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RESEARCH PAPER

Dietary adequacy and alcohol consumption of Inuvialuit women of child-bearing age in the Northwest Territories, Canada

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Abstract

Background: Previous studies highlight a possible association between alcohol-drinking patterns and dietary inadequacies, which may have negative implications, particularly for women of child-bearing age. The present study aimed to compare dietary adequacy among alcohol drinkers versus nondrinkers in Inuvialuit women of child-bearing age.
Methods: A cross-sectional survey of 92 randomly selected women of child-bearing age (19–44 years) was conducted in three communities in the Northwest Territories of Arctic Canada, using a validated quantitative food frequency questionnaire. Data were analysed to compare mean daily energy and nutrient intakes, dietary adequacy and nutrient densities (per 4184 kJ) between alcohol drinkers and nondrinkers, as well as heavy drinkers and nonheavy drinkers, using the nonparametric Wilcoxen rank sum test.
Results: The response rate was between 65% and 85% depending on the community sampled. Of the study participants, 54% (n = 49) were drinkers and 46% (n = 42) were nondrinkers. Of the drinkers, 45% (n = 22) were heavy drinkers. Mean energy intakes were high among all women, although they were significantly higher among drinkers [17 179 kJ (4106 kcal)] compared to nondrinkers [13 317 kJ (3183 kcal)]. There were no significant differences in nutrient intake between the two groups; however, drinkers had a lower nutrient density for most nutrients. Heavy drinkers had a significantly lower nutrient density for all nutrients, except protein, iron, and vitamins B_6, C and D, compared to nonheavy drinkers.
Conclusions: The findings of the present study provide evidence of inadequate dietary intake among Inuvialuit of child-bearing age, regardless of alcohol-drinking behaviour.

Introduction

The harmful use of alcohol is a significant contributor to the global burden of disease and is listed as the third leading risk factor for premature deaths and disabilities, mainly through injuries and domestic violence, or an increased risk of disease, including cancers, gastrointestinal diseases, neurological disorders and cardiovascular disease [World Health Organization (WHO), 2009]. Alcohol has also been identified as one of the four most common modifiable and preventable risk factors for major noncommunicable diseases. Furthermore, there is emerging evidence that the harmful use of alcohol contributes to the health burden caused by communicable diseases such as tuberculosis and HIV/AIDS (WHO, 2011).

The patterns, context and overall level of alcohol consumption influence the health of the population as a whole. In North America, heavy alcohol use caused an estimated 9% of disability-adjusted life-years (Public Health Agency of Canada, 2008). Women in the Northwest

Territories (NWT) have among the highest prevalence rates for high-risk alcohol use in Canada (Public Health Agency of Canada, 2008). The 2009 Addictions Survey showed that 74% of females aged >15 years were alcohol consumers (Northwest Territories Health & Social Services, 2010).

The oxidative stress associated with heavy alcohol consumption increases risk and contributes to the onset and progression of coronary heart disease, stroke and diabetes mellitus (Rehm *et al.*, 2003; Balbi *et al.*, 2010). However, low volumes of alcohol consumption may have a protective mechanism against such diseases (Rehm *et al.*, 2003).

It has been hypothesised that nutritional inadequacies may be more pronounced in certain individuals with unhealthy lifestyle behaviours such as the harmful use of alcohol. Previous research on alcohol consumption and dietary intake patterns highlight an association between the intake of alcohol and decreased diet quality (Garriguet, 2009; National Institute on Alcohol Abuse & Alcoholism, 2010). A recent study among Inuvialuit in three NWT communities showed that alcohol consumers had significantly lower micronutrient densities (Rittmueller *et al.*, 2012). This is of particular concern to dietary adequacy because of the effect of alcohol on gastric emptying, intestinal motility, and the disrupted digestion and malabsorption caused by gastrointestinal mucosal damage, as well as impaired pancreatic and liver function (Bode & Bode, 2003; Seitz & Stickel, 2007). Intake of adequate micronutrients is especially important for women of child-bearing age because dietary patterns affect body and lung growth development in the foetus via DNA methylation (Tobi *et al.*, 2011). Inadequate intakes of select micronutrients during pregnancy may therefore induce epigenetic changes because folate and vitamin B_{12} are important methyl donors during pregnancy (Steegers-Theunissen *et al.*, 2009) and vitamin E may potentially influence airway development via the alternation of gene expression and airway epithelial cell signalling (Turner *et al.*, 2010). Understanding the dietary patterns of Inuvialuit women of child-bearing age in Arctic Canada who are alcohol consumers is essential for the development of interventional programmes specific to this population. The present study aimed to describe the general prevalence of alcohol drinkers and analyse dietary adequacy among Inuvialuit women of child-bearing age who are alcohol drinkers versus nondrinkers in the NWT, Canada.

Materials and methods

All data were collected at baseline for the Healthy Foods North nutrition and lifestyle intervention. The setting, recruitment methods and data collection procedures have been described in detail elsewhere (Sharma, 2010). Briefly, homes were randomly selected in three communities in the NWT using local housing maps. Subjects were chosen to participate in the study provided that they were women aged 19–44 years, had lived in the community for at least 6 months, and were the main food preparers and shoppers for their household. Pregnant and breastfeeding women were excluded as a result of their different nutritional requirements. The communities in the NWT range in size from 400 to 3500 people, with two food stores in smaller communities and three food stores in the largest community. The stores' food supplies are provided by air freight year round and by barge/sealift during a small window of time in the summer months when the ice melts (Sharma, 2010). The largest community represents the regional administrative centre, whereas the smaller ones are comparatively more remote and activities, such as hunting and fishing, are more a part of daily life. Of the chosen communities, 40–90% of the populations are Inuvialuit and mean incomes range from $33 000 with 50% employment rate to $64 000 with 60% employment, specifically for the Aboriginal population group (Statistics Canada, 2011).

Data collection

All participants were contacted by staff for an interview, and the interview was either conducted immediately or scheduled for another time that was more convenient for the subject. Participants were contacted up to seven times and, if no response was received after the seventh attempt, staff moved on to the next household using the preplanned map. Participation rates varied from 65% to 85% between the communities. Trained staff collected dietary data using a culturally appropriate, validated quantitative food frequency questionnaire (QFFQ), which was developed specifically for the study population (Pakseresht & Sharma, 2010). An interviewer fluent in the local language or an interpreter was used for participants whose primary language was not English. The QFFQ consisted of 142 line items, including alcoholic beverages, and participants were asked to report frequency of consumption over a 30-day period by choosing from eight categories that ranged from 'never' to 'two or more times per day'. Three-dimensional food models (NASCO Company, Fort Atkinson, WI, USA), household units (e.g. bowls, spoons), standard units (e.g. cups) and local food packages were carefully chosen with input from community members to best estimate the mean portion sizes of all food items. Nutrient intake was calculated per person using NUTRIBASE CLINICAL NUTRITION MANAGER, version 9 (Cybersoft Inc., Phoenix, AZ, USA), a computerised dietary database based on the US Department of Agriculture (USDA) National Nutrient Database for Standard Reference. Anthropometric data, including participant weights and heights, were also collected, as well

as demographic information to indicate socio-economic status. The principle investigator (SS) examined all data for completeness and, for any incomplete data sets, the interviewer contacted the respondent to obtain the missing information. All participants, regardless of completion, were given a $25 gift certificate for a local store to thank them for their time.

All subjects provided their written consent to participate in the study after disclosure of the objectives and methods of the study. Ethical approval was obtained from the Committee on Human Studies at the University of Hawaii, the Office of Human Research Ethics at the University of North Carolina at Chapel Hill, and the Beaufort Delta Health & Social Services Authority Ethics Review Committee, NWT. The Aurora Research Institute (Inuvik, NWT) granted the research licence.

Statistical analysis

Descriptive statistics included age, body mass index (normal weight 20–24.9 kg m^{-2}, overweight 25–29.9 kg m^{-2} and obese $\geq$30 kg m^{-2}), marital status (single/married or common law), education [none or some junior high school (HS)/junior HS or HS completed/college or trade school or university], smoking status (yes/no) and measures of socio-economic status, including the number of people in the household with income or who were self-employed. Mean daily energy and nutrient intakes were compared between alcohol drinkers (consuming >0 g day^{-1}) and nondrinkers, and the age appropriate daily recommended intake (DRI) and adequate intake values were used for dietary fibre, vitamin D, calcium, vitamin K, vitamin B_5, potassium and sodium. Dietary adequacy was calculated using the estimated average requirements. Dietary data were also analysed per 4184 kJ per individual and the nonparametric Wilcoxen Rank sum test was used to determine statistically significant ($\alpha = 0.05$) discrepancies between alcohol drinkers and nondrinkers and between heavy drinkers [defined as those who drink more than five standard drinks on one occasion (68 g), 12 or more times per year (Statistics Canada, 2010)] and nonheavy drinkers. Results that qualified as extreme energy intakes [<2092 kJ (<500 kcal), $n = 0$; >29 288 kJ (>7000 kcal), $n = 5$] were excluded from the study. Data were analysed using SAS, version 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 97 participants completed the QFFQ, and five were excluded from analysis based on extreme caloric intake [>29 288 kJ (>7000 kcal)]. Data were analysed from 92 women, aged 19–44 years, of which 50 (54%) were drinkers and 42 (46%) were nondrinkers. Alcohol consumers and nonconsumers were not significantly different in terms of mean age and body mass index. In addition, there were no significant differences in smoking status, marital status, education completed, number of people in the household with income, and the number of

Table 1 Characteristics of Inuvialuit women of child-bearing age (19–44 years) by alcohol status ($n = 91$*)

	Drinkers ($n = 49$)		Nondrinkers ($n = 42$)		
Variables	Mean	(SD)	Mean	(SD)	*P*-value
Age (years)	34.6	(6.9)	34.4	(7.3)	0.93
BMI*	30.5	(8.9)	31.0	(9.7)	1.0
Alcohol (g day^{-1})			–	–	
Total alcohol	20.1	(27.8)	–	–	
Liquor	11.7	(21.8)	–	–	
Beer	11.6	(15.9)	–	–	
Wine	4.3	(4.8)	–	–	–
BMI category†	*n*	(%)	*n*	(%)	
Normal weight (<25.0 kg m^{-2})	26	(28.6)	20	(22.0)	
Overweight (25–29.9 kg m^{-2})	8	(8.8)	5	(5.5)	
Obese ($\geq$30.0 kg m^{-2})	15	(16.5)	17	(18.7)	0.43
Smoking status					
Nonsmoker	11	(12.1)	12	(13.2)	
Smoker	38	(41.8)	30	(33.0)	0.51
Marital status					
Single	20	(22.0)	16	(17.6)	
Married or common law	28	(30.8)	25	(27.5)	0.85
Education					
None/some junior high school	11	(12.1)	10	(11.0)	
Junior HS or HS completed	23	(25.3)	19	(20.9)	
College, trade school or university	14	(15.4)	13	(14.3)	0.54
Number of people with income in household					
0	11	(12.1)	10	(11.0)	
1	21	(23.1)	16	(17.6)	
2	9	(9.9)	14	(15.4)	
3 or more	8	(8.8)	2	(2.2)	0.51
Number of self employed people in household					
0	42	(46.1)	29	(31.8)	
1	6	(6.6)	12	(13.1)	
2	1	(1.1)	1	(1.1)	0.09

*One participant was excluded from this analysis as a result of incomplete data.

†BMI based on the World Health Organization classification [World Health Organization (WHO), 2004].

BMI, body mass index; HS, high school.

people self-employed between the groups. The mean consumption of alcohol among drinkers was 20.1 g day^{-1}. The most frequently consumed source of alcohol was liquor (11.7 g day^{-1}), followed by beer (11.6 g day^{-1}) and wine (4.3 g day^{-1}) (Table 1).

Mean energy intake for all women exceeded the DRI of 7531 kJ (1800 kcal), and there was a significant difference in energy intake between drinkers [17 179 kJ (4106 kcal)] and nondrinkers [13 317 kJ (3183 kcal)] (Table 2).

Many women, regardless of alcohol consumption, were below the DRI for most micronutrients, with >60% below recommendations for dietary fibre, potassium, and vitamins D and E. Compared to nondrinkers, alcohol drinkers had a lower nutrient density (gram of nutrient per 4184 kJ) for most nutrients ($P < 0.05$), except cholesterol and vitamins A, B_{12}, C and D (Table 3). In addition, among drinkers, heavy drinkers had a significantly lower nutrient density for all nutrients, except protein, iron, vitamins B_6, C and D, compared to nonheavy drinkers (Table 4).

Table 2 Energy and nutrient intake among Inuvialuit women of child-bearing age: drinkers versus nondrinkers

	Mean (SD)			% below DRI			
Nutrients	Drinkers	Nondrinkers	*P*-value	Drinkers	Nondrinkers	*P*-value	DRI*
Energy (kJ)†	17 179 (8146)	13 317 (6141)	0.04	14.0	21.4	0.4	7531
% Energy carbohydrate†	43.5 (13.4)	53.0 (9.8)	0.0006	48.0	11.9	0.0002	45–65
% Energy from fat†	25.0 (7.2)	30.2 (5.5)	0.0003	26.0	7.1	0.02	20–35
% Energy protein†	13.9 (5.3)	17.1 (5.9)	0.003	26.0	7.1	0.02	10–35
Carbohydrate (g)	428 (241)	417 (202)	0.97	–	–	–	–
Fat (g)	109 (59)	108 (56)	1	–	–	–	–
Protein (g)	136 (74)	139 (81)	0.97	–	–	–	–
Sugar (g)	227 (156)	229 (136)	0.78	–	–	–	–
Fibre (g)	23.3 (15.5)	21.9 (11.6)	0.93	67.4	66.7	0.95	25§
Folate (μg)‡	445 (205)	469 (257)	0.77	38.8	26.2	0.21	400¶
Polyunsaturated fat (g)	17.4 (12.0)	16.3 (8.6)	0.94	–	–	–	–
Omega 3 (g)	1.8 (1.0)	1.8 (1.2)	0.82	–	–	–	–
Omega 6 (g)	17.9 (16.4)	15.1 (8.0)	0.78	–	–	–	–
Cholesterol (mg)	466 (224)	434 (253)	0.46	–	–	–	ALAP
Vitamin A (IU)	451 (320)	383 (328)	0.15	24.5	31.0	0.49	700¶
Vitamin B_1 (mg)	2.7 (1.9)	2.6 (1.4)	0.7	6.1	2.4	0.39	1.1¶
Vitamin B_2 (mg)	4.5 (2.6)	4.3 (2.2)	0.7	0	0	–	1.1¶
Vitamin B_3 (mg)	40.9 (27.1)	38.3 (20.3)	0.76	4.1	0	0.19	14**
Vitamin B_5 (mg)	10.6 (5.2)	10.3 (5.5)	0.66	14.3	7.1	0.28	5¶
Vitamin B_6 (mg)	3.2 (2.6)	2.8 (1.5)	0.72	10.2	7.1	0.61	1.3¶
Vitamin B_{12} (μg)	15.0 (11.4)	14.5 (11.2)	0.77	2.0	0	0.35	2.4¶
Vitamin C (mg)	281 (248)	215 (207)	0.07	8.2	16.7	0.22	75¶
Vitamin D (μg)**	6.2 (4.1)	7.1 (7.8)	0.88	81.6	71.4	0.25	5§
Vitamin E (mg)††	4.0 (7.6)	2.2 (2.3)	0.55	98.0	97.6	0.91	15¶
Calcium (mg)	1345 (705)	1478 (1054)	0.73	30.6	23.8	0.47	1000§
Magnesium (g)	389 (176)	379 (160)	0.89	28.6	23.8	0.61	320‡‡
Potassium (mg)	4.2 (1.9)	4.2 (1.9)	0.98	65.3	66.7	0.89	4.7§
Sodium (mg)	4.9 (2.8)	5.4 (3.0)	0.59	6.1	2.4	0.39	1.5§
Iron (mg)	25.2 (14.8)	25.9 (16.1)	0.9	6.1	7.1	0.85	18¶
Selenium (μg)	167 (92)	172 (110)	0.99	2.0	4.8	0.47	55¶
Zinc (mg)	19.6 (10.9)	19.5 (10.9)	0.93	6.1	9.5	0.55	8¶

*The dietary reference intake is presented using adequate intake, recommended dietary allowance and acceptable macronutrient distribution ranges for women aged 19–50 years.

†Acceptable macronutrient distribution ranges are the estimated amounts of calories needed to maintain energy balance for women aged 31–50 years at the level of very low physical activity.

‡Dietary folate equivalent.

§Adequate intake.

¶Recommended dietary allowance.

**As cholecalciferol in the absence of adequate exposure to sunlight.

††As α-tocopherol.

‡‡Value for ages 31–50 years chosen because the population studied had a higher percentage of women in this age category.

ALAP, as low as possible; DRI, dietary reference intake.

Discussion

The results of the present study show that approximately half of the women of child-bearing age in the NWT were alcohol drinkers, which is a finding consistent with previous studies (Northwest Territories Health & Social Services, 2006). Although Aboriginal populations report consuming alcohol less frequently compared to non-Aboriginal populations (69% versus 86%) in the NWT, the pattern of drinking among Aboriginal residents is of concern (Northwest Territories Health & Social Services, 2006). A survey of alcohol consumption in the NWT reported that 39% of Aboriginal females typically consume five or more drinks on one occasion, which is an increase from 24% since 1996 (Northwest Territories Health & Social Services, 2010).

Our results show that, among drinkers, 20.1 g day^{-1} was the mean amount of alcohol reportedly consumed. Inferences that can be made from alcohol preference (liquor contains more alcohol) and the mean amounts consumed (drinking >5 g of alcohol at a time is considered high-risk) suggest that patterns of high-risk drinking are exhibited among women of child-bearing age. Studies on the long-term effects of high-risk drinking patterns have reported an increased risk of health, social, educational and economic adversity continuing into later adult life (Institute on Alcohol Studies, 2007). In addition, patterns of high-risk drinking have been associated with increased central adiposity in women, a known risk factor for chronic disease (Yeomans, 2010).

We found that energy intake among women of child-bearing age was above the dietary recommendations;

Table 3 Nutrient density per 4184 kJ for selected nutrients among Inuvialuit women of child-bearing age who are alcohol drinkers versus nondrinkers

	Alcohol drinkers (n = 50)			Alcohol nondrinkers (n = 42)			
Nutrients	Mean	(SD)	Median	Mean	(SD)	Median	*P*-value
Carbohydrate (g)	108.8	(33.6)	115.5	132.5	(24.5)	130.5	0.001
Fat (g)	27.7	(8.0)	28.2	33.5	(6.1)	34.2	0.001
Protein (g)	34.8	(13.3)	32.1	42.7	(14.7)	41.3	0.004
Fibre (g)	5.9	(2.9)	5.7	7.2	(2.8)	6.8	0.027
Folate (μg)*	124.6	(75.7)	113.3	152.9	(48.5)	147.8	0.001
Sugar (g)	58.2	(28.4)	53.0	72.4	(28.4)	68.0	0.012
Saturated fat (g)	9.2	(2.8)	9.4	11.6	(2.6)	11.5	0.001
Monounsaturated fat (g)	10.0	(3.0)	10.6	12.2	(2.5)	12.5	0.001
Polyunsaturated fat (g)	4.4	(1.9)	4.0	5.1	(1.1)	5.0	0.008
Omega-3 (g)	0.5	(0.2)	0.4	0.6	(0.2)	0.5	0.032
Omega-6 (g)	4.4	(2.6)	3.7	4.8	(1.4)	4.6	0.033
Potassium (g)	1.2	(0.9)	1.1	1.4	(0.4)	1.3	0.001
Cholesterol (mg)	125.3	(52.3)	116.5	135.8	(52.7)	133.9	0.302
Calcium (mg)	350.0	(124.4)	327.5	455.3	(176.7)	420.2	0.003
Iron (mg)	6.4	(2.7)	5.8	8.0	(2.9)	7.3	0.003
Magnesium (g)	107.7	(67.8)	99.8	125.0	(35.8)	121.2	0.002
Phosphorous	562.6	(177.1)	558.0	731.6	(223.6)	705.1	0.0002
Selenium (μg)	45.4	(28.0)	39.2	57.0	(38.4)	47.9	0.030
Sodium (g)	1.3	(0.4)	1.2	1.7	(0.6)	1.5	0.0004
Vitamin B_3 (mg)	10.3	(4.4)	9.9	12.2	(3.6)	11.7	0.006
Vitamin B_2 (mg)	1.3	(1.1)	1.1	1.4	(0.4)	1.4	0.006
Vitamin B_1 (mg)	0.7	(0.3)	0.6	0.8	(0.2)	0.8	0.0003
Pantothenic acid (mg)	3.1	(3.2)	2.6	3.4	(1.3)	3.3	0.019
Vitamin A (RAE†) (μg)	223.8	(95.4)	209.5	249.8	(127.9)	219.1	0.520
Vitamin B_{12} (μg)	3.7	(2.1)	3.3	4.4	(2.4)	4.0	0.118
Vitamin B_6 (mg)	0.8	(0.4)	0.8	0.9	(0.3)	0.9	0.018
Vitamin C (mg)	68.9	(45.5)	61.7	65.6	(52.5)	53.9	0.461
Vitamin D (μg)‡	1.6	(0.9)	1.5	2.2	(2.1)	1.7	0.147
Vitamin E (mg)§	1.2	(0.5)	1.2	1.6	(0.6)	1.5	0.011
Zinc (mg)	5.0	(2.0)	4.9	6.1	(2.2)	5.8	0.004

*Dietary folate equivalent.

†Retinol activity equivalent.

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

§As α-tocopherol.

Table 4 Nutrient density per 4184 kJ for selected nutrients among Inuvialuit women of child-bearing age who are heavy alcohol drinkers* versus nonheavy drinkers

	Heavy drinkers (n = 22)			Nonheavy drinkers (n = 27)			
Nutrients	Mean	(SD)	Median	Mean	(SD)	Median	P-value
Carbohydrate (g)	85.6	(30.1)	86.2	127.4	(23.9)	126.2	0.0001
Fat (g)	21.8	(5.6)	22.3	32.6	(6.3)	33.3	0.0001
Protein (g)	31.3	(12.2)	30.0	38.0	(13.9)	35.8	0.126
Fibre (g)	4.6	(2.3)	3.8	6.9	(2.9)	6.5	0.008
Folate (μg)†	86.4	(28.1)	81.9	156.9	(88.4)	147.2	0.0001
Sugar (g)	46.9	(20.4)	44.9	66.6	(31.4)	65.5	0.026
Saturated fat (g)	7.2	(2.2)	7.1	10.8	(2.3)	11.4	0.0001
Monounsaturated fat (g)	7.9	(2.3)	8.0	11.7	(2.5)	11.7	0.0001
Polyunsaturated fat (g)	3.3	(1.1)	3.3	5.3	(2.0)	5.3	0.0001
Omega-3 (g)	0.4	(0.1)	0.3	0.6	(0.2)	0.5	0.002
Omega-6 (g)	3.2	(1.3)	3.0	5.3	(3.1)	4.8	0.003
Potassium (g)	0.9	(0.3)	0.9	1.4	(1.2)	1.2	0.001
Cholesterol (mg)	104.4	(37.3)	96.5	144.0	(56.7)	149.0	0.023
Calcium (mg)	282.5	(97.9)	277.4	400.8	(120.0)	372.9	0.002
Iron (mg)	5.9	(2.6)	5.2	6.9	(2.7)	6.2	0.141
Magnesium (g)	80.9	(26.7)	86.1	129.7	(83.5)	116.9	0.0004
Phosphorous	494.7	(156.4)	510.2	619.4	(179.0)	581.2	0.018
Selenium (μg)	35.1	(17.7)	30.2	54.0	(32.4)	48.9	0.004
Sodium (g)	1.1	(0.5)	1.1	1.4	(0.4)	1.4	0.003
Vitamin B_3 (mg)	8.6	(3.0)	7.8	11.8	(5.0)	10.6	0.008
Vitamin B_2 (mg)	0.9	(0.3)	0.8	1.5	(1.3)	1.3	0.002
Vitamin B_1 (mg)	0.6	(0.2)	0.5	0.8	(0.4)	0.7	0.017
Pantothenic acid (mg)	2.2	(0.8)	2.0	3.9	(4.2)	3.3	0.001
Vitamin A (RAE‡) (μg)	175.5	(77.5)	165.0	261.4	(93.6)	245.8	0.002
Vitamin B_{12} (μg)	3.5	(1.7)	3.4	3.8	(2.5)	3.3	1.000
Vitamin B_6 (mg)	0.7	(0.3)	0.7	0.9	(0.4)	0.8	0.121
Vitamin C (mg)	56.9	(33.3)	42.9	77.2	(52.5)	63.3	0.215
Vitamin D (μg)§	1.3	(0.7)	1.4	1.8	(1.1)	1.4	0.194
Vitamin E (mg)¶	1.0	(0.4)	0.9	1.4	(0.4)	1.4	0.001
Zinc (mg)	4.4	(1.7)	4.4	5.2	(2.2)	5.5	0.085

*Heavy drinker is defined as drinking more than 68 g of alcohol on one occasion, more than 12 times per year (Statistics Canada, 2010).
†Dietary folate equivalent.
‡Retinol activity equivalent.
§As cholecalciferol in the absence of adequate exposure to sunlight.
¶As α-tocopherol.

however, intake among alcohol drinkers was significantly higher than nondrinkers. Most women were below the DRI for key nutrients, specifically for dietary fibre, and vitamins D and E, with no significant differences between drinkers and nondrinkers. These results are consistent with the known patterns of dietary shift among Aboriginal populations in Arctic Canada, characterised by a decreased consumption of nutrient-dense traditional foods and an increased consumption of prepackaged, non-nutrient dense foods (Sharma *et al.*, 2009; Sharma, 2010).

However, despite the observation of no difference in total nutrient intake between alcohol drinkers and nondrinkers in the present study, nutrient density was significantly lower among drinkers compared to nondrinkers. These results are in agreement with those of a new study by researchers at the National Institute on Alcohol Abuse and Alcoholism, the National Cancer Institute and the USDA, who found that increased alcoholic beverage consumption was associated with decreased diet quality. Drinkers were found to eat less fruit and consume more calories not only from alcoholic beverages, but also from foods high in unhealthy fats and added sugars (National Institute on Alcohol Abuse & Alcoholism, 2010).

In addition to a decreased diet quality among alcohol drinkers, exposure of the mucosal side of the small intestine to alcohol inhibits the absorption of many nutrients, including monosaccharides, several L-amino acid residues, and some fatty acids and vitamins (Lieber,

1990; Bode & Bode, 2003). Low serum levels of folic acid, thiamine, and vitamins B_{12}, B_6, C, A, D, E and K, magnesium, zinc and selenium, have been observed in individuals with a high alcohol consumption (Bode & Bode, 2003).

It is well established that maternal nutrition status during preconception, pregnancy and lactation directly impacts both maternal and infant health. Alcohol consumption during pregnancy, even at relatively low levels, increases the risk of poor maternal birth outcomes. Fetal Alcohol Spectrum Disorder, a term encompassing a range of physical, cognitive, and behavioural disabilities resulting from alcohol exposure during gestation, is the leading cause of developmental and cognitive disabilities in Canadian children (Stade *et al.*, 2009; Patra *et al.*, 2011). Although prenatal women have been found to significantly decrease alcohol consumption during pregnancy (Tough *et al.*, 2007), frequent high-risk drinking presents a risk to birth outcomes for women who do not know they are pregnant, or for those women who fail to stop drinking during pregnancy.

Overall, alcohol consumption and the subsequent metabolism of ethanol in the liver by microbial enzymes leads to the generation of acetaldehyde and oxygen free radicals that promote oxidative stress, a known risk factor for chronic disease development. Oxidative stress in the liver is associated with the development of alcohol-related liver disease, directly or through decreased hepatic levels of vitamin A, which plays an important role in mediating cell function and carcinogenesis (Balbi *et al.*, 2010). Cell-signalling pathways that regulate hepatocyte function, proliferation and apoptosis are also affected through depletion of the body's natural antioxidant supply of glutathione and increased oxygen radical production (McKillop & Schrum, 2005).

The limitations to the present study are related to inherent limitations in the QFFQ instrument that include over- or under-reporting, and interviewer/interviewee bias. Because patterns of high-risk drinking have been reported to occur among Aboriginal women in the Canadian Arctic (Public Health Agency of Canada, 2008), dietary data collection may have missed irregular but large consumption levels on some days via the use of the QFFQ. In addition, an under-reporting of alcohol consumption may have occurred by participants in the dry community where alcohol is prohibited. Alcohol consumption among Inuvialuit women of a child-bearing age deserves further investigation using a data collection instrument that is more sensitive to the alcohol consumption patterns for this population.

Inuvialuit society consists of close social connections and family ties, which promote opportunities for the development of nutritional educational programmes. The core concept of these programmes should focus on the relationship between diet quality, alcohol consumption and their importance for women of child-bearing age. Effective intervention strategies that include collaborative action and community involvement could improve the health of women and future generations.

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Conflicts of interest, sources of funding and authorship

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FK performed the statistical analysis and wrote the manuscript. KS wrote the first draft of the manuscript. AC helped write the manuscript. SS conceived the study and oversaw the project.
All authors made a substantial contribution to the acquisition and interpretation of the data, were part of the writing or critical reviewing of the article, and approved the final version submitted for publication.

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