

ORIGINAL ARTICLE

DIETARY INTAKE OF ALASKA NATIVE PEOPLE IN TWO REGIONS AND IMPLICATIONS FOR HEALTH: THE ALASKA NATIVE DIETARY AND SUBSISTENCE FOOD ASSESSMENT PROJECT

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ABSTRACT

Objectives. To calculate the energy and nutrient intake in 2 regions of Alaska and to describe the implications for development of chronic disease among Alaska Native people (AN).

Study design. Cross-sectional observation; 10 villages and 2 hub communities in rural Alaska; 333 participants ages 13 to 88 years old.

Methods. Trained interviewers collected 24-hour diet recalls during 4 seasons.

Results. In both regions, AN reported a combination of traditional Native foods and store bought foods; most of the energy comes from store-bought foods; a high proportion of nutrients come from Native foods, especially protein, iron and omega-3 fatty acids. Mean intakes of omega-3 fatty acids, from fish and sea mammals, are over twenty times greater than those of the general U.S. population. Mean intakes of protein, iron, selenium, vitamin A, vitamin C (men) and folate (men) met recommended levels; intakes of calcium and fiber were below recommended levels; carbohydrate and saturated fat (% energy) were above.

Conclusions. Traditional foods continue to contribute a significant amount of nutrients to the diet in rural Alaska. Excess simple sugars may be contributing to the rise in obesity and diabetes. Low intakes of calcium, dietary fiber, fruits and vegetables may contribute to the increased incidence of cancers of the digestive system. Emphasis on the positive aspects of Native foods and increased consumption of fruits, vegetables and calcium-rich foods are warranted.

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INTRODUCTION

Information about the diet of Alaska Native people is limited. Their diet traditionally consisted of foods that were hunted, gathered and harvested. These included fish, land and marine mammals, plants and berries and were referred to as “Native,” “traditional” or subsistence foods. The present-day diet of Alaska Native people includes available store-bought foods (1–9). Some studies have been published about the diet and the relationship to disease (10–13). However, these studies have been limited to specific regions, the sample sizes included only a few people, they used different methods, and they are not recent studies. Many of the over 200 villages in Alaska have never had a survey done to document dietary intake.

A report by Kuhnlein et al. finds that the traditional food systems in Canada’s Arctic are most likely the best global examples of Indigenous peoples’ food being superior to the market food used as alternatives (14). In Alaska, Native foods are especially nutritious as they are dense in protein, iron, Vitamin B12, polyunsaturated fats, monounsaturated fats and omega-3 fatty acids. In addition, they are low in saturated fat, added sugar and salt. Native meats such as moose and caribou are generally lean. Berries and greens are high in water content and micronutrients and low in empty calories. Hunting, gathering, harvesting and preserving Native foods are energy intensive, providing physical activity. Furthermore, Native foods are highly valued and contribute to the spiritual, cultural and social well-being of the AN, as well as the health of individuals, families and communities. Kuhnlein and Recevuer cited traditional foods as being

key to dietary quality among Canadian Arctic people. They found that on the days when at least one traditional food was eaten, the diet contained more energy, less carbohydrate and fat and more protein than days when only store-bought food was eaten (15). A study of Alaska Native adults conducted in 1987–1988, found that they consumed six times more fish but less fruits and vegetables than did the general U.S. adult population (4). In 2002, a survey in 13 villages found that traditional foods were still commonly consumed in large amounts (2).

Other Alaska studies suggest, however, that there is a trend towards a greater dependency on store-bought foods and less on traditional foods (1,3–5). In the 1950s, local foods provided adults with up to half and children with about one-third of their energy intake (6). A 1992 study documented that local foods provided Siberian Yupik adults in Alaska with 25% of their energy (10). In 2000–2003, it was found that Eskimo adults in the Norton Sound region of Alaska obtained only 15% of their energy from local foods (1).

Alaska is a large state that contains multiple distinct ecologic regions. Plants, animals and fish available for use as food differ by region and even between neighbouring villages. Given the variations in foods based on geography, the degree of traditional food use, the recognition that many communities have not been surveyed and that many of the surveys were conducted several years ago, we concluded that there is a need for more recent dietary information. The aim of this study is to describe the total diet, including both Native and store-bought foods, currently eaten by Alaska Native people in 2 regions and compare it to current recommendations.

MATERIAL AND METHODS

Two areas of Alaska participated, one represented by the Yukon-Kuskokwim Health Corporation in the Yukon-Kuskokwim Region (YK) of south-western Alaska, and the other by the Maniilaq Association in the Maniilaq Region (MR) of north-west Alaska. Villages in these regions are geographically isolated and are accessible only by plane or boat. In 2000, the Alaska Native population was 20,714 in the YK Region who lived in 48 Yup'ik/Cupik and Indian villages. In the Maniilaq Region there were 6,867 people living in 12 Inupiat Eskimo communities. Five south-west villages participating in this survey ranged from 338 to 780 residents, plus the hub city of Bethel, containing 5,960 residents. Five participating north-west villages ranged from 256 to 757 residents, with 3,082 living in the participating hub community of Kotzebue. Villages were invited to participate based on the advice of regional experts with detailed knowledge of the varieties of local foods commonly used. Twelve villages were recommended to encompass the wide variety of foods eaten in the region. A visit was made to each village to present the project to the tribal council. Ten of the original 12 expressed interest in participating in the project, and so an additional 2 villages were invited to participate, for a total of 12 communities.

The study was approved by the Alaska Area Institutional Review Board, the Yukon Kuskokwim Health Corporation (YKHC), the Maniilaq Association and the Tribal Councils of all 12 communities. Interviewers were identified by participating communities and were trained to assist with data collection. Alaska Native residents 13 years of age and older were

invited to participate, with a goal of enrolling at least 20 participants per village, 1 per household. Interviewers were instructed to enroll equal numbers of people in each age category. Categories were defined by the Dietary Reference Intakes standard which were established to define dietary adequacy (16). The enrollment procedure followed the directives of each Tribal Council and resulted in a convenience sample. Each participant signed an informed consent/assent form. Interviewers provided the necessary translation for participants who spoke Yupik or Inupiaq.

To measure intakes throughout the 4 seasons, interviewers conducted an initial 24-h recall in person, while up to 3 subsequent recalls were done by telephone. Recalls were conducted between 2002 and 2004. Participants were asked to list all foods consumed in the previous 24-h period. The interviewer collected detailed information from the participant, including everything that person ate or drank in the previous 24 hours. Twenty-four hour recalls are open ended, and allow for an unlimited level of specificity regarding type of food, food source, food processing method, food preparation, other details related to foods and the amounts consumed. The interviewer used a variety of standard cups, dishes, food models, measuring cups, spoons and rulers to elicit accurate information about portion sizes. After the first recall, each participant received a set of measuring cups and spoons to describe portion sizes during the subsequent telephone interviews. Following completion of each recall, participants received a small monetary incentive (\$5).

Dietary intake data were analysed for nutrients using Nutrition Data System for Research (NDS-R) software, version 5.0_35

(2004) developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN. Further analysis was done with SAS Version 9.1.3 (Cary, NC) and Microsoft Access 2003 (Bellingham, WA). The nutrient profiles of many Alaska Native foods, such as seal and walrus, are included in the NDS-R database. Substitutions of similar foods were used for foods that were not present in the database (or not present in the form they were eaten), such as sheefish and dried chum salmon. Intakes were compared to the Dietary Reference Intakes (DRIs) to estimate adequate intake for individuals using either the Recommended Dietary Allowances (RDA) or Adequate Intake (AI) in the absence of an RDA, specific to the age and gender of the participant (16). American Heart Association recommendations were used when a DRI was not stated (17). Intakes were also compared to the general U.S. intakes in the National Health and Nutrition Examination Survey 2003–2004 (NHANES) (18).

Native foods were considered to be any locally gathered and harvested foods, including wild greens, berries, fish, land mammals, sea mammals (oil and meat from seals, walrus and whales, blubber from walrus and seals and the skin and subcutaneous layer of fat from whales known as muktuk). Some mixed dishes are included in the Native foods category. For example, agutuk (sometimes called “Eskimo ice cream”) is a mixed dish that varies by region, but generally contains berries or fish, some form of fat such as seal oil or vegetable shortening, and sugar. Agutuk was included in the Native food calculation, and therefore small amounts of store-bought ingredients, such as vegetable shortening and sugar, are included in the final analysis of the nutrient content of Native foods. Foods introduced to

the area with the advent of stores, such as fry bread, Pilot Bread® and white rice, are not categorized as Native foods. Likewise, store-bought fish, such as tuna and fish sticks, were not included in Native foods. Recipes used to prepare foods that were eaten by an individual were used in the analysis. When a specific recipe was unavailable, default recipes for agutuk, caribou soup and other mixed dishes were used.

Foods were combined according to the NDS-R groups. Additional groups were comprised of Alaskan foods, such as caribou and moose and marine mammals (seal, whale, walrus, blubber, seal oil, whale oil and muktuk). The vegetable group included wild Alaska greens as well as store-bought white potatoes, fried potatoes, dark leafy greens, starchy vegetables and salad. The fruit group included wild Alaska berries as well as whole fruit, dried and mixed fruit dishes and 100% fruit juice.

RESULTS

There were 333 participants, ranging in age from 13 to 88 years and enrolled from 2 regions (Table I). More women than men completed the dietary surveys (n=218 and 115, respectively).

A total of 874 24-hour recalls were collected. Seventy-five percent of participants completed 2 or more diet recalls; 51% of participants completed 3 or more 24-h recalls; 26% completed 4. Completion rates were similar between regions. Similar numbers of recalls were collected in each of the 4 seasons (30% fall, 27% winter, 20% spring and 23% summer). A total of 1,818 different foods were reported. In addition, vitamin/mineral supplements were reported on 27% of the 24-h recalls. However,

Table I. Age distribution of 333 Alaska Native people by region and gender, 2002–2004.

Age (y)	YKHC				Maniilaq				Total			
	Men n	%	Women n	%	Men n	%	Women n	%	Men n	Women n	Total n	%
13–18	16	21	10	10	4	9	11	10	20	21	41	13
19–30	10	14	22	21	6	14	22	19	16	44	60	18
31–50	22	30	27	26	16	38	36	32	38	63	101	30
51–70	18	25	25	24	10	24	20	17	28	45	73	22
71–88	7	10	20	19	6	14	25	22	13	45	58	17
Totals	73	100	104	100	42	100	114	100	115	218	333	100

Table II. Daily nutrient intakes of 333 Alaska Native people by gender, 2002–2004.

Nutrient	Men			Women		
	Mean	SEM ^a	Median	Mean	SEM	Median
Energy (kcal)	2471	79	2376	2020	51	1908
Energy (kJ)	10341	331	9944	8454	213	7985
<i>Percent of calories from:</i>						
<i>protein</i>	18	0.5	18	19	0.5	17
<i>carbohydrates</i>	44	1.1	46	45	0.8	47
<i>total fat</i>	37	0.9	37	36	0.6	36
<i>saturated fat</i>	10	0.3	10	11	0.2	12
<i>trans fat</i>	2.2	0.1	2.0	2.3	0.1	2.0
<i>ALA^b</i>	0.5	0.1	0.5	0.5	0.01	0.5
Protein (g)	112	4.6	99	92	3.1	81
Carbohydrates (g)	273	11	259	228	6.8	213
Sucrose (g)	58	3.6	52	48	2.0	43
Fructose (g)	28	2.0	22	25	1.4	20
Fat (g)	104	4.2	100	83	2.7	78
Saturated fat (g)	29	1.2	29	25	0.9	22
Monounsaturated fats (g)	43	1.9	41	33	1.1	30
Polyunsaturated fats (g)	23	1.2	23	18	0.7	16
ALA (g)	1.4	0.1	1.2	1.1	0.05	1.0
EPA (g) ^c	1.6	0.2	0.6	1.0	.01	0.5
DHA (g) ^d	2.1	0.3	1.0	1.4	0.1	0.7
Trans fats (g)	6.2	0.4	5.7	5.2	0.2	4.4
Cholesterol (mg)	471	29	437	348	17	287
Calcium (mg)	560	31	497	485	18	435
Iron (mg)	22	1.1	19	19	0.9	16
Magnesium (mg)	305	11	279	248	7.2	237
Potassium (mg)	2947	111	2792	2318	76	2185
Selenium (mcg)	186	10	163	145	5.3	126
Sodium (mg)	3871	156	3524	3907	98	3011
Zinc (mcg)	13	0.6	12	13	1.5	9.9
Vitamin A (RAE) ^e	1119	137	895	781	52	650
Folate (mcg)	435	19	398	339	10	319
Vitamin C (mg)	100	9.6	74	69	4.0	53
Vitamin D (mg)	27	3.4	11	17	1.4	7.8
Vitamin E (mg)	11	0.6	9.9	9.6	0.5	8.2
Dietary fiber (g)	13	0.6	12	11	0.4	10

^aStandard error of the mean.^b α -linolenic acid, 18:3n-3.^ceicosapentaenoic acid, 20:5n-3.^ddocosahexanoic acid, 22:6n-3.^emcg retinol activity equivalents.

information on dietary supplements is not included in the results because product name or ingredients were not collected.

Table II describes the mean and median intakes of selected nutrients. The diet included high intakes of several nutrients that included omega-3 fatty acids but also carbohydrates. On the other hand, intakes of calcium and fiber were low. For most of the nutrients, men consumed significantly more than women.

Table III summarizes the proportion of men and women who met current recommendations. Compared with the dietary recommendations that are established for nearly all healthy individuals in the United States and Canada, almost all men and women met or exceeded recommendations for protein, carbohydrate and selenium (16,17).

The recommended intake for saturated fat is less than 10% of total energy (17), and only

44% of men and 42% of women met the recommendation. For iron, 64% of the women and 91% of men met the recommended intakes. At least half of men and women fell below the recommended intakes for folate, vitamin A and vitamin C. Only 7% of people met the recommendation that they limit their intake of trans fats to <1% of their calories. Similarly, only 14% of men and 7% of women met the recommendation for calcium, and less than 4% reported met their recommended intake of fiber.

Table IV describes the proportion of nutrients and energy from Native foods.

Native foods were reported on at least one of their interview days by 271 participants (81%). Over 100 Native foods were reported; those mentioned most often were salmon (mainly king and chum), seal oil (used as a dip for dried fish and to add flavour to other foods), caribou, agutuk, moose, berries, white fish,

Table III. Daily nutrient intakes from 24-h recalls of 333 Alaska Native people, 2002–2004, compared with dietary recommendations.

	Daily recommendation ^a	% Men who met recommendation	% Women who met recommendation
Protein	56 g (M) ^b , 46 g (W) ^c	91	92
Carbohydrates	130 g	88	88
Fat	≤30% calories ^d	22	24
Saturated fat	< 10% calories ^d	44	42
ALA	<1.2% total calories	98	99
Trans fats	< 1% total calories	7	7
Calcium	1000 mg	14	7
Iron	8 mg (M), 18 mg (W)	91	64
Selenium,	55 mcg	98	94
Vitamin A	900 RAE (M),700 RAE(W)	49	44
Folate	400 mcg	49	28
Vitamin C	90 mg (M),75 mg (W)	42	37
Vitamin D	5 mcg	38	46
Vitamin E	15 mg	77	90
Dietary fiber	38g (M), 25 g (W)	1	4

^aRecommendations shown are from Dietary Reference Intakes for ages 19–50 (16) unless otherwise noted. Each person's intakes were compared to appropriate recommendations for their age and gender.

^bDaily recommendation for men, where it differs from the recommendation for women.

^cDaily recommendation for women.

^dAmerican Heart Association dietary recommendation (17).

sheefish, reindeer and muktuk. Overall, 21% of calories came from Native foods (22.8% of total calories in the YK Region; 19.9% of the total calories in the Maniilaq Region). On the one hand, a disproportionately high amount of several nutrients came from Native foods: 46% of protein, 83% of vitamin D, 37% of iron, 35% of zinc, 34% of polyunsaturated fat, 90% of the eicosapentaenoic acid (EPA PUFA 20:5n-3) and 93% of the docosahexaenoic acid (DHA PUFA 22:6n-3). On the other hand, they contributed only 8% of vitamin C and 7% of dietary fiber. It is important to note that Native foods contributed only 3% of the carbohydrate, 4% of the sucrose and 16% of the sodium reported.

Table V describes the food sources of selected nutrients.

Native foods, specifically fish, seafood and marine mammals, were among the

leading sources for most of the nutrients shown in Table V. Fish, seafood, caribou and moose accounted for 40% of the protein and for 25% of the iron in the overall diet. It's important to note that fortified cereals and pasta were major contributors of iron at 16%.

Table VI compares nutrient intakes with those of the general U.S. population by gender (18). Of note, Alaska Native people reported consuming a much higher mean intake of certain nutrients, especially EPA and DHA. Both men and women also consumed more iron, selenium and vitamin A. However, study participants consumed less calcium and folate than NHANES participants.

When comparing the two regions, there were no significant differences for either sex, but for one exception. Maniilaq men reported less calcium than YK men.

Table IV. Proportion of energy and nutrients contributed by Native foods for 333 participants in 2 regions of Alaska, 2002–2004.

Proportion of energy and nutrients from Native foods	YKHC %	Maniilaq %	Total %
Calories	23	20	21
Protein	46	45	46
Carbohydrates	3	2	3
Total fat	33	28	31
Saturated fat	26	19	22
Monounsaturated fat	35	32	33
Polyunsaturated fat	38	29	34
ALA	28	19	24
EPA	85	99	90
DHA	91	72	93
Cholesterol	39	40	40
Sucrose	5	3	4
Iron	31	41	37
Zinc	29	41	35
Sodium	17	14	16
Vitamin A	22	30	26
Vitamin C	5	12	8
Vitamin D	81	85	83
Dietary fiber	8	5	7

Dietary intake of Alaska Native people

Table V. Food groups contributing to specific nutrients consumed by 333 Alaska Native people in 2 regions of Alaska, 2002–2004.^a

Energy (calories)	%	SFA (g)	%	Calcium (mg)	%	Vitamin A (RAE)	%
<i>Fish and Seafood</i>	10	Beef	12	Fluid milk	14	Vegetables	21
Cereal and pasta	8	<i>Fish and seafood</i>	9	<i>Fish and seafood</i>	9	<i>Marine mammals</i>	18
Beef	6	<i>Marine mammals</i>	6	Bread and rolls	7	Fruit drinks	8
Protein (g)	%	MFA (g)	%	Iron (mg)	%	Folate (mcg)	%
<i>Fish and Seafood</i>	27	<i>Marine mammals</i>	16	Cereals and pasta	16	Cereals and pasta	23
<i>Caribou/moose</i>	13	<i>Fish and seafood</i>	11	<i>Marine mammals</i>	13	Fruit drinks	10
Beef	9	Beef	9	<i>Caribou/moose</i>	12	Breads and rolls	10
Carbohydrates (g)	%	PFA (g)	%	Sodium (mg)	%	Vitamin C (mg)	%
Cereals and pasta	15	<i>Marine mammals</i>	13	Cereal and pasta	13	Fruit drinks	46
Soda pop	12	<i>Fish and seafood</i>	12	<i>Fish and seafood</i>	11	Fruits	21
Fruit drinks	9	Vegetables	9	Beef	9	Vegetables	14
Fat (g)	%	ALA (g)	%	Zinc (mg)	%	Vitamin D (mcg)	%
<i>Marine mammals</i>	12	Vegetables	9	<i>Caribou/Moose</i>	19	<i>Fish and seafood</i>	56
<i>Fish and seafood</i>	11	Mayonnaise	7	Beef	14	<i>Marine mammals</i>	33
Beef	9	Bread and rolls	7	<i>Fish and seafood</i>	12	Milk	3
Dietary fiber (g)	%	EPA (g)	%	Selenium (mg)	%	Vitamin E (mcg)	%
Vegetables	20	<i>Marine mammals</i>	55	<i>Fish and seafood</i>	31	<i>Fish and seafood</i>	23
Fruits	14	<i>Fish and seafood</i>	44	<i>Marine mammals</i>	10	<i>Marine mammals</i>	10
Cereal and pasta	10	<i>Caribou/moose</i>	0.02	Cereal and pasta	8	Vegetables	9
		DHA (g)	%	Magnesium (mg)	%		
		<i>Marine mammals</i>	49	<i>Fish and seafood</i>	18		
		<i>Fish and seafood</i>	47	Coffee	11		
		<i>Caribou/moose</i>	1	Cereal and pasta	10		
		Cholesterol (mg)	%	Potassium	%		
		<i>Fish and seafood</i>	23	<i>Fish and seafood</i>	20		
		<i>Caribou/moose</i>	12	Vegetables	13		
		Beef	8	Coffee	12		

^aItalics denote Native food groups.

Table VI. Comparison of mean nutrient intake of Alaska Native people, 2002–2004, and NHANES, 2003–2004.^a

	Maniilaq Men	95% CI	YKHC Men	95% CI	NHANES Men	Maniilaq Women	95% CI	YKHC Women	95% CI	NHANES Women
Energy, kcal	2338	2096- 2580	2548	2349- 2747	2612	2082	1946- 2219	1953	1805- 2100	1850
Fat g	96	84-109	109	98-119	98	82	75-88	85	76-93	71
Saturated Fat, g	27	24-31	30	27-33	32	25	23-27	24	22-27	23
ALA, g	1.2	1.0-1.4	1.5	1.3-1.7	1.7	1.1	1.0-1.3	1.2	1.0-1.3	1.4
EPA, g	1.3	0.9-1.8	1.8	1.2-2.4	0.05	0.8	0.6-1.0	1.2	1.0-1.6	0.03
DHA, g	1.8	1.2-2.4	2.3	1.6-3.1	0.09	1.1	0.9-1.4	1.6	1.2-2.0	0.06
Calcium, mg	460	391-529	618	535-701	998	499	452-546	469	414-525	771
Iron, mg	25.5	20.7-30.3	20.6	18.5-22.8	18	21.4	18.4-24.3	16.9	15.0-18.8	13
Selenium, mcg	176	148-204	191	167-216	129	139	127-151	152	135-170	91
Vitamin A, RAE	913	729-1097	1238	828-1648	660	788	653-923	775	622-927	547
Folate, mcg	420	349-492	444	402-485	614	341	314-367	337	306-367	470
Vitamin C, mg	86	53-119	109	86-131	93	68	59-77	71	58-84	82

^aNational Health and Nutrition Examination Survey, 2003–2004, adults 20 and over (18).

DISCUSSION

This report includes multiple important findings about the consumption of Native foods and nutrients by Alaska Native people 13 years of age and older in 2 regions of Alaska. It confirms that Native foods continue to play an important role in their diet and contribute to the high consumption of protein, iron and omega 3 fatty acids. Consistent with our findings, other investigations reported that Native foods provide a high proportion of nutrients in the diet (1–4,6,10,11), but a lower proportion was observed in at least 1 other Alaska Native group who lived in an urban setting (5). Any further decrease in these foods can be expected to negatively affect the intake of many nutrients. Fish and seafood especially contributed to energy, protein, mono- and polyunsaturated fatty acids, selenium, magnesium and vitamins D and E.

These findings have important health implications. Our findings agree with what other research has shown: daily seal oil and salmon consumption were associated with lower prevalence of glucose intolerance compared with individuals reporting less-than-daily consumption (12); higher intakes of the omega-3 fatty acids may afford some degree of protection against coronary heart disease (16); lower rates of atherosclerotic lesions among AN on autopsy compared with non-Native people was attributed to high intake of omega-3 fatty acids (19); and greater amounts of alpha-tocopherol and fresh bird intake were associated with higher HDL/LDL-cholesterol ratios (11).

There were minimal differences in nutrient intake between the regions. There were more differences when we compared each region

with NHANES. The most notable difference between the regional intakes and NHANES was the much greater intake of EPA and DHA among the Alaskan participants.

People in both regions report intakes of omega-3 fatty acids well above the recommendations of 0.3 to 0.5 g/d of EPA+DHA and 0.8-1.1 g/d of ALA (α -linolenic acid, 18:3n-3) (20). The difference in intake of EPA between the 2 regions probably reflects greater intake of fish and sea mammals by residents of the south-west region surveyed. This finding illustrates one of several variations between regions and the need to recognize regional differences when evaluating diet or making dietary recommendations. Based on the number of times fish and seafood appear as a major source of nutrients for the participants in this study, it seems likely that they would easily meet the American Heart Association recommendation to consume 2 fish meals per week.

The median intakes of carbohydrates of men and women in our study are within the DRI median ranges of approximately 220–330 g/d for men and 180–230 g/d for women (16). This intake is higher than Alaska Native people historically consumed. Prior to the availability of store-bought foods, there were few carbohydrate sources in the diet. Draper estimates that prior to European contact, carbohydrate intake was approximately 10 g per day (21), mainly from berries, roots, greens, the stomach contents of herbivorous animals and those available from meat and fish sources such as liver, fish roe and muktuk (6). As early as 1950 investigators have documented and commented on the increase in carbohydrates in the Native diet (6, 7). Naylor describes 3 changes that

have occurred concurrently among AN over the past few decades: an increased proportion of carbohydrates in the diet, increased prevalence of obesity and increased prevalence of diabetes (22). It has been proposed that the increased intake of carbohydrates and sucrose among Alaska Native people are associated with the concurrent increases in diabetes and obesity (22).

We found that much of the carbohydrate consumption was from foods rich in simple sugars. The relationship between increasing consumption of fructose and sucrose and the increases in type 2 diabetes and obesity in the U.S. is under active discussion (23). Increased consumption of added sugars can result in decreased intakes of certain micronutrients as well (16). No previous dietary surveys in Alaska report fructose intake. However, sugar-sweetened soda pop, which contains fructose, was consumed in large quantity by the participants of this study (contributing 5% of total energy) and a high intake of soda pop has been documented among southwest region teenagers (3,8) as well as among adults in the 2 regions (1,3). The proportion of total energy obtained from soft drinks and fruit drinks in this study is similar to the U.S. general population, 9% (24).

Our study found low calcium intakes, which has been previously reported (4–5,10). Low levels of calcium intake may contribute to osteoporosis, an important public health problem for Alaska Native women, especially as their life expectancy increases. Low-bone density is highly prevalent among Alaska Native women, affecting 45% as evidenced by hip, ankle and foot fractures or a diagnosis of osteoporosis (25). In one study, smoking was an additional risk factor and 45% reported

they currently smoked cigarettes (25). In our study, fluid milk accounted for just 2% of total calories reported, but provided 14% of the dietary calcium.

We documented low dietary fiber intake and low vegetable and fruit intakes, which is consistent with previous studies (1,3–5,10). Low dietary fiber intake has been associated with a variety of adverse clinical effects, including impaired laxation, reduced calcium absorption, an increased risk of cancer, obesity, heart disease and type 2 diabetes (16). U.S. national health objectives call for consuming at least 6 daily servings of grain products, with at least 3 being whole grains (26). How these diet-disease interactions affect Alaska Native people has yet to be explored in-depth.

Although there was a wide range of intake in this study, caffeine consumption averaged 309 mg/day. Cummings et al. identified caffeine consumption of 190 mg/day as a risk factor for hip fracture among older white women (27). Given the women in our study had low dietary calcium intakes, frequent coffee consumption, low fiber intake and a high prevalence of smoking, there emphasis needs to be placed on their increased consumption of calcium, vitamin D and fiber and their reduction of tobacco use in future health programs.

Mean intakes of total fat, saturated fat and trans fatty acids exceeded recommendations. However, intakes of saturated fat and trans fatty acids are of greater concern than total fat intake, this is because the level of total fat is influenced by generous intakes of desirable unsaturated fats among American Native people in general. Current national recommendations are focusing greater attention on

the type of fat (less saturated and trans fats and more omega-3 fats) (16). The U.S. target for total fat consumption is equal to or less than 30% of total calories from fat (27). We found that only 22–24% of the participants met this recommendation. The recommended level of <1% of energy from trans fats was met by only 7% of our participants. Increased total and LDL cholesterol levels and, in turn, cardiovascular disease have been linked to higher intakes of trans fatty acids (16). The 2010 target in the U.S. for saturated fat intake is less than 10% of total calories (27). Among AN in this study, only 44% of men and 42% of women met that goal.

It is probable that the dietary intakes we observed — low intakes of fruits, vegetables, dietary fiber, milk and calcium — are contributing to the development of cancers when a variety of evidence is considered. In the 1990s, cancer became the leading cause of death among Alaska Native people, and the cancer mortality rate is 30% higher than that of whites in the U.S. (28). Alaska Native people are 40% more likely to die of lung cancer than whites and experience excess risk for nearly all cancers of the digestive system, including colorectal cancer (28). An international panel that reviewed research on the primary prevention of cancer, food, nutrition and physical activity found probable evidence that vegetables and fruits decrease the risk of mouth, throat, esophagus and stomach cancers, and that fruits also decrease the risk of lung cancer (29). There is also probable evidence that decreased risk of colorectal cancer is associated with dietary fiber, milk and calcium supplements (29). Our finding of low fruit and vegetable intake (1.6 servings/day) is consistent with a statewide survey that

found 83% of Native adults in rural Alaska do not eat 5 servings of fruits and vegetables per day (30).

Nutrition education that is culturally appropriate is an effective tool in the promotion and maintenance of healthy practices. Emphasizing Native foods, especially over beef, which is the source of 11% of the saturated fats, would reduce the intake of saturated fats and enhance the intake of many nutrients. To counter low intakes of calcium and high sugar consumption, we support increasing low fat milk consumption for those who can tolerate it and reducing intakes of sugary beverages. Promoting the increased consumption of fruits and vegetables, including local berries such as blueberries, will increase intakes of fiber, phytochemicals and many nutrients.

There are some limitations of this study. The sample size of 20 people per village was small and did not represent the age distribution of the village, although when aggregated, there were 156 and 177 people representing the 2 regions respectively. We intentionally sought out equal numbers in each age group, which resulted in a greater number of older participants and fewer adolescents than in the general population. We do not feel, however, that this introduced any appreciable bias as foods available to all age groups in the villages are similar. Results may be influenced by gender because the sample included a higher proportion of women than the general AN population. However, findings that we reported are typically gender specific and adequacy of intake was calculated for each person based on their age and gender.

The accuracy of the 24-hour recall is dependent on the participant's short-term memory, as well as the ability of both the interviewer

and the participant to accurately estimate amounts consumed. A multi-pass method was used to help assure that all foods eaten were recorded. As with all recall studies, foods are sometimes inadvertently omitted or portion sizes are underestimated, which can lead to the under-reporting of the total diet. However, multiple recalls increase the ability of 24-h recalls to reflect usual intake. Multiple recalls also improve estimates of average intake when many foods are eaten seasonally.

While some traditional foods were missing from the NDS-R database, including specific foods such as fermented seal flipper, as well as foods in the form in which they were eaten, such as dried chum salmon, the software used was selected because it included more AN foods than other software databases.

Estimates of the vitamins and minerals intake may be low because of the exclusion of supplements from our analysis. More than one-quarter of recalls included supplements, so the actual intake of vitamins and minerals may be somewhat greater than calculated.

We limited the majority of our comparisons to the DRIs. For some nutrients, such as omega-6 and omega-3, there is not yet a recommended intake for healthy individuals. In the case of cholesterol, the DRIs state that there is no evidence for a necessary intake of cholesterol. Also, sodium intake may be greater than reported because amounts of salt added while cooking and when eating at the table were not included in our calculation of sodium intake and would be misleading to compare against the recommendations. Other methods of evaluating dietary adequacy, such as the Diet Quality Index International (31), might be considered for

future dietary evaluation of Alaska Native people. However, the Healthy Eating Index was found to be inappropriate for use with Yupik Eskimos of western Alaska in at least one other study (3).

Conclusions

The energy and nutrient intakes of Alaska Native people in 2 regions were calculated. A large proportion of nutrients came from traditional foods. At the same time, we documented levels of carbohydrates that exceed recommendations along with notable intakes of simple sugars. These levels might be contributing to an excess intake of energy that lead to a rise in obesity and diabetes. The low intake of calcium, dietary fiber, fruits and vegetables could be contributing to the increased incidence of cancers of the digestive system.

These results suggest areas of concern that require further investigation among Alaska Native people, as there are many new questions about the role of their unique diet in maintaining good health and preventing chronic diseases. Although our study was confined to 2 regions, we believe our findings support the need for a system of ongoing, uniform nutrition monitoring that would include multiple regions and cultures in Alaska, track changes in dietary intake and provide continual information to update nutrition policies, education and interventions.

Our findings support current dietary recommendations that are intended to minimize development of chronic disease among Alaska Native people. For residents 13 years of age and above in these 2 regions, we concur with these recommendations: (1)

the continued use of traditional Native foods because of their outstanding nutrient content, their contribution to maintaining the cultures of Alaska Native people and the physical benefits associated with hunting, gathering and preparing traditional foods; (2) achieving and maintaining desirable weight and energy balance through limiting the intake of calories, especially sugary beverages that are high in calories and low in nutrient value, and participating in regular physical activity; (3) consuming as little trans fat and saturated fat as possible; (4) increasing the consumption of fiber-rich foods, including vegetables, fruits and whole grains; and (5) assuring the optimal consumption of minerals and vitamins, especially calcium.

Alaska Native people in these regions and elsewhere continue to have an outstanding source of nutrient-dense traditional foods available to them. Encouraging an increase in these foods as well as an improved selection of nutrient-dense store-bought foods could improve their overall diet and health.

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