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Dietary Quality Varies Among Adults on the Flathead Nation of the Confederated Salish and Kootenai Tribes in Montana

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Abstract

Background.—Diet-related chronic disease is among the most pressing public health issues and represents a health disparity among Native American communities.

Objective.—A community-based participatory approach was taken to evaluate dietary quality of adult residents of the Flathead Reservation of the Confederated Salish & Kootenai Tribes in Montana (the Flathead Nation).

Methods.—A survey was administered to collect basic demographic information and food security status. Dietary quality was assessed using the 24-hour dietary recall method with subsequent calculation of Healthy Eating Index 2010 (HEI-2010) scores, modified HEI without a dairy category, and the Dietary Diversity Scores (DDS). Participants included 80 adults from different households across eight communities (n=10 per community) at the Flathead Nation.

Results.—Approximately 50% of participants reported low or very low food security status while the remainder scored high or marginal food security. The mean total HEI-2010 score of study participants was 45.5 out of 100 points with a range between 20.0 to 78.1. The mean DDS of

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study participants was 4.6 (±1.365) out of a total of 9 points. Participants with higher DDS had significantly higher intake of dietary fiber ($p<0.0003$), potassium (0.0024), and cholesterol ($p<0.0048$) compared to the lower DDS group. No significant correlations were found between HEI-2010 scores with DDS, demographic information, or food security status while significant differences were found between food security status and income ($p<0.01$) and enrollment in nutrition assistance programs ($p<0.03$).

Conclusions.—This study highlights the need to evaluate multiple parameters of dietary quality coupled with a community-based participatory approach in order for findings to be culturally relevant and support food and nutrition interventions.

Keywords

food security; dietary guidelines; Healthy Eating Index; dietary diversity; Native American

Introduction

Adverse health outcomes linked to poor dietary quality including obesity, overweight, and nutrition-related chronic disease are among the most pressing public health issues of our time (1). Poor dietary quality is associated with the consumption of energy dense and ultra-processed foods and beverages high in saturated and trans fats, sugar, and sodium (2, 3). In contrast to poor dietary quality, nutrient-dense dietary patterns contribute to the avoidance of nutrition-related weight gain and chronic diseases (4). There is global agreement that a healthy diet is nutrient dense and consists of a variety of fruits, vegetables, legumes, whole grains, and nuts (5).

Specific dietary recommendations and how adherence to these recommendations is measured vary across the globe (6). National dietary guidelines serve to inform consumers on what to eat, provide a unified public health voice regarding where the government stands on dietary advice, and to inform food and nutrition policies and programs (7, 8). For example, in the United States, the national Dietary Guidelines for Americans (DGA) inform the National School Lunch Program (9). The DGA posits that a high-quality diet includes: half of a consumer's plate should be fruits and vegetables; a variety of vegetables; fruits, mostly whole fruits; at least half of grains should be whole grains; a variety of protein foods; fat free or low-fat dairy; and consume less sodium, saturated fat, and added sugar (1).

As measured by adherence to the DGA, evidence suggests that tribal communities across the United States are among the most vulnerable populations regarding poor dietary quality (10–12). Modern Native American diets have been characterized as low in fruits and vegetables, lean meats, and healthy fats and high in refined grains, sugars, salts, and saturated fats and have resulted in nutrition-related health disparities (13). Native American adults are 60% more likely to be obese than non-Hispanic whites (10), twice as likely to be food insecure than non-Hispanic whites (11), and experience diabetes mellitus at a higher rate than any other race or ethnic group in the United States (12).

The dietary quality of the modern Native American diet is a result of a transition that occurred at post-colonial contact and associated socio-ecological changes (14–19). While

indigenous food systems of Native Americans vary regionally, they can be broadly characterized as high in animal proteins and fats and a diversity of plant sources (e.g., beans, seeds, squash, tubers, berries, maize, wild rice) (20, 21). Indigenous diets of Native Americans promoted health as supported by evidence that very few nutrition-related chronic diseases existed (22, 23). During post-colonial times, a food environment and nutrition transition occurred away from diets that relied on local natural resources to diets with more processed and energy-dense foods from the built food environment (24–27).

Previous studies have highlighted that the food environment plays a key role in influencing food choices and the composition of an individual's diet (28). The food environment is the part of the food system that influence the foods that are available, affordable, convenient, and desirable for individuals (29, 27). Food environments include those that are wild, cultivated, and built. Wild and cultivated food environments include subsistence foods procured from forests, home gardens, fields, pasture, and other agricultural systems (30). Built (or market) food environment consists of food procured from retail outlets such as farmers markets and grocery stores (30). Today, residents of Native American reservations face challenges to accessing healthy, affordable foods in their built food environment due to limited infrastructure, long distances to food outlets, and fewer healthy options (31–33). The food environment challenges faced by Native American communities in accessing healthy and affordable food is coupled with low food security (11, 34,35). The aforementioned challenges are in line with research indicating that reduced access to healthy food is a key determinant of both food insecurity and poor dietary quality that can lead to nutrition-related health disparities (36, 37).

Interventions to improve food environments and dietary behaviors among Native American communities are needed in order to reduce nutrition-related health disparities among this population. The research presented here examines dietary quality among residents of the Confederated Salish & Kootenai Tribes of the Flathead Reservation in Montana (hereafter referred to as the Flathead Nation) with the objective to develop evidence-based, culturally-relevant food environment interventions that mitigate nutrition-related health disparities. This study took a community-based participatory approach in order to be culturally relevant (38–40).

Along with community partners, the research team selected to analyze dietary quality in multiple ways in order to take a culturally-sensitive approach to examining diets. Specifically, the Healthy Eating Index (HEI) based on the 2010 DGA (HEI-2010) was used to examine dietary quality from a national dietary guidelines perspective. As national dietary guidelines have been criticized for being culturally insensitive to different cultural groups (41), additional dietary approaches that are more relevant to indigenous food systems were taken. HEI scores, that evaluate consumption of dairy products (42–45), were adapted to remove the dairy category based on the rationale that dairy products are relatively high in lactose and a majority of Native Americans lack the ability to digest lactose and are lactose intolerant (46, 47, 8). Dietary Diversity Scores (DDS) were further measured as dietary diversity is a characteristic of indigenous food systems (22). DDS have been used to observe general patterns in diet quality, nutrient adequacy, and food security in cultural contexts

globally (48–51). High dietary diversity has been associated with high dietary quality (48), lower incidence of type 2 diabetes (52, 53), and both low and high body mass index (52, 54).

The overall research question of this study is: Does dietary quality of residents of the Flathead Nation vary based on food security status and demographic factors? The specific research questions of this study are: (i) Based on the HEI-2010 and modified HEI (without a dairy category), how do dietary patterns of residents of the Flathead Nation align with nutrition guidelines outlined in the DGA 2010?, (ii) Are diets of residents of the Flathead Nation diverse based on DDS?, (iii) Is there a positive relationship between HEI-2010 and DDS?, and (iv) Do HEI-2010 and DDS vary with demographic factors and food security status? This study is intended to serve as a guide for future research and practice on culturally-sensitive approaches to examine dietary behaviors among Native American populations. In addition, findings are intended to be applied to develop evidence-based and culturally relevant food and nutrition interventions that promote nutritious and sustainable diets for adults residing at the Flathead Nation.

Methods

This study collected cross-sectional data from households across the Flathead Nation in 2015 using a community-based participatory approach to study dietary quality as measured by dietary intake and assessed by adherence to nutrition recommendations based on the Healthy Eating Index (HEI) as well as by dietary diversity scores (DDS).

Setting

The Flathead Nation is located in Northwest Montana (55). The tribal lands, approximately 1.3 million acres, belong to the Bitterroot Salish, Upper Pend d'Oreille, and the Kootenai tribes and individual Native Americans own 768,000 acres. Eight recognized townships exist on the reservation including Arlee, Mission, Hot Springs, Ronan, Pablo, Polson, Elmo, and Charlo. Population statistics report that 28,993 people reside on the Flathead Nation that include 7,791 Native American residents (56, 57).

At the time of the study, the Flathead Nation had 13 grocery stores along with convenience stores and the Food Distribution Program on Indian Reservations (FDPIR, also known as the "Commodities Center"). Elmo was the only town without a grocer or convenience store. Each town on the reservation has a community garden of edible plants that was established by the tribal college on the reservation, Salish and Kootenai College. Lake County statistics indicate that 18% of residents are food insecure, which includes both Native American residents as well as non-tribal residents (58).

Community-based Participatory Approach

A community-based participatory approach was taken where community members were actively involved in all aspects of the research process as equal partners (59). The study authors include tribal community members of the Flathead Nation and researchers affiliated with Salish Kootenai College and Montana State University. Authors collaborated with a Community Advisory Board (CAB) of food and nutrition stakeholders residing on the Flathead Nation in order to understand and improve nutrition-related health disparities

among this population. The study process started with a workshop to identify community-defined problems related to food. The team prioritized examining and improving dietary quality. Collectively, team members selected relevant methods, study sites, sample size, and implementation of methods through an iterative process.

All partners involved contributed their expertise to enhance the study design which included integrating knowledge of the community with a western scientific approach. For example, the integration of knowledge led to the measurement of dietary patterns in multiple ways that reflect both a national dietary guidelines perspective (the HEI) as well as an approach that is more relevant for indigenous food systems (modified HEI without a dairy category and DDS). A researcher on the team with expertise in conducting dietary recalls trained students and participating community members. Data was analyzed by the study team. A workshop was hosted to share findings and elicit feedback from the CAB and other community members regarding interpretation and dissemination of findings.

Participants

Ten participants from different households from each of the eight communities (N=80) of the Flathead Nation were recruited to participate in this study. Recruitment was conducted by flyers and word of mouth. The participants were invited to complete 24-hour recalls and demographic data surveys. Eligible participants were over 18 years of age and residents of the Flathead Nation.

Demographic Survey

A survey was designed and implemented to collect basic demographic information (age, education, income level, race, township) and food security status. Food security status was assessed through administering the ERS/USDA 6-item Food Security Module (60). Classification of food security status was determined by the number of questions answered affirmatively (“often,” “sometimes,” “almost every month,” “some months but not every month” or “yes” – depending upon the question). Participants were assigned food security status according to the number of affirmative responses: high or marginal food security (0 to 1 affirmative responses); low food security (2 to 4 affirmative responses); or very low food security (5 to 6 affirmative response).

24-Hour Recall

Dietary intake data were collected using the multiple pass 24-hour recall method (61). To increase validity, the research team was trained to neutrally guide participants in their recall of food consumption from 12 AM to 11:59PM on the previous day, collect initial dietary recall data, probe for missed data such as brand, beverages, and condiments, and provide serving size examples.

Analysis

Statistical tests were conducted using JMP (version 12.0 SAS Institute Inc., Cary, NC) and SAS (version 9.4 SAS Institute Inc., Cary, NC). Descriptive statistics were calculated to quantitatively describe population demographics. Demographic parameters were compared to food security status, HEI-2010 Total Score, and DDS using inferential statistics. A

contingency analysis with the Pearson test was applied to examine differences between food security status, HEI-2010 Total Score, and DDS with nominal variables. A one-way analysis of variance (ANOVA) was applied to examine differences between food security status, HEI-2010 Total Score, and DDS with continuous variables. The Tukey-Kramer HSD was further used to compare pairs of means.

Dietary recall data were collected by a trained researcher with pen and paper and entered into Nutritionist Pro Diet Analysis (Axxya Systems) for energy and nutrient composition by participant. Using descriptive statistics, self-reported dietary intake was compared to 2015 Dietary Guidelines for Americans including: (1) general nutrient recommendations for total kilocalories (estimated calorie needs by day, age, sex, and physical activity level), (2) total fat (< 35% of energy intake), (3) saturated fat (< 10% of total fat), (4) added sugars (<10% of energy intake), (5) sodium (<2300 milligrams), (6) cholesterol (as little as possible), (7) potassium (4700 milligrams), (8) dietary fiber (28 grams for women, 33.6 grams for men), (9) calcium (1000 milligrams), (10) vitamin D (15 micrograms), (11) fruits (2 cup-equivalents per day) and, (12) vegetables (2.5 cup-equivalents per day). Further, each food item was assigned a USDA food code or ingredient code. Determination of best fit matches were based on the item description. Food group composition was determined using Food Patterns Equivalents Database 2011-2012 (62).

The Healthy Eating Index-2010 (HEI-2010) was used to measure how reported diets aligned with the 2010 DGA (63, 64). This resulted in an overall diet quality index made up of 12 components for a total of 100 points (63). Of the 12 components, nine assessed the adequacy of intake of total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids (63). The other three components assessed foods and nutrients that should be consumed in moderation: refined grains, sodium, and empty calories. Total vegetables, greens and beans, total fruit, whole fruit, seafood and plant proteins, and total protein foods can receive a maximum score of 5; whole grains, low-fat dairy, fatty acid ratio, refined grains, and sodium can receive a maximum score of 10; and empty calories can earn a maximum of 20 points (63). With the exception of the fatty acid ratio, HEI-2010 scores used standards expressed as either a percent of calories or per 1,000 calories. HEI-2010 component and total scores were calculated using published SAS code (65) (version 9.4 SAS Institute Inc., Cary, NC), modified to assess this specific data. In addition, the HEI-2010 score was also calculated without the dairy component as many Native Americans are lactose intolerant (8, 46, 47). The total HEI score without a dairy category is 90.

Dietary Diversity Scores (DDS) were calculated using self-reported data from 24-hour dietary recalls. Calculating DDS involves categorizing foods consumed into unique food groups recognized in many cultures (e.g., vitamin A rich fruits and vegetables, eggs) and assigning a unique score (48). Analysis and validation of scores is described in the United Nations Food and Agriculture Organization Guidelines for Measuring Household and Individual Dietary Diversity (66). Foods consumed by the participant were categorized into 16 food groups (cereals; white tubers and roots; vitamin A-rich vegetables and tubers; dark green leafy vegetables; other vegetables; vitamin A-rich fruits; other fruits; organ meat; flesh meats; eggs; fish and seafood; legumes, nuts, seeds; milk and milk products; oils and fats;

sweets; spices, condiments, beverages). A “1” was recorded within a food group if any of the participant’s reported foods fulfilled a group. A “0” was recorded for within a food group if none of the participant’s reported foods fulfilled that group. The sum of the number of food groups consumed by the individual was recorded as the DDS.

In addition to DDS, an aggregation of the original 16 food groups was created using the Women’s Dietary Diversity Score (66, 67) (WDDS), which consists of 10 food groups: (grains, white tubers and roots, plantains; pulses (beans, peas, lentils); nuts and seeds; dairy; meat, poultry, fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; other fruits. The WDDS ranks on a scale of 0 to 9.

A DDS and WDDS was classified as “high” if the participant scored 6 to 9, “medium” if the participant scored 4 to 5, or “low” if the participant scored 1 to 3. Descriptive statistics were used to determine which individual food groups were consumed most and least frequently. A one-way ANOVA with ordered differences report for mean intake was conducted for key nutrients reported in the DGA 2015 (kilocalories, total fat, saturated fat, sugars, sodium, cholesterol, potassium, dietary fiber, calcium, vitamin D, fruits, and vegetables) across DDS and WDDS classifications (high, medium, low). Scores were analyzed by determining which individual food groups were consumed most frequently across all levels of diversity as well as which aggregated categories were most frequently consumed.

The HEI-2010 Total Score was compared to the DDS. Because the maximum score for the DDS was 16 and for the Women’s DDS was 9, summed scores were scaled to be directly comparable to the HEI-2010 Total Score of 100 by creating ratios of score earned to total score. To test if the DDS and the Women’s DDS resulted in similar findings as the HEI-2010 Total Score, Pearson correlation coefficients were used to measure the linear correlation between the scores. In order to test if the Women’s DDS classifications were related to the HEI-2010 Total Score, HEI-2010 Total Scores were first classified as “high” if the participant scored 66.67 to 100.00, “medium” if the participant scored 33.33 or more, but less than 66.67, or “low” if the participant scored less than 33.33. Chi square analysis was used to measure the relationship

The significance level for all tests was set at $p < 0.05$. The Salish Kootenai College and Montana State University Institutional Review Boards approved this research.

Results

Participant Demographics

Participants on average were middle aged and most often identified as Native American (73.42%) and less often as white, African American, or Hispanic (Table 1). The majority of participants were female (78.75%) and reported high school graduation (81.82%). Of nearly 79% of participants who reported attending college, less than 40% reported graduating. Household income levels were overall low, with a small sample reporting more than 35,000 and 50,000 dollars per year. See Table 1 for specific demographics information.

All participants demonstrated some capacity of food insecurity. Approximately 50% of participants reported low or very low food security status (Figure 1), while the remainder scored high or marginal food security. See Figure 1.

Healthy Eating Index 2010 (HEI-2010) and Modified HEI

Table 2 indicates the mean total HEI-2010 score of study participants was 45.5, with total HEI-2010 scores ranging from 20.0 to 78.1 (the total HEI-2010 score is the sum of the scores for the 12 components of this indicator that ranges from 0 to 100, with a higher score indicative of a more healthful diet). In addition, the modified HEI score without a dairy category was 41.3 out of 90. For each food component, 50% or less of participants met the recommendations based upon HEI 2010 calculated with and without the dairy component.

Dietary Diversity Scores

Milk and milk products (84%), starchy staples (64%), other fruits and vegetables (56%), and flesh meats, poultry, fish, and seafood (51%) were consumed the most frequently. Organ meats (0%), dark green leafy vegetables (5%), legumes, nuts, and seeds (14%), vitamin A-rich fruits and vegetables (19%), eggs (30%) were consumed the least frequently.

Mean DDS among the sample (n=80) was 4.6 (±1.365). A total of 19 participants were classified in the high dietary diversity group, 45 participants were classified in the medium dietary diversity group, and 16 participants were classified in the low dietary diversity group. The high dietary diversity group indicated significantly higher intake than the low dietary diversity group of dietary fiber ($p<0.0003$), potassium (0.0024), and cholesterol ($p<0.0048$) (Figure 2: A, B, C). At the $\alpha=0.05$ level, significant difference in consumption was also shown between medium and low dietary diversity groups of all three nutrients. The only significant difference in consumption between high and medium dietary diversity groups was shown by dietary fiber ($p<0.0293$).

Considered as individual food groups instead of aggregated categories, cereals were most widely consumed across all three dietary diversity groups. 95.10% of participants reported consumption of foods that fall into this group which includes corn, oats, wheat, rice or any foods produced with or made from these grains. Second most consumed foods fell into the flesh meats group with 85.61% of participants reporting consumption. The aggregated vitamin A-rich fruits and vegetables category showed considerable disparity in consumption across high (44.7%), medium (15.6%) and low (0%) diversity diets. The most disparity was shown in consumption of legumes, nuts, and seeds with 89% of high diversity diets consuming foods from this category, 24% of medium diversity diets and 0% of low diversity diets.

HEI-2010 Total Score compared to DDS

The DDS, WDDS, and HEI-2010 Total Score shared directionality indicating they were able to detect similar levels of dietary quality. The DDS score and HEI-2010 Total Score demonstrated a weak correlation, albeit statistically significant ($r(78) = 0.26$, $p = 0.019$). A similar relationship was observed between the WDDS score and HEI-2010 Total Score ($r(78) = 0.23$, $p = 0.038$). As show in Table 3, there was a significant relationship among

WDDS score classifications and HEI-2010 Total Score classifications ($X^2(1, N = 90) = 11.95, p = 0.018$).

Relationships Between HEI-2010, DDS, Demographic Variables, and Food Security Status

There was no significant difference found between HEI-2010 scores or DDS and demographic information or food security status. Significant differences were found between food security status and the following demographic factors: income ($p < 0.01$), enrollment for the free and reduced lunch program ($p < 0.02$), and enrollment for the free breakfast program ($p < 0.03$). Specifically, significant differences in income were found between the highest two levels of food security with the lowest level of food security ($p < 0.05$) while no differences were found for income between the highest two levels of food security status ($p > 0.90$). See Figure 3. No significant differences were found between food security status and the following demographic factors: age ($p > 0.42$), gender ($p > 0.15$), adults in household ($p > 0.93$), children in household ($p > 0.23$), education ($p > 0.54$), enrollment in SNAP ($p > 0.30$), enrollment in FDPIR ($p > 0.14$), enrollment in WIC ($p > 0.75$), health conditions ($p > 0.37$), owning a refrigerator ($p > 0.26$), and owning a stove ($p > 0.15$).

Significant differences were found between DDS and income ($p < 0.04$) with the highest income having the highest dietary diversity. There was also a significant difference between DDS and number of children in the household ($p < 0.002$) with highest scores for households with the greatest number of children. However, no significant differences were found between HEI and income ($p < 0.21$).

Discussion

This study provides evidence that sampled residents of the Flathead Nation have nutrition-related disparities with relatively low dietary quality based on HEI-2010 scores, modified HEI scores without a dairy category, and DDS as well as relatively high rates of food insecurity. However, findings highlight that variation occurs in dietary patterns of residents of the Flathead Nation. Findings suggest that culturally-relevant food and nutrition interventions designed to modify dietary choices and increase food security of on the Flathead Nation are warranted that recognize the variation of dietary quality among residents.

Study participants had a mean HEI-2010 score of 45.5 out of 100, which represents less than half of the maximum score for nutritional adequacy recommendations by the DGA. Modified HEI scores without a dairy category indicate a mean score of 41.3 out of 90. Findings elucidate that variation exists in dietary quality among participants, with a HEI-2010 score ranging from 20.0 to 78.1 and modified HEI scores from 10.0 to 77.0. The total HEI-2010 scores of study participants are congruent with that of low-income adults in the United States that have HEI-2010 scores of 45.4 (68). However, total HEI-2010 scores of study participants highlight a disparity in dietary quality compared with that of the total population of the United States that has a HEI-2010 total score of 59 (69). HEI-2010 scores of participants in this study were slightly higher than Supplemental Nutrition Assistance Program (SNAP) participants (68).

Along with overall nutritional inadequacy reflected through HEI scores, approximately 50% of participants reported low or very low food security. The food security status of study participants shows a marked health disparity compared to overall Americans with 12.7% percent of Americans reporting high or marginal food insecurity based on the ERS/USDA 6-item Food Security Module (70).

Results illustrate that less than 25% of study participants met dietary recommendations for Total Fruit, Whole Fruit, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Seafood and Plant Protein, Fatty Acids, and Sodium. Total Protein Foods, Refined Grains, and Empty Calories were the food components that most study participants consumed in amounts that more closely aligned to dietary recommendations, with 40% or more of study participants meeting the recommendations for these food groups. Empty Calories was the only food category that was met by 50% or more of study participants.

Fruit and vegetable interventions have the potential to reduce the risk of obesity and diet-related chronic disease (1,71). Given that the percent of the study population meeting daily requirements for fruit and vegetable consumption is low and on par with the entire US and global populations (72), future food and nutrition interventions should target improved access and consumption of these specific food groups. Recommendations following this study should be culturally appropriate to tribes and contextually tailored to reservation food environments. For example, as a majority of study participants were Native American, opportunities to incorporate indigenous plant foods into interventions should be considered.

In the United States, several strategies exist to increase access to fruit and vegetable consumption through USDA nutrition assistance programs (73). The Federal Distribution Program on Indian Reservations (FDPIR) is one USDA nutrition assistance program (74, 75) specific to Indian reservations and is a potential setting for implementing fruit and vegetable interventions on reservations. Previous research has shown that the nutrient quality of offerings of the FDPIR based on HEI-2010 scores is notably below maximum scores indicating potential for improvement and food environment reform (76). Concurrently, several successful initiatives have been conducted at FDPIR centers in culturally appropriate ways including cooking demonstrations, taste tests, gardening demonstrations with traditional foods, and health and wellness programs (77) that serve as models for food environment transformation. Efforts should further be made to decrease the prevalence of ultra-processed foods in the food environment as these foods are associated with unhealthy diets and diet-related chronic disease (19). Previous research indicated that produce is lower in quality in more rural food environments including on the Flathead Nation (78–80), which has the potential to influence selection of more energy dense foods.

DDS supported some of the patterns that emerged from the HEI-2010 scores while providing supplementary evidence for a more comprehensive understanding of dietary quality. Vitamin A-rich fruits and vegetables as well as dark green leafy vegetables were among the least frequently consumed food groups based on DDS scores. Cereals including products made of corn, oats, wheat, and rice were most widely consumed food groups followed by flesh meats. Highly processed cereals, or refined grains, are often associated

with empty calories (19,81) and high-meat consumption is associated with diet-related chronic disease (82).

Furthermore, reflecting the unique dietary needs of Native American populations, such as lactose intolerance, are necessary (8, 46, 47). For example, 14% of participants met requirements for dairy as measured by HEI-2010 and 84% of participants consumed milk and milk products as measured by DDS. DDS captured a wider range of milk and milk product foods outside of dairy, which many Native Americans cannot tolerate. Other sources of calcium that are more culturally relevant should be encouraged in populations that are lactose intolerant (41).

DDS scores did not support or were not comparable other dietary patterns that emerged from the HEI-2010. Food categories were analyzed differently using HEI-2010 versus DDS. In one example, HEI-2010 measures Seafood and Plant Proteins while DDS measures legumes, nuts, and seeds. This observation underscores the importance of using more than one dietary tool to measure the contribution of diets to health, especially for populations that have dietary needs that differ from the general population.

Comparison of DDS scores between the high, medium, and low dietary diversity groups indicated that higher DDS were associated with increased consumption of vitamin A-rich fruits and vegetables. While almost half of participants with high DDS consumed vitamin A-rich fruits and vegetables, less than 20% of the medium DDS group and none of the low DDS group consumed vitamin A-rich fruits and vegetables. Further comparison of high and low DDS groups indicate that higher DDS were associated with increased consumption of dietary fiber, potassium, and cholesterol.

Analysis of food security status with demographic variables indicates that differences in food security status are significantly related to differences in income with the least food secure population having the lowest income and thus financial access to food. Likewise, DDS scores were significantly related to income with the highest income having the highest scores. However, no significant differences were found between HEI-2010 and income. These relationships demonstrate that food security and DDS on the Flathead Nation is driven by income which influences financial access to adequate and diverse foods.

This study has several limitations as it uses self-reported dietary recall data which is based on an individuals' memory and perceptions and may not reflect actual behaviors. In addition, findings are based on dietary recall for a single day rather than over time and thus do not represent longer-term dietary intake patterns (83, 84) or variation that may occur temporally in different seasons or times of the month. Future studies should examine how dietary quality of residents of the Flathead Nation vary over time such as seasonally and different times of the month.

Based on the findings, the literature, and ongoing food and nutrition programs, the research team and Community Advisory Board have designed and are implementing a two-phase intervention to improve dietary quality that meets the cultural food needs and contextual food environment priorities on the Flathead Nation. Future studies are called for that

evaluate linkages between food environment modifications, food choices, dietary quality, and health outcomes.

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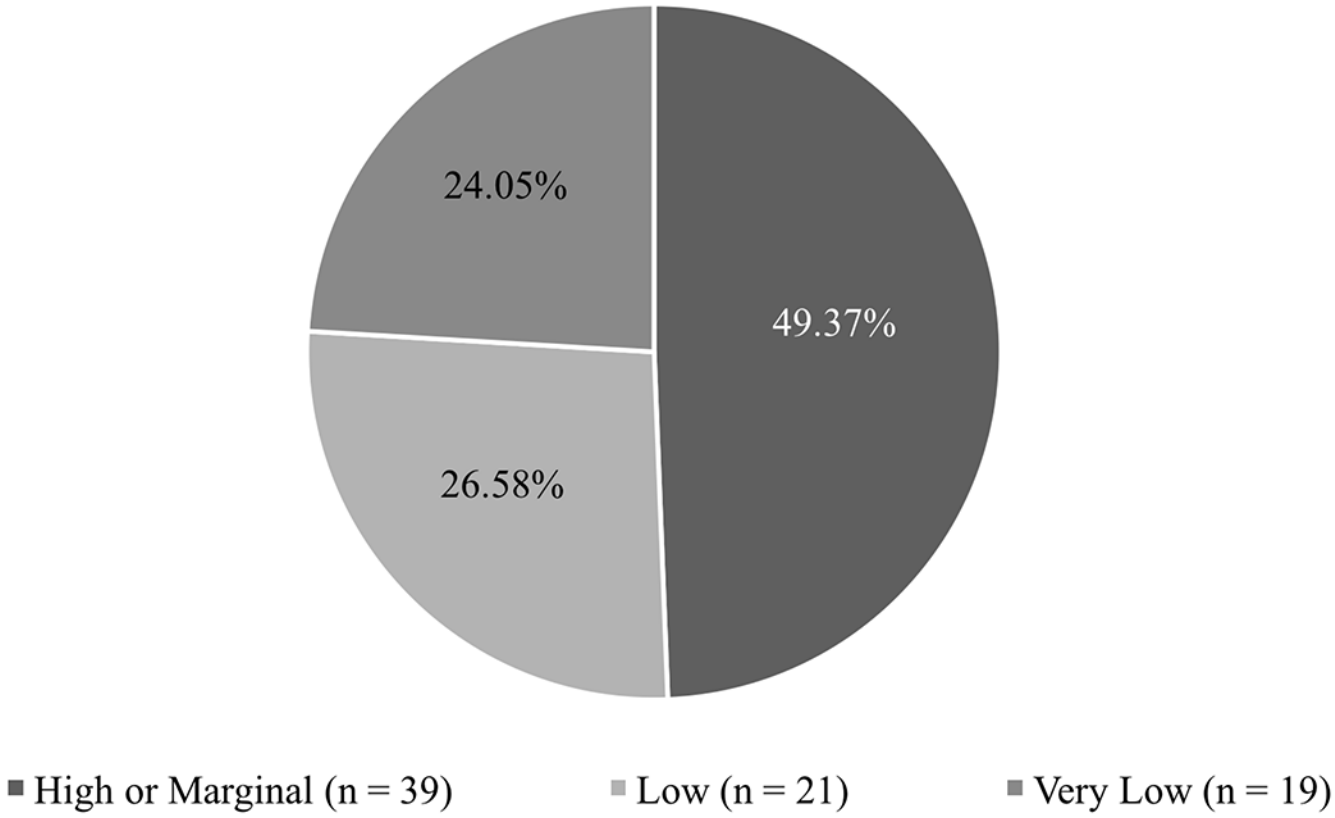

Figure 1. Food Security Status among Dietary Quality Study Participants Residing on the Flathead Nation, 2015 (N=79)

Note: Food security rates measured by Six-item Short Form Food Security Survey Module - USDA ERS. *High food security* (raw score of 0) defined as no reported indications of food-access problems or limitations. *Marginal food security* (raw score of 1) defined as anxiety over food sufficiency or shortage of food in the house. Little or no indication of changes in diets or food intake. *Low food security* (raw score of 2 to 4) defined as reduced quality, variety, or desirability of diet. Little or no indication of reduced food intake. *Very low food security* (raw score of 5 to 6) defined as multiple indications of disrupted eating patterns and reduced food intake.

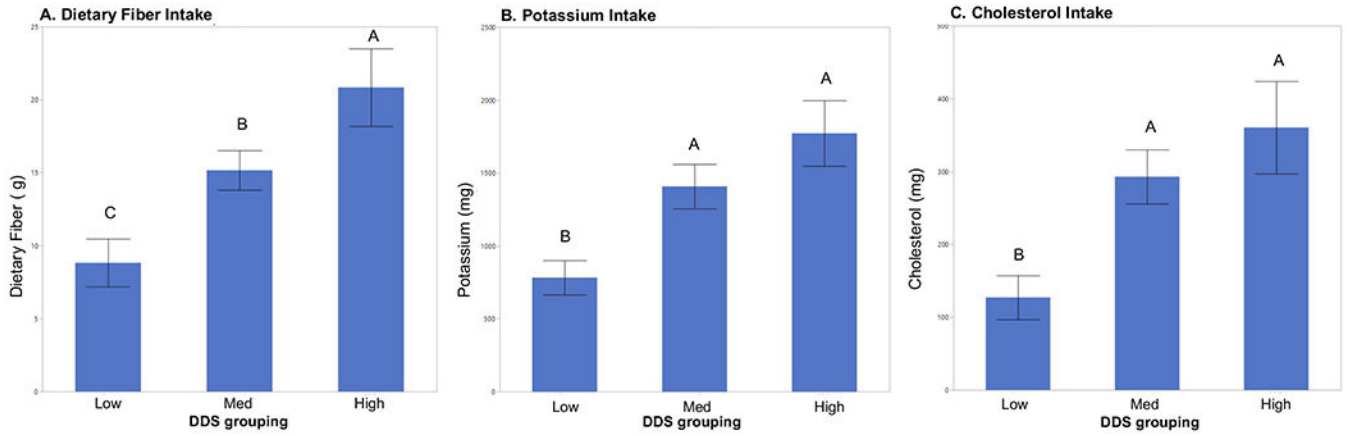

Figure 2.

(A) Dietary fiber ($p<0.0003$), (B) Potassium ($p<0.0024$) and (C) Cholesterol ($p<0.0048$) intake was significantly higher in high diversity diets among Flathead Nation Study Participants, 2015 (n = 80)

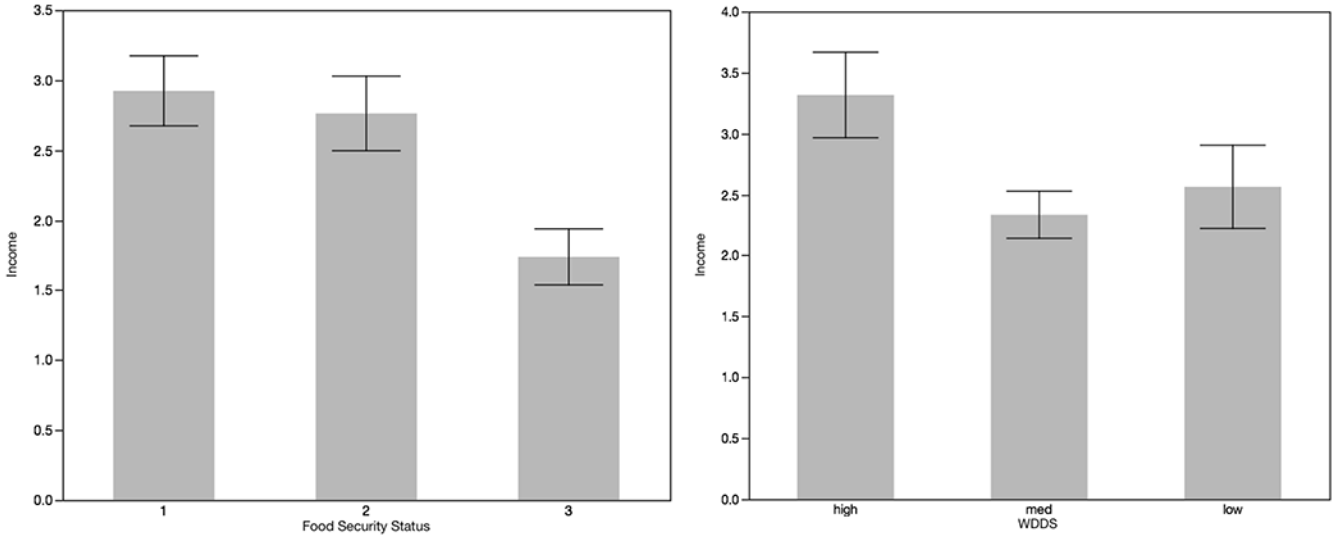

Figure 3. Relationship of Food Security Status and Dietary Diversity Scores with Income among Flathead Nation Study Participants, 2015 (N=79)

Note: Food security rates measured by Six-item Short Form Food Security Survey Module - USDA ERS. *High food security* (raw score of 0) defined as no reported indications of food-access problems or limitations. *Marginal food security* (raw score of 1) defined as anxiety over food sufficiency or shortage of food in the house. Little or no indication of changes in diets or food intake. *Low food security* (raw score of 2 to 4) defined as reduced quality, variety, or desirability of diet. Little or no indication of reduced food intake. *Very low food security* (raw score of 5 to 6) defined as multiple indications of disrupted eating patterns and reduced food intake. In addition to DDS, the Women's Dietary Diversity Score (70, 71) (WDDS) consists of 10 food groups: (grains, white tubers and roots, plantains; pulses (beans, peas, lentils); nuts and seeds; dairy; meat, poultry, fish; eggs; dark green leafy vegetables; other vitamin A-rich fruits and vegetables; other vegetables; other fruits. The Women's DDS ranks on a scale of 0 to 9. A WDDS was classified as "high" if the participant scored 6 to 9, "medium" if the participant scored 4 to 5, or "low" if the participant scored 1 to 3.

Table 1.

Demographic Characteristics of Dietary Quality Study Participants Residing on the Flathead Nation, 2015

Characteristic	%
Age[a]	11.57%
Gender	
Female	78.75%
Male	21.25%
Education	
Partial High School	18.18%
High School Graduate	81.82%
No College	21.05%
Partial College	39.47%
College Graduate	39.47%
Household Income	
Less than 15K	30.00%
15K-25K	21.25%
25K-35K	20.00%
35K-50K	15.00%
More than 50K	13.75%
Race	
African American	5.06%
Native American	73.42%
Hispanic	2.53%
White	29.11%

[a]80 participants completed demographic survey. 79 participants responded to the “How old are you (years)?”

Table 2.

HEI-2010 Component and Total Scores among Flathead Nation Study Participants, 2015 (n = 80)

Component	Maximum Value		Standard for Maximum Score	Standard for Minimum Score of Zero	Mean (SD)		Range
	Dairy	No Dairy			Dairy	No Dairy	
Total Fruit[a]	5	5	≥0.8 cup equivalent per 1,000 kcal	No Fruit	1.2 (1.5)	1.2 (1.5)	0 - 5
Whole Fruit[b]	5	5	≥0.4 cup equivalent per 1,000 kcal	No Whole Fruit	1.6 (2.0)	1.6 (2.0)	0 - 5
Total Vegetables[c]	5	5	≥1.1 cup equivalents per 1,000 kcal	No Vegetables	2.7 (1.8)	2.7 (1.8)	0 - 5
Greens and Beans[c]	5	5	≥0.2 cup equivalent per 1,000 kcal	No Dark Green Vegetables or Beans and Peas	1.2 (2.1)	1.2 (2.1)	0 - 5
Whole Grains	10	10	≥1.5 oz equivalents per 1,000 kcal	No Whole Grains	3.3 (3.9)	3.3 (3.9)	0 - 10
Dairy[d]	10	NA	≥1.3 cup equivalents per 1,000 kcal	No Dairy	4.0 (3.4)	NA	0 - 10
Total Protein Foods[e]	5	5	≥2.5 oz equivalents per 1,000 kcal	No Protein Foods	3.5 (1.7)	3.5 (1.7)	0 - 5
Seafood and Plant Proteins[e,f]	5	5	≥0.8 oz equivalent per 1,000 kcal	No Seafood or Plant Proteins	1.4 (2.1)	1.4 (2.1)	0 - 10
Fatty Acids[g]	10	10	(PUFAs+MUFAs)/SFAs >2.5	(PUFAs+MUFAs)/ SFAs ≤1.2	1.6 (3.1)	1.6 (3.1)	0 - 10
Refined Grains	10	10	≤1.8 oz equivalents per 1,000 kcal	≥4.3 oz equivalents per 1,000 kcal	7.0 (3.8)	7.0 (3.8)	0 - 10
Sodium	10	10	≤1.1 g per 1,000 kcal	≥2.0 g per 1,000 kcal	3.7 (3.9)	3.7 (3.9)	0 - 10
Empty Calories[h]	20	20	≤19% of energy	≥50% of energy	14.0 (7.7)	14.0 (7.7)	0 - 20
Total	100	90			45.3 (12.2)	41.3 (12.3)	20.0 to 78.1

[a] Includes fruit juice.

[b] Includes all forms except juice.

[c] Includes any beans and peas not counted as Total Protein Foods

[d] Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.

[e] Beans and peas are included here (and not with vegetables) when the Total Protein Foods standard is otherwise not met.

[f] Includes seafood, nuts, seeds, soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.

[g] Ratio of polyunsaturated fatty acids (PUFAs) and monounsaturated fatty acids (MUFAs) to saturated fatty acids (SFAs).

[h] Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is >13 g/1,000 kcal.

Table 3.

WDDS Score Classification Compared to the HEI-2010 Total Score Classification among Flathead Nation Study Participants, 2015 (n = 80)

	WDDS score classification				
HEI-2010 Total Score classification		**Low**	**Medium**	**High**	**Total**
Low	N Percent	4 5.00	5 6.25	3 3.75	12 15.00
Medium	N Percent	12 15.00	40 50.00	13 16.25	65 81.25
High	N Percent	0 0.00	0 0.00	3 3.75	3 3.75
Total	N Percent	16 20.00	45 56.25	19 23.75	80 100.00