ABSTRACT

Objectives. To determine whether dietary westernization is associated with intake of select nutrients among Alaska Natives living in remote communities. To investigate participant characteristics associated with adherence to the traditional Alaska Native diet.

Study Design. Cross-sectional survey.

Methods. A 24-hour recall was collected from 241 men and 307 women aged 14-94 years living in seven remote communities of Western Alaska. Bivariate analyses and ANOVA were used to examine the relationship between energy from traditional foods (the primary variable of interest), participant characteristics and intake of select nutrients.

Results. Traditional foods accounted for 22% of energy intake overall. This estimate varied by age, educational attainment, and geographic location. Participants in the highest quintile of traditional food intake consumed significantly more vitamin A, vitamin D, Vitamin E, Iron, and n-3 fatty acids than participants in the lowest quintile (p<0.001). Intake of vitamin C, calcium, and total dietary fiber decreased with increased consumption of traditional foods (p<0.001).

Conclusions. The degree of dietary westernization contributes to nutrient intake, both positively and negatively, in a dose response manner. Participant characteristics, particularly age, must be addressed in the development of a nutrition education program since they are associated with distinct dietary intakes. (Int J Circumpolar Health 2007; 66(1):62-70)

Keywords: Alaska Natives, diet, traditional foods, dietary westernization
INTRODUCTION

Remote Arctic communities have experienced relatively rapid changes in lifestyle, including changes in diet (1-4). Specifically, consumption of a traditional subsistence diet has given way to an increased reliance on imported western foods. This shift is likely to contribute to a decline in diet quality and an increase in the prevalence of type 2 diabetes, cardiovascular disease and obesity.

The benefits of a traditional subsistence diet among Alaska Natives are poorly understood, particularly given an absence of long term prospective studies. Westernization over the past century has precipitated major changes in food sources and intake of numerous nutrients among Alaska Natives. Nevertheless, communities in Southwestern Alaska were among the last to experience western influence (5) and retain a mixed traditional-western diet. This situation provides a valuable context for examining the contribution of a traditional diet to nutrient intake and the development of chronic disease.

The Center for Alaska Native Health Research (CANHR) was established in 2001 to address increasing health disparities observed between Alaska Natives and non-native populations. The center currently supports interdisciplinary research investigating genetic, nutritional, and behavioral risk factors for chronic disease among Alaska Natives. The objective of the present paper is to add to the growing body of literature documenting the nutritional effects of dietary westernization, which has been defined as “the diffusion and adoption of western food culture”(6).

Specifically, our objectives were to: 1) determine the leading sources of traditional foods; 2) determine the degree of dependence on traditional subsistence foods by population subgroups; and 3) to examine the contribution of traditional foods to nutrient intake.

MATERIAL AND METHODS

This paper presents findings from data collected in all seasons between December 2003 and March 2005. The study population for the current study included 241 men and 307 women living in seven remote communities in the Yukon-Kuskokwim Delta; ages ranged from 14-94 years.

Rural communities in the Yukon-Kuskowkim Delta, located in southwestern Alaska, are home to approximately 16,500 Alaska Natives. The remote communities are served primarily by local air service companies, and occasionally by barge in the summer months. In 2000, the median age was 25.3 years old, compared to 35.9 in the US population. Per capita income in the census area was roughly $12,603, and 20.6% of individuals fell below the national poverty level (7). The per capita income in each individual village was significantly lower than in the census area. The majority of the population, particularly the younger generation, was bilingual, speaking both Yup’ik and English; 94.8-98.9% were Alaska Natives.

The study protocol has been described previously (8, 9). Briefly, participants were recruited via word of mouth, flyers, and the locally popular VHF (very high frequency) radios.
Exclusion criteria included the following: age <14 y and pregnancy. The University of Alaska at Fairbanks and the University of California at Davis Institutional Review Boards approved the study protocol.

Dietary data were collected from each participant by certified interviewers using a computer assisted 24-hour recall (Nutrition Data System for Research (NDS-R) software version 4.06) (10). Participants were asked to recall all food and beverages consumed over a 24-hour period using a multiple pass approach to minimize recall bias. Although the majority of participants were bilingual, a native Yup’ik speaker also trained in the use of NDS-R software assisted non-English speakers.

Nutrient calculations for the 24-hour recall were performed using the NDS-R Food and Nutrient Database 33, released July 2003, which includes many Alaska Native foods (11). Both Alaska Native and western foods that were missing from the database were either substituted for similar food items when appropriate or the food was added to the database by request. The majority of communities in the Yukon-Kuskokwim Delta prohibit the use and possession of alcoholic beverages, thus alcohol intake was not recorded. Use of vitamin and mineral supplements were rare in this population and were not included in analysis.

Traditional foods were defined as those foods harvested from the local environment, and included berries, marine mammals, fish, game animals, and wild greens (12). The contribution of traditional foods to mean energy was calculated. Mixed foods were disaggregated, so only traditional ingredients were included in the calculation.

Demographic variables included in analyses were: age (continuous variable), educational attainment (≥ 8th grade) and geographical location (coastal, rural or small city). We chose to limit educational attainment to two categories because participants under the age of 20 years may not have achieved their maximal level of education.

Statistical Analyses
All statistical tests were performed using SPSS software (version 13.0; SPSS, Inc, Chicago). A p-value of ≤ 0.05 was considered statistically significant.

A total of 566 participants completed the 24-hour recall. Individuals reporting an energy intake of greater than 3 standard deviations above the mean and that were deemed unreliable were excluded from analysis (n=18). An individual was considered unreliable if they were unable to recall details about one or more meals or did not appear to understand the protocol for other reasons. Analyses were conducted on 548 individuals.

Pearson correlations were used to assess the relationship between energy intake from traditional foods and participant characteristics. Traditional food intake was categorized by quintile cutoffs based on the distribution of traditional food consumption among all participants. Differences in select nutrient intakes between quintiles were examined using ANOVA and Bonferroni’s post hoc tests. These nutrients were selected because they have been identified as areas of concern in the general US population or because their intakes were hypothesized to be unusual among Alaska Natives (13).
RESULTS

The study sample was composed of 241 men and 307 women. The average age was 38.6±17.4 years and there was no significant difference in age distribution between sexes. Forty-one percent of the sample resided in coastal communities, 47.8% in inland communities, and the remaining 10.6% lived in the small city.

Traditional foods consumed fell under 9 broad categories (Fig. 1). Four food groups (fish and fish roe, animal fat, game meat, and game fowl) contributed more than 90% of traditional food intake. Marine sources, primarily fish and seal oil, independently contributed 69% of energy intake. Plant sources of traditional foods comprised less than 3% of traditional food intake.

Traditional foods accounted for 22% of the diet among all participants; this estimate varied significantly by participant characteristic (Table I). Traditional food intake between men and women did not differ. A 35.6 ± 3.1 percent (mean ± SE) difference in traditional food intake was observed between the oldest and the youngest age group. When comparing the proportion of the diet from traditional foods between participants living in coastal (n=3) and riverine communities (n=3) no difference was observed. Participants in the small city, however, derived significantly less of their diet from traditional foods than participants living in the rural communities. Participants with less than an 8th grade education consumed significantly more traditional foods than participants with more than a high school education (p<0.001).

Figure 1. Contribution of nine food groups to traditional food intake (% energy).
A significant increase in age was observed across quintiles of increasing traditional food intake \((p<0.001)\) (Table II). Participants who reported consuming the most traditional foods derived 10.7±1.4 % more energy from fat and 18.1±0.8 % more energy from protein than participants who did not consume any traditional foods. On average, participants within the two lowest quintiles of traditional food intake consumed 30% more energy from carbohydrates than participants in the highest quintile. Intake of select nutrients also varied significantly according to the level of traditional food intake. Participants in the highest quintile of traditional food intake consumed significantly, more vitamin A, vitamin D, Vitamin E, Iron, and n-3 fatty acids than participants in the two lowest quintiles \((p<0.001)\). Intake of vitamin C, calcium, and total dietary fiber decreased with increased consumption of traditional foods \((p<0.001)\).

### Table I. Traditional food intake (% energy) by participant characteristic.

| Variable               | Traditional food Mean ± SD | p        |
|------------------------|----------------------------|----------|
| Sex                    |                            | 0.462    |
| Men                    | 23.0 ± 23.7                |          |
| Women                  | 21.5 ± 21.8                |          |
| Age group              |                            | <0.001   |
| 14-19 y                | 7.1 ± 10.7                 |          |
| 20-39 y                | 18.4 ± 19.9                |          |
| 40-59 y                | 25.5 ± 21.1                |          |
| ≥ 60 y                 | 42.6 ± 26.6                |          |
| Location               |                            | 0.001    |
| Coastal village        | 24.6 ± 24.2                |          |
| Riverine village       | 22.4 ± 22.1                |          |
| Small city             | 11.2 ± 14.5                |          |
| Last grade completed   |                            | <0.001   |
| < 8th grade            | 32.7 ± 27.1                |          |
| ≥ 8th grade            | 18.9 ± 22.5                |          |

Bivariate analysis was used to test the degree to which the variables were related.
Table II. Select nutrient intake of CANHR participants by quintile of traditional food intake (mean ± SD).

| Nutrient                        | Quintile 1 (0) | Quintile 2 (6.5-38.7) | Quintile 3 (39.8-60.9) | Quintile 4 (61.0-81.1) | Quintile 5 (82.2-100.2) | p for trend |
|--------------------------------|----------------|------------------------|------------------------|------------------------|-------------------------|-------------|
| Traditional food intake (kcal) | 1950.0 ± 933.1 | 2189.7 ± 868.7 | 2056.7 ± 817.1 | 1863.7 ± 895.9 | 1775.0 ± 971.7 | <0.001      |
| Age (y)                        | 30.0 ± 14.3 | 30.5 ± 13.5 | 38.3 ± 15.4 | 44.3 ± 16.9 | 50.3 ± 17.3 | <0.001      |
| Energy (g)                     | 71.9 ± 41.8 | 81.9 ± 45.2 | 87.1 ± 50.4 | 82.5 ± 53.1 | 88.3 ± 57.0 | <0.001      |
| Carbohydrate (g)               | 269.8 ± 143.4 | 294.0 ± 118.8 | 240.9 ± 100.2 | 190.0 ± 98.9 | 112.9 ± 80.7 | <0.001      |
| Protein (g)                    | 61.9 ± 34.2 | 74.9 ± 36.3 | 82.2 ± 32.5 | 93.0 ± 44.4 | 131.8 ± 88.1 | <0.001      |
| Fat energy (%)                 | 3.2 ± 8.9 | 3.2 ± 10.5 | 3.6 ± 11.2 | 3.8 ± 11.6 | 4.3 ± 12.5 | <0.001      |
| Carbohydrate energy (%)        | 55.9 ± 11.6 | 54.8 ± 11.4 | 47.5 ± 10.4 | 41.5 ± 10.4 | 25.8 ± 11.1 | <0.001      |
| Fat (g)                        | 7.1 ± 4.3 | 13.7 ± 4.3 | 16.8 ± 5.3 | 20.5 ± 5.2 | 30.8 ± 9.8 | <0.001      |
| Vitamin A Activity (RE) (mcg)  | 633.4 ± 581.1 | 741.8 ± 627.9 | 1284.1 ± 4055.3 | 3771.4 ± 11865.6 | 4163.3 ± 12344.2 | <0.001      |
| Total Folate (mcg)             | 362.7 ± 209.3 | 381.8 ± 204.5 | 350.3 ± 199.9 | 374.3 ± 393.9 | 313.2 ± 418.7 | =0.541      |
| Vitamin D (mcg)                | 77.7 ± 74.4 | 93.4 ± 105.6 | 62.3 ± 54.9 | 50.1 ± 62.9 | 44.2 ± 72.1 | <0.001      |
| Vitamin E (Total Alpha-Tocopherol) (mg) | 2.7 ± 2.4 | 6.6 ± 7.1 | 10.9 ± 11.4 | 18.0 ± 20.0 | 30.8 ± 30.2 | =0.001      |
| Calcium (mg)                   | 549.8 ± 486.6 | 509.5 ± 395.6 | 415.8 ± 298.9 | 297.8 ± 204.5 | 304.9 ± 271.2 | <0.001      |
| Iron (mg)                      | 13.8 ± 8.0 | 16.6 ± 7.7 | 17.6 ± 11.1 | 19.3 ± 14.7 | 19.3 ± 16.6 | =0.002      |
| Total Dietary Fiber (g)        | 12.2 ± 8.2 | 12.3 ± 7.3 | 11.6 ± 7.2 | 9.5 ± 6.6 | 5.6 ± 4.2 | <0.001      |
| Omega-3 Fatty Acids (g)        | 1.1 ± 0.8 | 2.1 ± 1.7 | 4.1 ± 3.6 | 5.7 ± 4.2 | 11.5 ± 8.2 | <0.001      |

Means without a common superscript are significantly different, p<0.05 (Bonferroni's post hoc test)
DISCUSSION

Our results show that participants of the CANHR study relied on a mix of traditional subsistence and imported western foods. Moreover, the relative contribution of each was both positively and negatively associated with intake of select nutrients, which may have important public health consequences.

The finding that CANHR participants derived on average 22 percent of their diet from traditional foods is consistent with previous reports from similar Alaska Native populations (1, 13-15). Although differences in methodology preclude making direct comparisons between the studies, all serve to emphasize the important observation that the traditional diet of pre-contact times is obsolete. Nevertheless, evidence indicates that traditional subsistence foods continue to contribute appreciably to the modern diet and intakes of specific nutrients.

Dietary westernization has affected certain subgroups of the population more than others. In addition to the present study, the Genetics of Coronary Artery Disease in Alaska Natives study (13) and the Alaska Siberia Project (16) identified age as an important factor related to dietary composition. A difference in the relative dependence on traditional and imported western foods by age is likely to account for the relationship. The observation that the diet of elders included more traditional foods confirms an earlier finding from the CANHR pilot study (9).

Interestingly, educational attainment was also significantly correlated with traditional food consumption. It is possible that participants with greater educational attainment would have been more likely to participate in wage economy. Several studies support this hypothesis. A study conducted by the Alaska Department of Fish and Game found that in rural areas a one-hundred dollar decrease in income resulted in a one pound increase in subsistence harvests per person per year (17). Similarly, Scott noted that consumption of imported Western food increased when seasonal wages were good (18). Evidence from an Alaska statewide survey of subsistence use in 98 communities supports these findings (19). Wolfe found a significant inverse relationship between subsistence harvests and mean taxable income ($r=.60; p<0.001$). It is also possible that educational attainment may serve as a marker for acculturation; this should be explored further.

In the present study, the diet of Alaska Natives living in the isolated coastal and riverine communities was more dependent on traditional foods than the diets of those living in the small city. This is consistent with previous studies that have found regional differences in a community’s dependence on traditional foods. An Alaska statewide survey of subsistence use in 98 communities reported a significant inverse relationship between subsistence harvests and miles from an urban center ($r=.548, p<0.001$) (19). Similarly, a study conducted among Canadian Inuit found that traditional food consumption increased with latitude; the northern communities are likely to have been the most remote (12).

The relative dietary contribution of traditional versus imported western foods appears to have a considerable effect on the macro and micro-nutrient composition of the diet. Diets that were high in traditional foods were concomitantly high in the fat soluble vitamins and iron when compared to diets low in tradi-
tional foods. Similarly, studies conducted among Dene/Metis communities in the Canadian Arctic have consistently found that on days when traditional food was consumed, intakes of select minerals were higher, and fat, saturated fat, and sucrose intakes were lower than on days when traditional foods were not consumed. Our study adds to this finding by showing a dose response relationship between level of traditional food intake and these nutrients.

Interestingly, both studies also found lower intakes of vitamin C, fiber, and calcium with increasing traditional food intake. Vitamin C and fiber are nutrients found almost exclusively in carbohydrate based foods; this likely explains the low presence of these nutrients in high traditional food diets, which by definition are low in carbohydrate. Indeed, the pre-contact traditional diet has been estimated to contain approximately 2% of energy from carbohydrate (20).

We previously reported that youths consumed significantly more fruits and vegetables than elders in the same population (9). Since youth also consume the fewest traditional foods this may account for the increased intake of vitamin C and fiber observed in participants consuming the least traditional foods. Furthermore, given that consumption of berries and wild greens was limited and that these foods supply the most vitamin C and fiber among all traditional foods, it is not surprising that intake of these nutrients declined with increasing traditional food intake.

Compared with national recommendations, calcium intake among Alaska Natives has been reported as low by a number of studies (13-15, 21, 22). Evidence from a study conducted in Canada, however, suggests that calcium intake from native sources, including fish, may be underestimated (23). Nevertheless, it is unlikely that correct estimation of traditional foods would appreciably increase estimates of calcium intake to adequate levels, particularly among the group consuming the high traditional food diet.

A limitation of the present study includes using percent of energy from traditional foods as the only measure of westernization; dietary patterns were not assessed in this study. Consideration of dietary patterns is likely to provide further insight into the effects of westernization on diet quality and warrant further exploration.

**Conclusions**

These data, while cross-sectional in nature, suggest that increasing traditional food intake may contribute to improved intakes of many nutrients. Clearly, promotion of healthy western foods, particularly those high in fiber, vitamin C, and calcium, is also essential to improving the Alaska Native diet. The current study identified personal characteristics associated with consumption of a diet including varying degrees of western and traditional foods. While this is an important step in identifying segments of the population for whom recommendations to increase intake of traditional and/or market foods would be most beneficial and feasible, further research should be undertaken in this area. Successful nutrition interventions must be based on a keen understanding of psychosocial characteristics associated with diet selection.
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