources of energy and selected nutrients were determined by alcohol consumption status.
Results: Energy intake was higher among all alcohol consumers regardless of gender. Male alcohol consumers had lower nutrient intake density (per 4,184 kJ) of protein, cholesterol and several micronutrients ($p \leq 0.05$), and female alcohol consumers had lower intake density of saturated fat ($p \leq 0.01$), thiamine, folate and sodium ($p \leq 0.05$). Among all men and women, 70–100% had inadequate intakes of dietary fibre, vitamin E and potassium. Non-nutrient-dense foods contributed similar amounts and traditional foods (TF) contributed 3% less to energy comparing alcohol consumers to non-consumers.
Conclusion: Nutrient inadequacies are prevalent among Aboriginal populations in the Canadian Arctic and may be exacerbated by alcohol consumption due to alcohol's effects on dietary intake, nutrient transport and metabolism. Adult Inuvialuit who consumed alcohol had increased caloric intake and consumed similar amounts of non-nutrient-dense foods and less nutrient-dense TF. Fewer dietary inadequacies were observed among alcohol consumers than non-consumers, which might be due to the increase in overall food intake among alcohol consumers; however, further exploration of volume and pattern of drinking might help explain this result.

Keywords: *NWT*; *Aboriginal*; *dietary adequacy*; *alcohol*; *chronic disease.*

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Alcohol consumption is a well-recognised behavioural risk factor for a myriad of chronic conditions (1,2). Increasing evidence suggests the detrimental influence of both high volume and/or pattern of alcohol consumption, such as infrequent heavy drinking (i.e. binge drinking), with an increased risk of morbidity and mortality from cardiovascular conditions, alcohol-induced disease (e.g. cardiomyopathy or fatty liver disease) and cancer (3–5).

In addition to damage to tissues, which alone increases nutrient malabsorption, alcohol consumption negatively affects nutrient intake, transport, absorption and metabolism (6,7). The altered nutrient profile among those who consume alcohol may further exacerbate alcohol's direct toxic effects and increase the risk of developing certain chronic diseases. Micronutrients such as zinc, retinoic acid and B-vitamins, are most notably affected by alcohol consumption. Even in the absence of impaired pancreatic and liver function, these nutrients are affected due to decreased dietary intake, disrupted nutrient metabolism or increased demand for these vitamins and minerals in alcohol metabolism (1,8,9).

Limited information is available on alcohol consumption and dietary intake among Inuvialuit, an Inuit population in the Northwest Territories (NWT); however, data from other Canadian Inuit and Aboriginal populations suggests an increased risk of chronic diseases related to these potentially modifiable behavioural risk factors among these similar populations (10,11). In 2006, Aboriginal populations in the NWT, which includes First

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Nations, Métis and Inuvialuit, consumed alcohol less frequently compared with non-Aboriginal populations in the NWT (69% vs. 86%), however, the pattern of drinking among Aboriginal residents is of concern (12). A higher proportion of Aboriginal residents reported consuming 5 or more drinks per occasion compared with non-Aboriginals (50% vs. 24%) and 56% of Aboriginal residents reported drinking this quantity at least once per month (12).

The Inuvialuit region has been experiencing a changing food environment throughout the last fifty years resulting in the decreased consumption of nutrient-dense traditional foods (TF) and increased consumption of processed, store-bought foods, such as soft drinks and chips, which lack essential nutrients (10,13,14). Previous dietary adequacy studies among this population have shown low intake of dietary fibre, calcium, folate and vitamins A, C and E, which might increase the risk for chronic disease development (15,16). Chronic diseases such as heart disease, stroke and certain cancers that are associated with both poor dietary intake and high volume alcohol consumption are prevalent among Inuit populations (2,10,13). Canadian Inuit have 3 times higher prevalence of heart disease and Circumpolar Inuit have higher age-standardised incidence ratios of stroke and aero-digestive cancers, specifically of the salivary gland and nasopharynx, compared with the national population (17–19). In an attempt to address the dietary inadequacy among this population Healthy Foods North (HFN), a culturally appropriate and community based program was designed to promote healthy eating and lifestyle among some communities in Northwest (NWT) and Nunavut (NU) (10).

The purpose of this study was to characterise and compare energy and nutrient intake, dietary adequacy and the top food sources of energy and selected nutrients among adult Inuvialuit in the NWT who reported consuming alcohol during a 30-day recall period compared with those who abstained.

Materials and methods

The survey instruments and data collection protocol have been described in detail elsewhere (10,15). In brief, a validated quantitative food frequency questionnaire (QFFQ) designed specifically for this population was administered between July 2007 and July 2008 to Inuvialuit residents in 3 communities in the NWT to collect dietary intake during the previous 30 days (15,20). Households were selected randomly using housing maps provided by the local government. One individual per household was recruited to participate and targeted participants were the main food shopper and/or preparer, which were typically women. Children ($<$19 years) as well as pregnant and breastfeeding women were excluded due to their altered and changing dietary requirements (10). Participants reported the consumption amount and frequency of 142 items, including alcohol, during a 30-day period by using three-dimensional food models and choosing from 8 categories ranging from "never" to "two or more times per day" (10). A food composition table specific for this population was developed primarily using the Canadian food composition tables within NutriBase, Clinical Nutrition Manager v. 7.17 (CyberSoft Inc., Phoenix, AZ), supplemented with data from the Canadian Nutrient File database (21).

The mean and standard deviation of daily energy and nutrient intake were calculated for all participants. To compare the diet quality of alcohol consumers to non-consumers, nutrient densities per 4,184 kJ were determined by dividing each participant's daily nutrient intake by their energy intake (kJ), multiplied by 4,184. Because nutrient densities were not normally distributed, the non-parametric Wilcoxon rank-sum test was used to determine statistically significant differences in nutrient intake densities between alcohol consumers vs. non-consumers. Alcohol consumers were defined as consuming $>$0 g of alcohol per day.

Dietary adequacy was calculated using the Estimated Average Requirements (EAR) based on the gender- and age-specific (19–30 years, 31–50 years, 51–70 years, $>$70 years) recommendations (22). If the EAR was not available, as for dietary fibre, vitamin D, vitamin K, pantothenic acid, potassium, sodium and calcium, the Adequate Intake (AI) was used instead. The number and percentage of participants not meeting the recommendations were determined for selected nutrients by gender and alcohol consumption status.

Overall, 230 participants were randomly selected to partake in the study. Participants who reported extreme energy intake ($<$2,092 kJ or $>$20,900 kJ, n = 12) or who had missing alcohol data (n = 2) were excluded from all analyses. All analyses were stratified by gender and alcohol consumption status. Data were analysed using SAS statistical software, version 9.2 (SAS Institute, Inc., Cary, NC). All tests and p-values were two-sided and considered statistically significant at a = 0.05. 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 as well as the Beaufort Delta Health and Social Services Authority Ethics Review Committee. As required by NWT legislation, a research license was obtained for this study from the Aurora Research Institute. All participants provided informed consent before the study.

Results

Among male (n = 46) and female (n = 170) participants, 27 men (mean age 38.6 $\pm$ 13.4 years) and 82 women (mean age 42.5 $\pm$ 13.2 years) reported alcohol

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Table I. Demographics and characteristics of the study sample of adult Inuvialuit

	Men						Women					
	Alcohol non-consumers			Alcohol consumers			Alcohol non-consumers			Alcohol consumers		
	n	%	Mean ± SD	n	%	Mean ± SD	n	%	Mean ± SD	n	%	Mean ± SD
Gender	19	41.3	–	27	58.7	–	88	51.8	–	82	48.2	–
Age (years)	–	–	49.2 ± 12.2	–	–	38.6 ± 13.4	–	–	46.5 ± 14.4	–	–	42.5 ± 13.2
Binge drinking[a]	0	NA	NA	22	81.5	–	0	NA	NA	56	68.3	–
Frequent consumers[b]	0	NA	NA	3	11.1	–	0	NA	NA	7	8.5	–
Total alcohol consumption	0	NA	NA	27	100.0		0	NA	NA	82	100.0	
Servings/month[c]		–	–			56.8 ± 107.7		–	–			39.6 ± 51.4
Ethanol (g/day)		–	–			20.4 ± 34.4		–	–			15.1 ± 18.7
Liquor consumption[d]	0	NA	NA	23	85.2		0	NA	NA	65	79.3	
Servings/month[c]		–	–			50.1 ± 113.4		–	–			34.1 ± 49.6
Ethanol (g/day)		–	–			15.3 ± 34.6		–	–			10.4 ± 15.2
Beer consumption[e]	0	NA	NA	14	51.9		0	NA	NA	47	57.3	
Servings/month		–	–			27.0 ± 32.5		–	–			21.4 ± 30.9
Ethanol (g/day)		–	–			10.9 ± 15.8		–	–			13.8 ± 16.6
Wine consumption[f]	0	NA	NA	1	3.7		0	NA	NA	11	13.4	
Servings/month[c]		–	–			2.5 ± NA		–	–			2.5 ± 2.9
Ethanol (g/day)		–	–			4.3 ± NA		–	–			4.2 ± 5.0

NA, Not applicable
[a]Binge drinking: consuming $\geq$5 servings of alcohol in one sitting as frequently as once per month to 2–3 times per week.
[b]Frequent Consumers: consuming alcohol more frequently than 3 times per week.
[c]1 serving of alcohol = 1 fl oz hard liquor or 367 ml beer or 400 ml wine.
[d]Among participants who consumed liquor.
[e]Among participants who consumed beer.
[f]Among participants who consumed wine.

consumption during the previous 30 days. The mean daily alcohol and ethanol intake is presented in Table I. The average total servings per month of liquor, beer and wine were 50.1, 27.0 and 2.5 servings, respectively, per male participant who consumed each type of alcohol. The average total servings of liquor, beer and wine were 34.1, 21.4 and 2.5 servings, respectively, per female participant who consumed each type of alcohol (Table I)[1]. The average daily energy intake among male alcohol consumers was 5,928 kJ above the Dietary Reference Intake (DRI; 9,205 kJ) and significantly higher than men who did not consume alcohol ($p \leq 0.01$;Table II). Female participants who consumed alcohol reported average daily energy intake that was 5,180 kJ above the DRI (7,531 kJ); however energy intakes did not differ between female consumers and non-consumers (Table II).

Men who reported consuming alcohol had higher average daily intakes of vitamins A, D and B6, polyunsaturated fatty acid ($p \leq 0.05$), carbohydrates, sugar, total fat, saturated fat, monosaturated fat, omega-6 fatty acid, sodium ($p \leq 0.01$), vitamin C and calcium ($p \leq 0.001$) compared with non-consumers (Table II). Conversely, intake density (per 4,184 kJ) was lower among male alcohol consumers for protein, cholesterol, riboflavin, niacin, folate, iron, selenium, zinc ($p \leq 0.05$), thiamine, pantothenic acid ($p \leq 0.01$), magnesium and potassium ($p \leq 0.001$) and higher for vitamin C ($p \leq 0.05$; Table III). Nutrient intakes were similar among women with the exception of higher vitamin C intake ($p \leq 0.05$); however, female alcohol consumers had lower intake densities of thiamine, total folate, sodium ($p \leq 0.05$) and saturated fat ($p \leq 0.01$) and higher intake density of vitamin C ($p \leq 0.01$) compared with women who did not consume alcohol (Table III).

Between 20–50% of men who consumed alcohol had inadequate intake of calcium, magnesium, vitamins A, D and K, and over three-quarters had inadequate intakes of fibre, vitamin E and potassium (Table IV). Between 20–50% of women who consumed alcohol were below the DRI for calcium, total folate, magnesium, and vitamins A and K, and more than 50% were below the recommendations for fibre, potassium and vitamins D and E

[1]Serving size: Liquor = 28 ml (1 oz), 272 kJ; Beer = 367 ml, 682 kJ; Wine = 400 ml, 1,167 kJ

Table II. Energy and selected nutrient intake among adult Inuvialuit by gender and alcohol consumption status[a]

Nutrients	Men			Women		
	Non-consumers (n = 19)	Alcohol consumers (n = 27)	DRI[c]	Non-consumers (n = 88)	Alcohol consumers (n = 82)	DRI[c]
Energy (kJ)[b]	9,840.4 ± 4,052.7	15,132.9 ± 5,738.0**	9,205[d]	12,093.2 ± 5,707.8	12,711.6 ± 5,827.4	7,531[d]
Percentage of energy from protein	18.6 ± 5.3	16.3 ± 4.9*	10–35[e]	18.0 ± 6.1	17.6 ± 6.2	10–35[e]
Percentage of energy from carbohydrates	48.2 ± 9.2	48.2 ± 7.5	45–65[e]	49.4 ± 9.2	47.8 ± 9.2	45–65[e]
Percentage of energy from fat	32.9 ± 6.2	32.2 ± 4.4	20–35[e]	32.7 ± 5.7	31.4 ± 5.6	20–35[e]
Protein (g)	108.3 ± 46.5	150.0 ± 88.3	–	132.0 ± 81.2	130.6 ± 68.2	–
Carbohydrate (g)	280.0 ± 120.1	430.1 ± 158.3**	–	353.2 ± 172.4	364.5 ± 190.0	–
Sugars (g)	135.0 ± 75.9	215.0 ± 84.4**	< 25% of energy[c]	178.0 ± 104.3	181.2 ± 115.9	< 25% of energy[c]
Dietary fibre (g)	14.1 ± 8.1	18.3 ± 8.6	38[f]	17.8 ± 10.1	18.00 ± 10.8	25[f]
Fat (g)	87.0 ± 43.1	128.5 ± 48.9**	–	106.1 ± 56.6	107.0 ± 55.9	–
Saturated fat (g)	28.5 ± 14.2	42.9 ± 16.4**	< 10% of energy[g]	35.6 ± 18.6	34.2 ± 17.0	< 10% of energy[g]
Monounsaturated fat (g)	33.1 ± 17.5	46.9 ± 17.7 **	–	38.7 ± 20.6	39.2 ± 20.7	–
Polyunsaturated fat (g)	13.8 ± 7.0	19.2 ± 8.0*	–	17.1 ± 10.6	17.9 ± 12.1	–
Omega-3 fatty acid (g)	1.6 ± 0.6	2.1 ± 1.1	–	2.0 ± 1.4	2.0 ± 1.2	–
Omega-6 fatty acid (g)	12.1 ± 5.6	19.1 ± 9.6**	–	15.5 ± 10.5	17.7 ± 16.1	–
Cholesterol (mg)	388.2 ± 147.7	512.1 ± 270.0	As low as possible	425.7 ± 264.3	430.2 ± 224.7	As low as possible
Vitamin A (μg-RAE[h])	542.2 ± 285.7	756.7 ± 325.8*	900[i]	709.8 ± 394.1	753.9 ± 400.2	700[i]
Thiamin (mg)	2.1 ± 1.1	2.5 ± 1.0	1.2[i]	2.4 ± 1.3	2.3 ± 1.5	1.1[i]
Riboflavin (mg)	3.8 ± 2.4	4.1 ± 1.6	1.3[i]	4.0 ± 2.1	4.0 ± 2.1	1.1[i]
Niacin (mg)	31.2 ± 13.4	40.0 ± 14.7	16[i]	35.6 ± 19.6	36.0 ± 21.3	14[i]
Pantothenic acid (mg)	10.4 ± 7.6	10.4 ± 4.5	5[f]	10.2 ± 5.8	10.1 ± 4.8	5[f]
Vitamin B-6 (mg)	2.2 ± 1.0	2.8 ± 1.1*	1.3[i]	2.6 ± 1.4	2.7 ± 1.9	1.3[i]
Total folate (μg)	399.2 ± 170.0	532.8 ± 256.2	400[i]	457.0 ± 245.1	442.0 ± 208.0	400[i]
Vitamin B-12 (μg)	11.5 ± 6.4	13.9 ± 8.3	2.4[i]	14.6 ± 11.9	13.5 ± 9.7	2.4[i]
Iron (mg)	21.1 ± 10.0	26.8 ± 19.3	8[i]	24.5 ± 15.6	24.2 ± 13.1	18[i]

Table 2 (*Continued*)

Nutrients	Men			Women		
	Non-consumers (n = 19)	Alcohol consumers (n = 27)	DRI[c]	Non-consumers (n = 88)	Alcohol consumers (n = 82)	DRI[c]
Vitamin C (mg)	106.5 ± 75.2	254.9 ± 143.3***	90[i]	156.6 ± 143.1	196.5 ± 161.2*	75[i]
Vitamin D (μg)[j]	5.0 ± 2.2	7.3 ± 4.2*	5[f]	7.1 ± 5.7	6.8 ± 5.7	5[f]
Vitamin E (mg)[k]	4.2 ± 2.0	5.5 ± 2.7	15[i]	5.0 ± 2.8	4.8 ± 2.4	15[i]
Vitamin K (μg)	198.2 ± 268.3	143.7 ± 80.7	120[f]	140.8 ± 111.6	152.5 ± 117.9	90[f]
Calcium (mg)	897.5 ± 405.0	1,563.1 ± 758.5***	1,000[f]	1,274.5 ± 848.2	1,207.4 ± 585.8	1000[f]
Magnesium (mg)	306.2 ± 141.8	382.3 ± 180.7	420[7]	354.7 ± 164.8	361.9 ± 159.9	320[i]
Potassium (g)	3.4 ± 1.8	4.1 ± 2.0	4.7[f]	3.9 ± 1.9	3.9 ± 1.7	4.7[f]
Sodium (g)	3.6 ± 1.8	5.7 ± 3.3**	1.5[f]	4.8 ± 2.7	4.4 ± 2.3	1.5[f]
Selenium (μg)	140.5 ± 64.6	172.1 ± 94.9	55[i]	161.9 ± 106.7	174.8 ± 129.5	55[i]
Zinc (mg)	16.3 ± 7.7	20.9 ± 10.7	11[i]	19.0 ± 12.1	18.9 ± 10.3	8[i]

[a]Values are means ± SD.
[b]1 kcal = 4.184 kJ.
[c]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 years, Acceptable Macronutrient Distribution Ranges (AMDR), and Recommendation on saturated fat intake by Joint WHO/FAO (Institute of Medicine of the National Academies, 2005; Joint WHO/FAO Expert Consultation, 2003).
[d]Estimated amounts of calories needed to maintain energy balance for women aged between 31–50 years at the level of very low physical activity-sedentary level.
[e]Acceptable Macronutrient Distribution Ranges (AMDR).
[f]Adequate Intake (AI).
[g]Recommendation on saturated fat intake by Joint WHO/FAO.
[h]Retinol activity equivalent.
[i]Recommended Dietary Allowance (RDA).
[j]As cholecalciferol. In the absence of adequate exposure to sunlight.
[k]As alpha–tocopherol.
*Different from non-consumers of same gender, $p \leq 0.05$.
**Different from non-consumers of same gender, $p \leq 0.01$.
***Different from non-consumers of same gender, $p \leq 0.001$.

Table III. Nutrient density per 4,184 kJ of selected nutrients among adult Inuvialuit by gender and alcohol consumption status

	Men		Women	
Nutrients	Non-consumers (n = 19)	Alcohol consumers (n = 27)	Non-consumers (n = 88)	Alcohol consumers (n = 82)
Protein (g)	46.5 ± 13.3	40.7 ± 12.2*	45.0 ± 15.1	44.0 ± 15.4
Carbohydrate (g)	120.5 ± 23.0	120.4 ± 18.7	123.6 ± 23.1	119.5 ± 23.0
Sugars (g)	60.0 ± 29.8	61.9 ± 21.1	62.8 ± 25.5	60.2 ± 24.0
Dietary fibre (g)	5.9 ± 2.1	5.0 ± 1.2	6.2 ± 2.0	5.9 ± 2.1
Fat (g)	36.6 ± 6.9	35.7 ± 4.8	36.4 ± 6.4	34.9 ± 6.2
Saturated fat (g)	11.9 ± 2.6	12.0 ± 2.4	12.3 ± 2.3	11.4 ± 2.5**
Monounsaturated fat (g)	13.7 ± 2.8	13.1 ± 2.0	13.2 ± 2.4	12.8 ± 2.5
Polyunsaturated fat (g)	5.8 ± 1.4	5.4 ± 1.2	5.8 ± 1.7	5.7 ± 2.0
Omega-3 fatty acid (g)	0.7 ± 0.2	0.6 ± 0.3	0.7 ± 0.3	0.7 ± 0.3
Omega-6 fatty acid (g)	5.1 ± 1.2	5.3 ± 1.5	5.2 ± 2.0	5.4 ± 2.9
Cholesterol (mg)	175.0 ± 52.9	143.5 ± 56.8*	148.5 ± 58.5	146.5 ± 51.0
Vitamin A (µg-RAE[b])	241.4 ± 84.5	216.3 ± 73.8	261.5 ± 117.0	264.7 ± 121.8
Thiamin (mg)	0.9 ± 0.3	0.7 ± 0.2**	0.8 ± 0.2	0.8 ± 0.3*, ‡
Riboflavin (mg)	1.6 ± 0.7	1.2 ± 0.3*	1.4 ± 0.4	1.4 ± 0.9
Niacin (mg)	13.4 ± 2.8	11.3 ± 2.3*	12.2 ± 3.2	11.8 ± 3.5
Pantothenic Acid (mg)	4.4 ± 2.2	2.9 ± 0.9**	3.6 ± 1.3	3.7 ± 2.8
Vitamin B-6 (mg)	0.9 ± 0.2	0.8 ± 0.2	0.9 ± 0.3	0.9 ± 0.3
Total folate (µg)	175.4 ± 43.7	147.5 ± 34.7*	163.7 ± 48.3	154.9 ± 71.6*
Vitamin B-12 (µg)	5.0 ± 2.4	3.9 ± 1.9	4.9 ± 2.8	4.4 ± 2.2
Iron (mg)	9.2 ± 3.3	7.2 ± 2.8*	8.4 ± 3.0	8.1 ± 3.0
Vitamin C (mg)	55.9 ± 54.8	74.8 ± 46.2*	52.2 ± 37.6	66.0 ± 40.1**
Vitamin D (µg)[c]	2.3 ± 1.0	2.1 ± 1.3	2.4 ± 1.9	2.5 ± 2.6
Vitamin E (mg)[d]	1.8 ± 0.5	1.5 ± 0.5	1.8 ± 0.6	1.6 ± 0.5
Vitamin K (µg)	83.6 ± 81.4	41.7 ± 23.9	53.2 ± 40.2	64.5 ± 94.2
Calcium (mg)	402.5 ± 119.3	439.7 ± 142.9	444.8 ± 177.8	410.5 ± 126.1
Magnesium (mg)	133.2 ± 31.4	104.4 ± 22.5***	127.2 ± 32.9	126.9 ± 58.3
Potassium (g)	1.5 ± 0.5	1.1 ± 0.3***	1.4 ± 0.4	1.4 ± 0.8
Sodium (g)	1.5 ± 0.4	1.5 ± 0.5	1.7 ± 0.7	1.5 ± 0.4*
Selenium (µg)	63.0 ± 24.9	46.9 ± 14.0*	57.9 ± 31.3	60.3 ± 37.8
Zinc (mg)	6.9 ± 2.0	5.7 ± 1.6*	6.5 ± 2.3	6.4 ± 2.2

[a]Values are means ± SD.
[b]Retinol activity equivalent.
[c]As cholecalciferol. In the absence of adequate exposure to sunlight.
[d]As alpha–tocopherol.
‡Mean thiamin intake for female non-consumers = 0.82 mg and female alcohol consumers = 0.76 mg.
*Different from non-consumers of same gender, $p \leq 0.05$.
**Different from non-consumers of same gender, $p \leq 0.01$.
***Different from non-consumers of same gender, $p \leq 0.001$.

(Table IV). The proportion of male and female alcohol consumers with inadequate intakes was similar or lower for all nutrients compared with alcohol non-consumers, with the exception of folate and the B-vitamins thiamine, niacin, pantothenic acid and vitamin B12, of which more female alcohol consumers than non-consumers reported inadequate intakes. Average sodium intake was approximately 3–4 times above the DRI for alcohol consumers and approximately 2–3 times above the DRI for non-consumers.

Among men and women combined, alcoholic beverages accounted for 6.4% of total energy and 2.5% of carbohydrates (Table V). Regardless of alcohol consumption status, non-nutrient-dense foods (NNDF) were the primary food source of energy, fat and carbohydrates. Traditional foods were the primary source for protein (Tables V and VI). Among those who consumed alcohol, NNDF contributed similar amounts to energy (+1.1%) and more to fat (+2.3%) and carbohydrates (+3.9%) compared with those who did not consume alcohol.

Table IV. Percent of adult Inuvialuit below the Dietary Reference Intakes by gender and alcohol consumption status

	Men		Women	
Nutrients	Non-consumers (n = 19) (%)	Alcohol consumers (n = 27) (%)	Non-consumers (n = 88) (%)	Alcohol consumers (n = 82) (%)
Dietary fibre (g)[a]	100.0	100.0	80.7	79.3
Calcium (mg)[a]	73.7	22.2	55.7	46.3
Total folate (μg-DFE[b])[c]	42.1	18.5	31.8	39.0
Vitamin A (μg-RAE[d])[c]	68.4	48.1	33.0	28.0
Vitamin B-6 (mg)[c]	21.1	3.7	13.6	13.4
Vitamin C (mg)[c]	42.1	14.8	27.3	11.0
Vitamin D (μg)[a,e]	73.7	33.3	62.5	53.7
Vitamin E (mg)[c,f]	100.0	96.3	97.7	98.8
Iron (mg)[c]	5.3	0.0	4.5	4.9
Zinc (mg)[c]	26.3	11.1	10.2	6.1
Thiamin (mg)[c]	21.1	3.7	4.5	8.5
Riboflavin (mg)[c]	5.3	0.0	0.0	0.0
Niacin (mg)[c]	5.3	0.0	2.3	4.9
Pantothenic acid (mg)[a]	15.8	14.8	10.2	13.4
Vitamin B-12 (μg)[c]	0.0	0.0	0.0	1.2
Vitamin K (μg)[a]	47.4	44.4	35.2	31.7
Magnesium (mg)[c]	68.4	48.1	30.7	30.5
Potassium (g)[a]	84.2	74.1	72.7	69.5
Sodium (g)[a]	15.8	0.0	3.4	3.7
Selenium (μg)[c]	5.3	0.0	3.4	1.2

[a]Adequate Intake (AI) used for comparison.
[b]Dietary Folate Equivalent.
[c]Estimated Average Requirement (EAR) used for comparison.
[d]Retinol Activity Equivalent.
[e]As cholecalciferol in the absence of adequate exposure to sunlight.
[f]As alpha–tocopherol.

Conversely, the contribution of TF to energy and protein were lower (−3.1% and −5.5%, respectively) among those who consumed alcohol compared with those who abstained.

Discussion

This study is the first to describe the differences in nutrient intake and dietary adequacy of adult Inuvialuit by alcohol consumption status. Overall, the dietary quality of male and female alcohol consumers in this study aligned with previous research in the United States and the 3 Canadian territories that highlight alcohol's contribution to decreased diet quality and altered dietary intake, though there were mixed results of decreased dietary adequacy (23,24).

Male alcohol consumers in this study reported significantly higher average daily energy and nutrient intakes compared with non-consumers; however, these intakes were similar between women regardless of alcohol consumption status. Although population-specific data is not available, Canadian Aboriginal women experience or perceive social stigma and shame for substance use and therefore might underreport alcohol consumption, which could help explain the similarly high energy intakes among women (25,26). In this population, average daily alcohol intake among females and males accounts for part of the 5,180–5,928 kJ intake above the DRI, though the proportion varies greatly depending on the type of drink consumed (i.e. liquor, beer or wine). The remaining excess energy intake might be explained by increased food consumption, a behaviour associated with moderate alcohol consumption (27). The average body mass index previously documented among this population was higher among women compared with men (30.5 and 28.6, respectively), which might help explain the higher caloric intake among women in this study (28). Gender has also been associated with intake estimation errors, so it is possible the high energy intake among all women in this study is due to general over reporting on the FFQ (21,29). Considering dietary patterns, all study participants reported high contribution of NNDF and low contribution of TF to energy intake which was expected given the

Table V. Top ten food sources of energy and selected nutrients among adult Inuvialuit who consume alcohol

Foods	Energy (%)	Foods	Protein (%)	Foods	Fat (%)	Foods	Carbohydrates (%)
Non-nutrient-dense foods	39.4	Traditional land foods	26.4	Non-nutrient-dense foods	40.3	Non-nutrient-dense foods	55.5
Beef and pork	9.6	Beef and pork	17.0	Beef and pork	18.2	White breads	12.8
White breads	8.7	Dairy	10.1	Dairy	10.5	Fruits	5.8
Traditional land foods	7.3	Traditional sea foods	9.9	White breads	5.7	Dairy	3.7
Dairy	6.9	Non-nutrient-dense foods	9.2	Traditional land foods	5.2	Cereals	2.8
Alcoholic beverages	6.4	Chicken/turkey	5.3	Chicken/turkey	3.8	Alcoholic beverages	2.5
Traditional sea foods	3.0	White breads	5.2	Traditional sky foods	3.6	Wheat breads	2.3
Fruits	2.6	Traditional sky foods	4.2	Traditional sea foods	3.5	Traditional land foods	2.0
Chicken/turkey	2.4	Soups and stews	3.5	Nuts	2.0	Rice	1.9
Traditional sky foods	1.9	Wheat breads	1.3	Soups and stews	1.7	Noodles	1.7
Total	88.2		92.2		94.6		91.0

on-going nutritional transition in this population (10). Male and female alcohol consumers had significantly lower intake density of macronutrients, vitamins and minerals, suggesting differences in dietary preferences and quality compared to non-consumers, which is consistent with the lower consumption of nutrient-rich TF noted among alcohol consumers in this study (30,31).

Despite decreased dietary quality, a smaller proportion of male alcohol consumers were below the DRI for all nutrients of interest compared with alcohol non-consumers. Therefore, male alcohol consumers appear to have fewer dietary inadequacies than non-consumers. Similarly, the proportion of female alcohol consumers below recommended nutrient intakes was equal to or lower than non-consumers, with the exception of folate. The lower proportions of alcohol consumers below the recommendations are likely attributable to increased overall food intake among alcohol consumers, such that the high volume of food consumed outweighed the low nutrient density of that food. Even though the proportion of alcohol consumers below the DRI were lower compared with non-consumers, they are notable because of alcohol's direct effect on increased gastric emptying, small intestinal motility, gastrointestinal mucosal damage, and impaired pancreatic and liver function, the latter 2 of which cause disrupted digestion and malabsorption (1,7–9). Further, inadequate nutrient intake among participants who consume high volumes of alcohol or have binge-drinking patterns, which includes 22–56% of participants, may exacerbate the risk of hemorrhagic stroke, coronary heart disease, liver damage and cancers of the oral cavity and breast (1,32–34).

Folate was one of the few nutrients with a higher proportion of female alcohol consumers below the recommended intake compared with non-consumers. This is notable because alcohol consumption decreases folate uptake in the small intestine and increases kidney excretion. (35,36). Low folate levels alone or in conjunction with other nutrient deficiencies, such as the vitamins B6 and B12, have been associated with increased risk of adverse reproductive outcomes in women of childbearing age, coronary heart disease, stroke and certain cancers (34,37). Low magnesium intake was reported among nearly half of male alcohol consumers in this study, which is notable because alcohol decreases intestinal magnesium absorption (38,39). Magnesium modulates a wide range of physiological mechanisms and its low intake could increase the risk of hypertension and alter calcium and vitamin D homeostasis (6,38,39). Additionally, low magnesium concentrations are correlated with poor thiamine metabolism and utilisation (40).

A high proportion of participants regardless of gender had unbalanced electrolyte intakes that may increase the risk of high blood pressure. Sodium intake among male and female alcohol consumers was between 3–4 times higher than the DRI, though this is likely underestimated as the questionnaire did not assess salt used during cooking or dining. Between 70–74% of study participants had inadequate potassium intake, which mitigates the blood pressure raising effects of sodium and has been inversely associated with hypertension (41). These factors, in addition to alcohol consumption and high caloric, saturated fat and cholesterol intakes might increase the

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Table VI. Top ten food sources of energy and selected nutrients among adult Inuvialuit who do not consume alcohol

Foods	Energy (%)	Foods	Protein (%)	Foods	Fat (%)	Foods	Carbohydrates (%)
Non-nutrient-dense foods	38.3	Traditional land foods	30.5	Non-nutrient-dense foods	38.0	Non-nutrient-dense foods	51.6
Beef and pork	9.5	Beef and pork	14.6	Beef and pork	17.5	White breads	13.4
White breads	9.5	Traditional sea foods	10.9	Dairy	10.8	Fruits	8.9
Traditional land foods	9.4	Dairy	9.7	Traditional land foods	6.3	Dairy	4.4
Dairy	7.6	Non-nutrient-dense foods	7.9	White breads	6.1	Cereals	3.6
Fruits	4.2	White breads	5.0	Traditional sky foods	4.2	Wheat breads	2.7
Traditional sea foods	3.6	Traditional sky foods	4.6	Traditional sea foods	4.0	Traditional land foods	2.3
Traditional sky foods	2.3	Chicken/turkey	4.1	Chicken/turkey	2.8	Potatoes	1.9
Cereals	2.2	Soups and stews	3.2	Nuts	2.1	Rice	1.6
Soups and stews	1.9	Seafood	1.7	Soups and stews	1.7	Beef and Pork	1.6
Total	88.5		92.1		93.6		92.0

risk of cerebrovascular and cardiovascular disease among this population (42,43).

Several men and women in this study had inadequate intakes of all 4 fat soluble vitamins. Low vitamin A intake could have implications for cancer and anemia (1,6,44,45). High prevalence of anemia has been documented among Inuit populations for decades, despite high iron intake from TF, and is likely due to a combination of factors including inadequate intakes of folate, riboflavin and vitamins A, C, E, B6 and B12 (46,47). The low intake of the fat soluble vitamins D, E and K, may have significant implications for bone and cardiovascular health (48).

This study is not without limitations. The legality of alcohol sales and consumption varied among the 3 communities: 1 community was completely dry, another prohibited alcohol sales and the third did not have any alcohol restrictions. As such, it is possible alcohol consumption was underreported in some of the communities. Due to small sample size, this study did not explore social and behavioural factors such as smoking and socioeconomic status, both of which are correlated with alcohol consumption and dietary intake among other populations (49–51). The small sample contributed to further study limitations by prohibiting the in–depth exploration of dietary intake differences by volume and pattern of drinking, which might help to explain the large variation in energy and nutrient intake as moderate and binge drinking have been associated with increased food consumption (27). This study aimed to include the main food shopper and preparer of the household, who are mostly women. As such, there were a small number of male participants, which limits the generalisability to the male Inuvialuit population. Despite these limitations, this study provided an overview of the dietary intake differences between Inuvialuit alcohol consumers and non-consumers, and highlighted certain dietary inadequacies which might place alcohol-consumers at greater risk for chronic diseases.

Conclusion

Adult Inuvialuit who consumed alcohol in this study had increased caloric intake and consumed more non-nutrient-dense foods and fewer nutrient-dense TF. The high energy intake among alcohol consumers compared with non-consumers suggests fewer dietary inadequacies among consumers. Further exploration of volume and pattern of drinking might help explain this result. Overall, the dietary inadequacies among all study participants, may contribute to increased risk of obesity, hypertension, cardiovascular disease, and stroke, especially among alcohol consumers. From a public health standpoint, this information could be used when designing nutrition education programs to highlight the relationship between alcohol consumption and diet quality with the risk of chronic disease development.

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