Age Differences in Vitamin A Intake Among Canadian Inuit

Grace M. Egeland, PhD[1]
Peter Berti, PhD[2]
Rula Soueida, MSc[1]
Laura T. Arbour, MD[4]
Olivier Receveur, PhD[3]
Harriet V. Kuhnlein, PhD[1]

ABSTRACT

Background: Inuit traditional food provides ample amounts of preformed vitamin A. However, the dietary transition away from traditional food raises concerns regarding dietary adequacy. Vitamin A is an essential nutrient with inadequate and excessive exposures having adverse effects.

Objective: To evaluate total dietary vitamin A intake for Canadian Inuit from market food and traditional food sources and to evaluate retinol concentrations in liver and blubber.

Methods: Dietary surveys were conducted in 18 communities representing 5 Inuit regions, and traditional food items were evaluated for nutrient content.

Results: Among those 15-40 years of age, 68% of men and 60% of women had a dietary vitamin A intake below the estimated average requirement (EAR) for retinol activity equivalents (RAE)/day. Among those over 40 years of age, only 11% of men and 15% of women had a dietary vitamin A intake below the EAR. Young Inuit men had a relative risk of 6.2 (95% CI= 4.5-8.4), and young Inuit women had a relative risk of 4.0 (95% CI= 3.1-5.0) for dietary inadequacy compared to the older Inuit men and women, respectively. The median retinol content of liver of ringed seal, caribou, and fish were comparable to levels observed in market food liver. Liver was less frequently consumed by those 15-40 years of age than among older Inuit.

Discussion: Sub-optimal vitamin A intake is the predominant nutritional concern rather than excessive exposures. Public health education campaigns are needed to improve vitamin A intake among the younger generations of Inuit men and women.

La traduction du résumé se trouve à la fin de l'article.

1. Centre for Indigenous Peoples' Nutrition and Environment (CINE) and School of Dietetics and Human Nutrition, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, QC
2. PATH, Toronto, ON
3. Department of Nutrition, University of Montreal, Montreal, QC
4. Children's and Women's Health Centre of BC, University of British Columbia, Vancouver, BC

Correspondence: Dr. G.M. Egeland, Centre for Indigenous Peoples' Nutrition and Environment (CINE) and School of Dietetics and Human Nutrition, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, QC H9X 2T6, Tel: 514-398-8642, Fax: 514-398-1020, E-mail: grace.egeland@mcgill.ca

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Vitamin A is important for immune function, gene expression, reproduction and embryonic development, growth, and normal vision with both excessive and inadequate intakes having adverse health impacts. The developing fetus is particularly sensitive to suboptimal and excessive exposures.[1-6] The term vitamin A includes preformed vitamin A found in foods of animal origin and the provitamin A carotenoids that are dietary precursors of retinol and are found in dark-green and yellow-orange fruits and vegetables.

Inuit traditional food includes liver and blubber which are rich in biologically active preformed vitamin A. However, the ongoing dietary transition away from traditional food to a greater reliance upon market food can introduce nutritional inadequacies in northern remote regions given market food preferences and the poor selection and availability of quality market food.[7] Today, suboptimal vitamin A intake has been noted in many northern communities,[8-10] and has been postulated to play a role in the high rate of infections and respiratory illness among Inuit children.[11]

The objectives of the current paper are to evaluate vitamin A intake among Canadian Inuit and report levels of vitamin A in liver and fat of species traditionally consumed in the Arctic.

METHODS

Community representatives from all 39 communities in 5 Inuit regions selected 18 communities for the dietary surveys to achieve geographic representation (Figure 1). Research agreements were obtained with each community and interviews were conducted by locally trained interviewers in local language when needed.[12-14] Random sampling of 10% of households in each community took place using household or utility lists. For small communities of 25 households or fewer, all households were selected for interview. Participation rate was greater than 70% in the communities. A 24-hour dietary recall questionnaire was administered in participants' homes, and interviewers used locally available portion models. Interviewers were trained to probe participants using multiple pass techniques for selected items or times of the day.[15] Participants were asked to keep a 7-day record of traditional food consumed and a 3-month traditional food frequency questionnaire was administered in summer (June-August) and winter (December-February). A total of 999 7-day dietary records and 1,875 24-hour recalls were collected. A second 24-hour recall was collected on a non-consecutive day for 17% of all study participants and for 20% of women 15-40 years of age. A total of 715 men and 909 women participated in the surveys conducted in 1998-1999.

Retinol Activity Equivalents (RAE) were calculated based upon new Dietary Reference Intakes (DRI) and procedures for analysis developed by the National Academy of Sciences, Institute of Medicine and Health Canada.[16-18] Also, an update of the carotenoid content of US foods was used to compute the RAE of the market food items.[19] The market food data were combined with the Centre for Indigenous Peoples' Nutrition and Environment's (CINE) traditional food nutrient composition database. The market food database was derived from the University of California Mini-list using existing US data,[20] and adjusted to include Canadian food items and nutrient fortification levels using the Canadian Nutrient file.[21] Retinol was measured in selected traditional food (liver and blubber) using a methodology that is described elsewhere.[13,22]

We used Software for Intake Distribution Estimation (SIDE) developed by Iowa State University to obtain estimates of usual nutrient intake distributions based upon observed intake. SAS version 8.0 was used to run the SIDE software which is in SAS syntax.[23] SIDE transforms observed nutrient intakes, where the transformed data represent the distribution of the population's usual nutrient intakes. Inter- and intra-person variability was examined by two age groups, 15-40 and greater than 40 years of age, for men and women separately. The usual intake of vitamin A was assessed for adequacy using the estimated average requirement (EAR), where the proportion falling below the EAR indicates prevalence of intakes below the requirement.[17] The tolerable upper intake level (UL) was used to evaluate the extent of usual daily intakes above the UL which reflects potential risk of adverse effects from excessive intakes. Plant-based sources of carotenoids were excluded in calculating the percent above the UL of

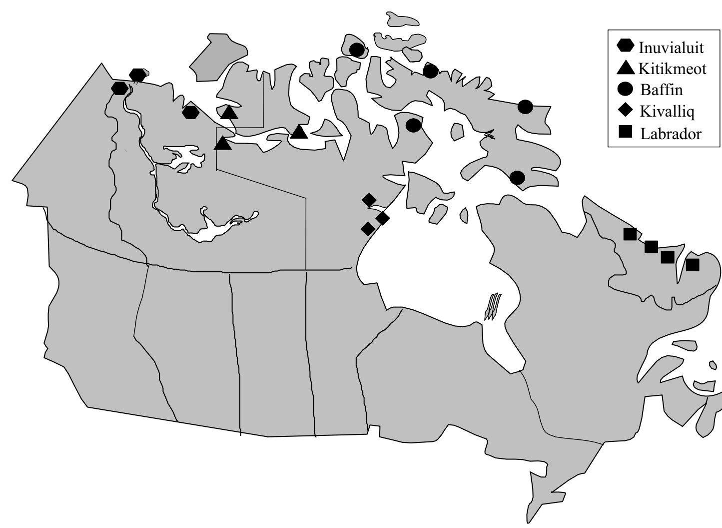

Figure 1. Participating Inuit regions

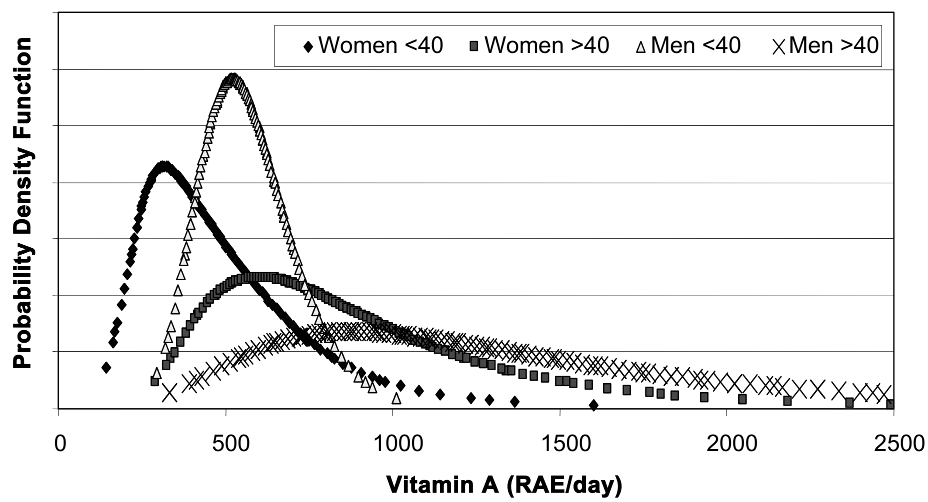

Figure 2. Usual Vitamin A intake by gender and age group: Canadian Inuit

3,000 μg/day of preformed vitamin A for adults.[6] The EAR is 500 RAE/day for females and 625 RAE/day for males.[6] Analyses were conducted on participants after excluding individuals reporting <10th percentile of energy intake in each sex and age group and those reporting intake over 4 standard deviations of the mean kcal. Relative risks and 95% confidence intervals and chi-square tests for differences in proportions were used to examine differences between age groups in vitamin A intake and traditional food consumption.

RESULTS

RAE intake varied by gender and age group (Figure 2). For male and female Inuit greater than 40 years of age, 85% of females and 89% of males had dietary intake above the EAR. In contrast, for Inuit aged 15-40, 60% of females and 68% of males fell below the EAR. Young Inuit men had a relative risk of 6.2 (95% CI= 4.5-8.4), and young Inuit women had a relative risk of 4.0 (95% CI= 3.1-5.0) for dietary inadequacy compared to the older Inuit men and women, respectively (Table I). Exclusion of those in the lowest 10th percentile of energy intake, increased the median energy intake by an average of 124 kcal in each age and sex group: for example among men, median energy intake increased from 2,161 to 2,288 kcal and from 1,951 to 2,077 for those aged 15-40 and those >40 years of age, respec-

TABLE I
Relative Risks for Usual Retinol Activity Equivalent (RAE) Intake Falling Below the Estimated Average Requirement (EAR) by Gender and Age: Canadian Inuit

		Vitamin A Intake (RAE/d)						
	Age (yrs)	(n)#	Mean	Median	SD	EAR	% < EAR	Relative Risk (95% CI)
Women	≤40	(522)	514	440	300	500	60	4.0 (3.0-5.2)
	>40	(297)	962	810	584	500	15	1.0 (reference)
Men	≤40	(398)	572	554	151	625	68	6.0 (4.2-8.5)
	>40	(246)	1477	1234	953	625	11	1.0 (reference)

TABLE II
Percent Reporting Liver Consumption in the Three-month Food Frequency Questionnaire by Age, Gender, Season and Species: Canadian Inuit

		Women 15-40 yrs.		Women > 40 yrs.		Men 15-40 yrs.		Men > 40 yrs.	
Species	Frequency per month	Summer (n=342)	Winter (n=339)	Summer (n=190)	Winter (n=205)	Summer (n=233)	Winter (n=289)	Summer (n=164)	Winter (n=167)
Caribou	<1	91	95	86	89	88	91	81	87
	≥1	9	5	14	11*	12	9	19	13
Char	<1	91	97	79	89	88	97	80	86
	≥1	9	3	21*	11*	12	3	20*	14*
Fowl	<1	98	93	90	82	96	93	91	78
	≥1	2	7	10*	18*	4	7	9*	22*
Ringed Seal	<1	81	90	66	78	70	88	57	68
	≥1	19	10	34*	22*	30	12	43*	32*

* Chi-square, p≤0.05 for age group differences within same gender and season.

TABLE III
Traditional Food Sources of Vitamin A

Species		Median Vitamin A µg/100 g	Min-max*
Blubber	Beluga	1360	221-4765
	Narwhal	1890	195-4867
	Walrus	200	77-1000
	Ringed Seal	400	75-700
Liver	Ringed Seal	5490	195-15,000
	Loche liver	3000	55-4000
	Caribou liver	9640	4122-32,000

* Amounts may vary depending on cooking procedures and animals' age, sex, and season harvest and habitat.

tively. These data indicate that underreporting still exists in our data, but that it is unlikely to account for the large differences observed in the distribution of vitamin A intake between older and younger Inuit.

In examination of the UL, 7% of men over 40 years of age, but no women and no men under 40 years of age had a preformed vitamin A intake above the UL. For the men over 40 years of age, the upper 99th percentile of intake was 5,090 µg of preformed vitamin A.

Vitamin supplement use was reported by 5.1% of all survey respondents and 8.6% of women of reproductive age. The average beta carotene and vitamin A content of supplements were 1,821 IU and 3,268 IU, respectively. If we assume that 8.6% of women aged 15-40 with dietary intakes below the EAR regularly took a vitamin supplement, the percent falling below the EAR would be reduced from 60% to 54.8%.

The 7-day food diary records indicated that the majority of survey respondents consumed liver relatively infrequently: 1.1% and 2.0% for women and men aged 15-40 years, respectively, and 2.7% among those over 40 years of age. In contrast, the 3-month FFQ showed a somewhat higher proportion of respondents indicated liver consumption at least once a month. For the summer months, 9% of young women reported consuming caribou liver, 9% char, 2% fowl, and 19% ringed seal liver, whereas for older Inuit women, summer liver consumption was more frequently reported: 14% for caribou, 21% for char, 10% for fowl, and 34% for ringed seal liver (X^2-tests, p≤0.05 for Char, fowl, and ringed seal)(Table II). Similar differences were observed in liver consumption between younger and older women during the winter season. Likewise, for men, older Inuit more frequently reported consuming liver than younger men. Also, young men and women reported similar liver consumption frequencies with the exception that men consumed significantly more ringed seal liver in summer months than women (X^2-test, p≤0.05). Whale liver consumption was not reported and kidney consumption was rarely reported.

Median retinol concentrations were 5,486 µg/100 g for ringed seal liver and 9,636 µg/100 g for caribou (Table III). These traditional food liver tissue levels are comparable to those observed in market food liver[24] and lower than Beluga and Narwhal whale (36,000 and 30,000 µg/100 g) measured in a Greenlandic study.[25] Beluga blubber contained average (median) retinol in concentrations of 1,360 µg/100 g and narwhal blubber contained average retinol concentrations of 1,890 µg/100 g. The Baffin region reported the most traditional food consumption: the percent of total RAE intake from market food ranged from 69% in Baffin, to 76-81% in Inuvialuit, Kitikmeot, and Kivalliq, to a high of 90% in Labrador. Among market food items, carrots, vegetables, butter, margarine, milk, and eggs were the leading sources of vitamin A intake.

DISCUSSION

The distribution of usual vitamin A intake derived from the 24-hour dietary recalls and repeat recalls, indicates that the predominant challenge is one of improving low vitamin A intake among the younger generations of Inuit. The large differences between the older and younger Inuit in vitamin A intake may be attributed to differences in traditional food consumption, given that older Inuit reported a greater percent of energy from traditional food than younger Inuit.[14] Under-reporting of energy intake is unlikely to account for the large age differences observed in vitamin A intake.

For all women and for men 15-40, none exceeded the UL for preformed vitamin A. For men over 40 years of age, 7% were found to have preformed vitamin A intake above 3,000 µg /day. The UL is based upon teratogenicity for women of childbearing age, and on liver abnormalities for all other adults and applies to preformed vitamin A only.[17] For liver abnormalities, the lowest observed adverse effect level of 14,000 µg/day from vitamin A supplements is divided by an uncertainty factor of 5 to provide a UL of 3,000 µg of preformed vitamin A. As the high end of vitamin A exposure among those exceeding the UL was 5,090 µg/day, these exposures are not excessive in terms of risk for liver toxicity. High vitamin A exposures do lead to bone mineral loss in rats[26] and may decrease bone mineral density in humans, however epidemiologic research findings are inconsistent[27-29] and require further evaluation.

For the younger generations of Inuit, the data suggest the need for public health education and interventions aimed at improving low vitamin A intake. Also, low vitamin A intake may be more deleterious in northern communities where there is a high prevalence of binge drinking.[30,31] There is evidence that the adverse effects of inadequate (and excessive) vitamin A exposures on the developing fetus is likely to be more pronounced among women who drink excessively and have had a history of alcohol abuse. Ethanol ingestion alters vitamin A metabolism and depletes vitamin A liver stores and alcohol intake has also been shown to increase the adverse effects of too little or too much vitamin A.[32-35] The metabolic interactions between ethanol and vitamin A have been postulated to play a role in the pathogenesis of fetal alcohol syndrome (FAS) as there is remarkable similarity between the dysmorphic and teratogenic effects of ethanol and vitamin A.[36-38] In addition to the metabolic interactions of ethanol and vitamin A, poor nutritional habits coincide with alcohol abuse and alcohol interferes with intestinal absorption of folate.[39] A combination of low vitamin A intake and a high prevalence of excessive alcohol consumption, and reduced absorption of key nutrients, may contribute to the high rates of congenital heart defects and FAS observed in northern populations.[40-42]

Education programs regarding market food sources of vitamin A rich food and the importance of vitamin A are needed. Liver can provide a good source of vitamin A and help improve hepatic stores to compensate for nutritional inadequacies. Also, given the high prevalence of iron deficiency anemia in many communities,[43,44] and the evidence that vitamin A and iron can reduce iron deficiency anemia to a greater degree than iron alone,[45] liver may be particularly helpful in reducing iron deficiency anemia for women and children. Given the variability in retinol in traditional food liver and in serving sizes, advocating liver consumption raises theoretical concerns regarding excessive exposures during pregnancy. Advocating small servings (50 g) during early pregnancy or when there is a risk of early pregnancy is prudent. The U.S. Centers for Disease Control advises that liver can be consumed in moderation during pregnancy.[46]

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RÉSUMÉ

Contexte : L'alimentation traditionnelle des Inuits est très riche en vitamine A préformée, mais on craint que l'abandon progressif des aliments traditionnels entraîne des carences alimentaires. La vitamine A est un élément nutritif essentiel dont le déficit ou l'excédent peut avoir des effets indésirables.

Objectif : Évaluer l'apport total en vitamine A provenant des sources de nourriture commerciales et traditionnelles dans l'alimentation des Inuits du Canada et évaluer les concentrations en rétinol dans le foie et le petit lard.

Méthode : Nous avons administré des questionnaires sur l'alimentation dans 18 collectivités représentant 5 régions inuites et évalué le contenu d'aliments traditionnels en éléments nutritifs.

Résultats : Chez les Inuits de 15 à 40 ans, 68 % des hommes et 60 % des femmes avaient un apport alimentaire en vitamine A inférieur au besoin moyen estimatif (BME) quotidien en équivalents rétinol (ER). Chez les plus de 40 ans, par contre, seulement 11 % des hommes et 15 % des femmes avaient un apport alimentaire en vitamine A inférieur au BME. Les jeunes hommes présentaient un risque relatif de carence alimentaire de 6,2 (IC de 95 %=4,5-8,4), et les jeunes femmes, un risque relatif de 4,0 (IC de 95 %= 3,1-5,0), respectivement, par rapport aux hommes et aux femmes plus âgés. Nous avons comparé la teneur médiane en rétinol dans des foies de phoque annelé, de caribou et de poisson et dans des foies vendus dans le commerce. Les Inuits de 15 à 40 ans consommaient moins souvent du foie que leurs aînés.

Discussion : Un apport sous-optimal en vitamine A préoccupe davantage les diététiciens qu'un apport excessif. Il faudrait mener des campagnes de sensibilisation du public afin d'améliorer l'apport en vitamine A chez les jeunes générations d'Inuits.