Published in final edited form as:
Public Health Nutr. 2012 October ; 15(10): 1948–1958. doi:10.1017/S1368980012000122.

Dietary patterns are associated with dietary recommendations but have limited relationship to body mass index in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort

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Abstract

Objective—Traditional food systems in indigenous groups have historically had health promoting benefits. The objectives of this study were to determine if a traditional dietary pattern of Pacific Northwest Tribal Nations (PNwT) could be derived using reduced rank regression (RRR) and if the pattern would be associated with lower body mass index (BMI) and current Dietary Reference Intakes (DRI).

Design—The baseline data from the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort were used to derive dietary patterns for the total sample and those with plausibly reported energy intakes.

Setting—Pacific Northwest Coast of Washington State, United States.

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Author disclosures: M. K. Fialkowski, M. A. McCrory, S. M. Roberts, J. K. Tracy, L. M. Grattan, C. J. Boushey, no conflicts of interest.

All authors were involved in critical review of the manuscript and approved the final manuscript. None of the authors had a conflict of interest.

Subjects—Adult PNwT members of the CoASTAL cohort with lab-measured weight and height and up to 4 days of dietary records (n=418).

Results—A traditional dietary pattern did not evolve from the analysis. Moderate consumption of a sweet drinks dietary pattern was associated with a lower BMI while higher consumption of a vegetarian based dietary pattern was associated with higher BMI. The highest consumers of the vegetarian based dietary pattern were almost 6 times more likely to meet the recommendations for dietary fiber.

Conclusions—Distinct dietary patterns were found. Further exploration is needed to confirm whether the lack of finding a traditional pattern is due to methodology or the loss of a traditional dietary pattern among this population. Longitudinal assessment of the CoASTAL cohort's dietary patterns needs to continue.

Keywords

dietary patterns; reduced rank regression; Native American adults; BMI

Introduction

Obesity prevalence rates in Native Americans and Alaska Natives, a geographically and culturally diverse population, have reached alarming rates. In comparison to other populations, such as non-Hispanic whites and Asians, Native Americans/Alaska Natives are more likely to be obese (body mass index [BMI] ≥ 30 kg/m^2) (1,2). Obesity contributes to morbidity and mortality within a population (3). With Native Americans/Alaska Natives displaying a disproportionate burden for chronic diseases such as cardiovascular disease, cancer, and diabetes (1), the high prevalence rates of obesity will affect the health status of these unique populations.

The high prevalence of obesity found within the Native American/Alaska Native population today may be related to the transition away from a traditional food system (TFS). A TFS includes all food within a particular culture available from local, natural resources that is culturally accepted and provides all of the essential nutrients necessary for optimal health (4). A TFS incorporates socio-cultural meanings, acquisition and processing techniques, use, composition, and the nutritional consequences of consumption (5). Many of the diets of TFSs were dependent on the geographic location and the seasons such as a dominance of meat in the Arctic Circle and a large proportion of carbohydrates from corn in the Southwest (6). A transition away from traditional foods occurs for various reasons including restricted traditional food resource use and harvesting areas, decreases in species density, concern about exposure to contaminants, and the availability of market foods (5,7,8).

The transition away from TFS is disconcerting given the evidence that TFSs have health promoting benefits (9–12). For example, the Mediterranean diet and the Asian diets have attracted considerable attention as healthier alternatives to the Western diet (13–16). With the presence of unique cultural and geographic eating patterns, indigenous populations may benefit from promoting their respective TFS. Such a change might improve health, reduce risk for disease, and positively influence cultural and traditional factors important to these populations.

In this study we sought to determine the dietary patterns present within a unique group of Native Americans from the Pacific Northwest participating in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort. The CoASTAL cohort represents a novel population and is of particular interest because of the high rates of obesity (17). Our primary hypothesis was that traditional foods of Pacific Northwest Tribal

Nations (PNwT), such as shellfish, salmon, venison, and berries, would have significant variance in consumption in comparison to other food groups. Our secondary hypothesis was that higher consumption of the traditional food pattern derived from the CoASTAL cohort would associate with a lower BMI and greater adherence to selected Dietary Reference Intakes (DRI) (18). Our final hypothesis was that limiting the sample to those considered to plausibly report energy intake (rEI) within the CoASTAL cohort would further elucidate the presence of a traditional dietary pattern and its association with a lower BMI and current dietary recommendations.

Materials and Methods

Study design and participant recruitment

The CoASTAL cohort originated from an official invitation of one of the Tribal Nations of the Pacific Northwest Coast of Washington State. The investigators and members of three neighboring Tribal Nations worked toward establishing trust, creating communication channels, and resolving study design issues prior to initiating the study. Enrollment for the five-year prospective study began in June 2005.

The sample for this cross-sectional analysis was selected from the 520 non-pregnant adults (18+ years) participating in the CoASTAL cohort. Dietary patterns were estimated for participants who completed up to 4 dietary records and had weight and height information collected during the first year (418/520; 80%). At the enrollment visit, participants provided information about educational attainment, occupation, and specific healthful behaviors (e.g., smoking). The Institutional Review Boards from the University of Maryland and Purdue University approved the study protocol. Details of the study rationale and methods have been published elsewhere (19), but are summarized briefly here.

Dietary assessment

Field coordinators, who were registered tribal members, participated in day-long training sessions with study dietitians initially and annually. Training included distribution of the dietary records, evaluating completeness of food entries, probing, portion size estimation, food preparation methods, and accuracy of data recording. These field coordinators were then able to train the participants in record keeping techniques using various measuring aids. Participants were provided a tool kit of measuring devices (e.g. measuring cups and spoons) and recording materials. Dietary records were completed every 4 months as two 1 day dietary records and one set of 2 days of dietary records for a total of 4 dietary records over 1 year. Respondents recording days were assigned based on the day of their first visit and at least one day included a weekend day. Data coding and entry were performed by staff trained in the use of the Nutrition Data System for Research (NDS-R) Database Version 4.07 (© Regents of the University of Minnesota). Food group servings from the dietary records were calculated as the mean of the number of days reported. At least 2 days were reported by 362 individuals (362/418; 87%) and the mean number of days recorded was 3.

Food groupings

We used reduced rank regression (RRR) to consolidate the 166 NDS-R food groupings from the dietary record data into 42 groups according to macro nutrient composition, culinary usage, cultural specificity, and prior classifications found in the literature using (20–24). Unit designation for the food groupings was servings per day. Some foods (e.g., eggs) comprised their own group. Multiple combinations of food groupings were tested including classifying all of the traditional foods into one food group. The end result did not differ between these combinations and therefore the food groupings ultimately used are described here. See Table 1 for the final food groupings.

Anthropometric measures

Participants were measured for height and weight by the trained field coordinators. Prior to measures, participants were instructed to remove heavy outer clothing to a single layer of clothing, remove shoes, and empty pockets. Height was measured to the nearest inch using a portable stadiometer (Shorr Infant/Child/Adult Portable Height-Length Measuring Board, Olney, Maryland). Weight was measured on a calibrated electronic scale and recorded to the nearest pound (SECA Digital Floor scale, Hanover, Maryland). BMI was calculated using the formula wt(kg)/ht(m)^2. Obesity was defined as a BMI ≥ 30 kg/m^2 (25).

Plausibility determination

Determination of individuals with plausibly reported energy intakes (rEI) were classified using previously developed and described methods (26,27). Briefly, DRI equations were used to calculate predicted energy requirements (28). rEI was evaluated as plausible or implausible after applying the 1.4 standard deviation (SD) cut-off method to the population sample (27). Individuals within 1.4 SD were considered to have plausible rEI, those with a SD above or below 1.4 SD were considered to implausibly report energy intake. There were no significant differences in characteristics between those considered to plausibly and implausibly report EI.

Statistical analysis

The statistical method RRR, otherwise known as the maximum redundancy analysis, using the PLS procedure in Statistical Analysis Software (SAS) was used to derive dietary pattern scores. The use of this method to derive dietary patterns has been described in detail elsewhere (29). In brief, RRR allows for the calculation of dietary pattern scores similarly to those extracted by factor analysis. However, where factor analysis determines dietary pattern scores by maximizing the explained variation of a set of predictor variables (e.g., food groups), RRR derives dietary pattern scores of predictor variables by accounting for as much of the variation in response variables (e.g., nutrients related to weight) as possible (29,30). The RRR approach has been reported to be preferred to factor analysis for determining dietary patterns that are predictive of risk for chronic disease (31) and therefore was selected as the method used to relate BMI to dietary patterns derived from the CoASTAL cohort.

In the present study, the nutrient densities of total fat, total carbohydrates, and fiber (g total fat per 4184 kJ [1000 kcal], g carbohydrates per 4184 kJ [1000 kcal], and g fiber per 4184 kJ [1000 kcal]) where chosen as the response variables because these variables have consistently been found to associate with weight status (e.g., BMI) (32–39). Intake data from the food groups (e.g., red meat, fruit, eggs, fish, pasta, etc.) determined by the dietary records served as predictors. These food groups (i.e., predictor variables) are summarized into distinct dietary patterns that capture the variation in the nutrient densities of total fat, total carbohydrates, and fiber (i.e., response variables). In RRR, the number of extracted dietary patterns cannot be higher than the number of selected response variables (i.e., total fat, total carbohydrates, and fiber); therefore, 3 dietary patterns were obtained for both the total and plausible groups (32).

Factor loadings, which reflect the correlation of individual food groups within each of the derived dietary patterns, were obtained from the RRR. To focus on food groups that significantly contributed to the dietary pattern, we only considered those food groups with an absolute factor loading > 0.2 (29,32,40–44). The food groups above the cut-off were used to label the dietary patterns. For each participant, a dietary pattern score was calculated by summing the product of the contributing food group intakes and scoring coefficients. Those food groupings with an absolute factor loading < 0.2 did not contribute to the dietary pattern score. The scores for each dietary pattern were then converted into quartiles for use in further analysis. Thus, for each dietary pattern quartile 4 would be composed of those who conform most (e.g., consume the most) to that particular pattern while quartile 1 would be the lowest conformers (e.g., consume the least).

In order to assess the relationship between BMI and quartiles of dietary pattern intake from the dietary records, multiple linear regression models were used. BMI classification does not differ by gender so men and women were analyzed both together and separately. These findings were confirmed with binary logistic regression models using obesity as the dependent variable. For evaluating attainment of nutrient recommendations, the Institute of Medicine specifies using the information from 24 h dietary recalls, observation, or dietary records (18). Therefore, binary logistic regression models were used to evaluate how the dietary patterns derived from the dietary records related to the DRIs for total fat, saturated fat, and dietary fiber. All models were adjusted for age (ages were calculated from date of birth and date of first visit), education, employment, and smoking status. Interaction terms were examined but none were significant. For those patterns found to significantly associate with BMI, the general linear model was used to determine the mean BMI of participants within each quartile after adjustment for age, education, employment, and smoking. All RRR analyses were performed using SAS Version 9.1 (SAS Institute, Cary, NC, USA). All other analyses were completed using Statistical Package for the Social Sciences (SPSS) 16.0 (Chicago, IL). Results were considered significant at $P<0.05$, using two-sided tests.

Results

Men and women included in this analysis were similar in age and BMI (Table 2). A majority of the individuals in the sample were between the ages of 31–50 years and had attended at least some college. Foods with a factor loading above $|0.2|$, which indicates the level of correlation to the derived dietary patterns, are shown in Table 3. A traditional food pattern did not emerge in either the total or plausible reporters of energy groups. A dietary pattern that loaded positively high in only fruit and sweet drinks explained most of the variation between the response variables and predictors in the total sample. The dietary pattern that explained the most variation for the plausible sample was a vegetarian and grains pattern. Legumes, tomato, pasta, sweetened drinks, and unsweetened cereals had high positive loadings on this pattern.

Only those dietary patterns that significantly associated with BMI and/or obesity are shown in Tables 4 and 5, as well as the adjusted mean BMI for each dietary pattern quartile. When examining the total group, significant associations were noted only when evaluating by gender. In men only, moderate consumption of the vegetables, fruit, and whole grains pattern was significantly associated with a lower BMI and a lower risk for being obese (See Table 4). For the plausible reporters of energy intake (Table 5), the highest quartile of healthy pattern consumers was associated with a significantly higher BMI than the lowest consumers. When plausible reporters were evaluated by gender, only women demonstrated a significant association between body size and the healthy pattern. The highest quartile of healthy pattern consumers had a BMI significantly higher than the lowest quartile of consumers (See Table 5). As shown in Table 5, the sweet drinks pattern associated significantly with body weight in women with moderately high consumption significantly associated with a lower BMI.

The likelihood of meeting the Acceptable Macronutrient Distribution Range (AMDR) for percent energy consumed from total fat and saturated fat as well as the Adequate Intake (AI) for dietary fiber was evaluated for the dietary patterns (See Table 6). Adjusted models only are shown. The likelihood of meeting the AMDR for total fat and saturated fat was significantly more likely among the highest consumers of the fruit and sweet drinks pattern.

The highest consumers of the vegetables, fruit, and whole grains pattern were almost 6 times more likely to meet the AI for dietary fiber. The highest consumers of the high fat and sugar pattern were almost 70% less likely to meet the AMDR for saturated fat. When limiting the sample to only those considered to plausibly report EI, the third and fourth quartiles of the vegetarian and grains pattern were much more likely to meet the AMDR for total fat and saturated fat. The highest consumers of the sweet drinks pattern were less likely to meet the AMDR for saturated fat and the AI for dietary fiber.

Discussion

Among this sample of PNwT adults, a traditional food pattern predominant in foods such as shellfish, fish, game, berries, and tea did not emerge using dietary records. Traditional foods were modeled in two different configurations and did not load positively high in any of the extracted dietary patterns examined. This would suggest that the variance was not great enough for traditional foods to emerge as an influential pattern. RRR seeks to capture the variation in intake with regard to certain response variables (29). In this study, the nutrient densities of total fat, carbohydrate, and dietary fiber were used as the response variables to maximize the explained variation among the dietary patterns (32–39). Although not detected by RRR, we know that in this CoASTAL cohort population, traditional foods are being consumed at some level (19). Previously, we reported that over 50% of participants who completed a dietary record were identified as a seafood consumer in comparison to 98% of those completing the FFQ (19). However, their consumption of seafood which would be considered a traditional food, did not describe the variance in intake based on the selected response variables. To capture the contributions of traditional foods to the health and nutrient intakes of this population, methods other than dietary patterns may need to be used (12,45). For example, the propensity method (45) takes advantage of the information from a FFQ as well as dietary records simultaneously.

The patterns derived in this population reflected two different types of eating habits. The pattern contributing the most variance to fat, carbohydrate, and fiber density was dominated by food items considered high in energy, such as sweetened beverages, similar to results found in other Native populations (8). In contrast, the dietary pattern contributing the second highest variance to those nutrient densities was heavily influenced by foods considered healthful such as whole grains and vegetables. The presence of a healthy pattern within this population is consistent with dietary pattern studies done in other populations (32,43,46–49). However, in contrast to most of the other studies (20,32,50,51), high intake of the healthy pattern from this study was associated with a higher BMI. Only one study found a similar association in women (52). Women from the NIH-AARP Diet and Health study with a dietary pattern dominated by food low in energy were associated with poorer health characteristics (52). Interestingly, similarly to the NIH-AARP Diet and Health study (52), we also found this association to differ by gender. Men tended to be “health conscious” with moderately high consumption of a pattern dominated by food considered to be healthy associated with a lower BMI and risk for being obese. But, this relationship did not remain once plausibly reporting energy intake was accounted for. Also consistent with findings in other populations was the presence of an “empty calorie” (e.g. fruit juice and sweet beverage) dietary pattern (53–55). Although a previous study did report this pattern to be associated with a higher BMI (55), we did not find this association in the CoASTAL cohort.

The differences noted between this population and findings in other populations may be methodological. The use of RRR to determine dietary patterns is a relatively new approach to determining dietary patterns in population based studies (29). RRR has not been used within Native American populations and applying this method to the CoASTAL cohort data set may further establish its effectiveness in deriving dietary patterns related to risk factors for chronic disease (e.g., obesity). Previously, dietary patterns have been derived using methods such as principal component analysis (PCA) analysis (54,56). RRR and PCA are both dimension reduction techniques that result in uncorrelated summary variables (e.g., dietary patterns). However, RRR has become the recommended method to use when evaluating how certain predictors (e.g., food groups) relate to a risk factor for disease (e.g., body weight) because dietary patterns are derived from predictor variables (e.g., food groups) by maximizing the amount of variation in response variables (e.g., body weight). RRR was successfully used to extract dietary patterns that predicted weight change among the cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC) (32). To our knowledge, most studies have used data from a FFQ or 24 h dietary recall(s) to derive dietary patterns and limited studies have used dietary records.

The noted differences from previous literature in reported associations between dietary patterns and BMI may be reflected by the cross-sectional nature of this study. For example, the high consumers of the healthier patterns may be trying to adopt a healthier eating pattern to lose weight or prevent further weight gain (52). These individuals may also be adopting healthier foods but not adopting recommended eating portions. Further study will need to occur to determine whether these dietary patterns are consistent and maintain the same relationship with body weight over time.

In comparison to the guidelines set for total fat, saturated fat, and dietary fiber, high consumption of some of the extracted dietary patterns can be promoted for increasing the likelihood of meeting these recommendations. For example, higher consumption of the fruit and sweet drink pattern; the vegetables, fruit, and whole grains pattern; and the vegetarian and grains pattern were associated with a significantly higher likelihood for meeting the above recommendations. Other dietary patterns, such as the high fat and sugar pattern, were consistent with expectations. High consumption of the high fat and sugar pattern reduced the likelihood for meeting the AMDR for saturated fat.

This study is different from other dietary pattern studies in that we accounted for plausibly rEI. Dietary assessment methods will likely always have some level of error and an adult's ability to accurately self-report their dietary intake may pose challenges (57,58). In a previous study, when accounting for plausibly rEI the results of the CoASTAL cohort's energy intake correlated significantly with objective measures, such as body weight and BMI (17,19). In this study, the amount of variation that was explained increased by 12% when limiting the sample to plausible reporters of energy intake. However, in this study we found that the dietary patterns extracted from the CoASTAL cohort were robust and not strongly influenced by underreporting suggesting that dietary patterns may reduce some of the error associated with dietary assessment. The dietary patterns extracted from the total sample were similar to those patterns extracted in the plausible group. This consistency may validate the presence of these dietary patterns.

In this study, the extracted dietary patterns are limited by the response variables that were chosen (e.g., total fat, carbohydrates, dietary fiber). These theoretically derived response variables based primarily on non-Hispanic white population groups (32–39) could be different from Native American populations. RRR has never been used to assess the diet of a Native American population; therefore, the response variables chosen may not fully explain the variance in intake of the predictor variables (e.g. food groups) with regard to body weight. Also, we did not determine how these dietary patterns associate with current dietary recommendations for other nutrients. Meeting the recommendations for total and saturated fat, and dietary fiber were evaluated due to these nutrients commonly being over or under consumed, respectively, in other Native populations (59–68). The proportion meeting the dietary recommendations for other nutrients will need to be explored. Finally, many of the defined food groups are composed of foods not commonly misreported; therefore, there is less of an opportunity for underreporting to affect our results (69).

In conclusion, we were not able to document a traditional food pattern in the CoASTAL cohort using RRR. This finding may mean that alternative response variables or methods are needed to describe traditional food patterns consumed today. In this study, dietary patterns that were high in healthier foods such as vegetables or in less healthful foods such as sweetened beverages were consistently derived. These dietary patterns were also found to significantly associate with the likelihood of meeting or not meeting the dietary recommendations for total fat, saturated fat, and dietary fiber. However, with regard to meeting recommendations for body weight, further longitudinal assessment will be needed to confirm these results.

Acknowledgments

The authors thank the Makah, Quinault, and Quileute Indian Nation Tribal Councils; Vincent Cooke and Rachel Johnson from the Makah Environmental Health Division; Bill Parkin from the Makah Marina; Mel Moon, Mitch Lesoing, Jay Burns, and Cathy Salazar from the Quileute Department of Natural Resources; Joe Schumacker and Dawn Radonski from the Quinault Department of Fisheries; our tribal medical advisory board, Thomas Van Eaton of Makah Health Services, Robert Young of the Quinault Health Center, and Brenda Jaime-Nielson and Brad Krall of the Quileute Health Center; and our tribal advisory committee, Theresa Parker, Deanna Buzzell-Gray, June Williams, Melissa Peterson-Renault, Mary Jo Butterfield, and Edith Hottowe from the Makah Indian Nation; and Alena Lopez, Ervin Obi, and Carolyn Gennari from the Quinault Indian Nation for their contributions and participation.

Sources of funding: Support for this work comes from the National Institute of Environmental Health Sciences (NIEHS; 5R01ES012459-05). This project was also partially supported by the National Institute of Health/National Center for Research Resources (NIH/NCRR) Grant Number RR025761 and the Alfred P. Sloan Foundation. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NIEHS, the NIH, the NCRR, of the Alfred P. Sloan Foundation. The authors' responsibilities were as follows: M.K.F., M.A.M., S.M.R., J.K.T., L.M.G., and C.J.B. designed research; M.K.F., S.M.R., L.M.G., and C.J.B. conducted research; M.A.M. and J.K.T. provided statistical guidance; M.K.F. analyzed the data and wrote the manuscript; L.M.G. and C.J.B. had primary responsibility for final content.

Abbreviations

(AMDR)	Acceptable Macronutrient Distribution Range
(AI)	Adequate Intake
(BMI)	Body mass index
(CoASTAL)	Communities Advancing the Studies of Tribal Nations Across the Lifespan
(DRI)	Dietary Reference Intakes
(EPIC)	European Prospective Investigation into Cancer and Nutrition
(FFQ)	Food frequency questionnaire
(NDS-R)	Nutrition Data System for Research
(PNwT)	Pacific Northwest Tribal Nations
(PCA)	principal component analysis
(RRR)	reduced rank regression
(rEI)	report energy intake
(SD)	standard deviation
(SAS)	Statistical Analysis Software

(SPSS)	Statistical Package for the Social Sciences
(TFS)	traditional food system

References

1. Pleis JR, Lethbridge-Cejku M. Summary health statistics for U.S. adults: National Health Interview Survey, 2006. National Center for Health Statistics. Vital Health Stat. 2007; 10(235)
2. Steele CB, Cardinez CJ, Richardson LC, et al. Surveillance for health behaviors of American Indians and Alaska Natives - findings from the Behavioral Risk Factor Surveillance System, 2000–2006. Cancer. 2008; 113:1131–1141. [PubMed: 18720374]
3. National Heart, Lung and Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report. National Institute of Health; 1998. Publication No. 98–4803
4. Kuhnlein HV, Receveur O. Dietary change and traditional food systems of indigenous peoples. Annu Rev Nutr. 1996; 16:417–442. [PubMed: 8839933]
5. Kuhnlein HV, Receveur O, Chan HM. Traditional food systems research with Canadian indigenous peoples. Int J Circumpolar Health. 2001; 60:112–122. [PubMed: 11507960]
6. West KM. Diabetes in American Indians and other native populations of the new world. Diabetes. 1974; 23:841–455. [PubMed: 4213890]
7. Kuhnlein HV. Change in the use of traditional foods by the Nuxalk Native people of British Columbia. Ecol Food Nutr. 1992; 27:259–282.
8. Sharma S, Yacavone M, Cao X, et al. Dietary intake and development of a quantitative FFQ for a nutritional intervention to reduce the risk of chronic disease in the Navajo Nation. Public Health Nutr. 2010; 13:350–359. [PubMed: 19860990]
9. Fujita R, Braun KL, Hughes CK. The traditional Hawaiian diet: A review of literature. Pac Health Dialog. 2004; 11:250–259. [PubMed: 16281710]
10. Shintani TT, Hughes CK, Beckham S, et al. Obesity and cardiovascular risk intervention through the ad libitum feeding of traditional Hawaiian diet. Am J Clin Nutr. 1991; 53:1647S–1651S. [PubMed: 2031501]
11. Bersamin A, Zidenberg-Cherr S, Stern JS, et al. Nutrient intakes are associated with adherence to a traditional diet among Yup'ik Eskimos living in remote Alaska native communities: The CANHR study. Int J Circumpolar Health. 2007; 66:62–70. [PubMed: 17451135]
12. Kuhnlein HV, Receveur O, Soueida R, et al. Arctic indigenous peoples experience the nutrition transition with changing dietary patterns and obesity. J Nutr. 2004; 134:1447–1453. [PubMed: 15173410]
13. Trichopoulou A, Costacou T, Bamia C, et al. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med. 2003; 348:2599–2608. [PubMed: 12826634]
14. Costacou T, Bamia C, Ferrari P, et al. Tracing the Mediterranean diet through principal components and cluster analysis in the Greek population. Eur J Clin Nutr. 2003; 57:1378–1385. [PubMed: 14576750]
15. Maskarinec G, Novotny R, Tasaki K. Dietary patterns are associated with Body Mass Index in multiethnic women. J Nutr. 2000; 130:3068–3072. [PubMed: 11110871]
16. Shimazu T, Kuriyama S, Hozawa A. Dietary patterns and cardiovascular disease mortality in Japan: A prospective cohort study. Int J Epidemiol. 2007; 36:600–609. [PubMed: 17317693]
17. Fialkowski MK, McCrory MA, Roberts SM, et al. Estimated nutrient intakes from food compared to Dietary Reference Intakes among adult members of Pacific Northwest Tribal Nations. J Nutr. 2010; 140:992–998. [PubMed: 20237069]
18. Institute of Medicine Food and Nutrition Board. Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. Washington, DC: National Academy Press; 2006.
19. Fialkowski MK, McCrory MA, Roberts SM, et al. Evaluation of dietary assessment tools used to assess the diet of adults participating in the Communities Advancing the Studies of Tribal Nations

Across the Lifespan (CoASTAL) cohort. J Am Diet Assoc. 2010; 110:65–73. [PubMed: 20102829]

20. Newby PK, Muller D, Hallfrisch J, et al. Food patterns measured by factor analysis and anthropometric changes in adults. Am J Clin Nutr. 2004; 80:504–513. [PubMed: 15277177]
21. Hu FB, Rimm EB, Stampfer MJ, et al. Prospective study of major dietary patterns and risk of coronary heart disease in men. Am J Clin Nutr. 2000; 72:912–921. [PubMed: 11010931]
22. Schulze MB, Hoffmann K, Kroke A, et al. Dietary patterns and their association with food and nutrient intake in the European Prospective Investigation into Cancer and Nutrition (EPIC) - Potsdam Study. Br J Nutr. 2001; 85:363–373. [PubMed: 11299082]
23. Carrera PM, Xiang G, Tucker KL. A study of dietary patterns in the Mexican-American population and their association with obesity. J Am Diet Assoc. 2007; 107:1735–1742. [PubMed: 17904933]
24. Hu FB, Rimm E, Smith-Warner SA, et al. Reproducibility and validity of dietary patterns assessed with a food-frequency questionnaire. Am J Clin Nutr. 1999; 69:243–249. [PubMed: 9989687]
25. World Health Organization. Obesity and overweight: Fact Sheet No 311.Internet. 2011. http://www.who.int/mediacentre/factsheets/fs311/en/index.html
26. McCrory MA, Hajduk CL, Roberts SB. Procedures for screening out inaccurate reports of dietary energy intake. Public Health Nutr. 2002; 5:873–882. [PubMed: 12633510]
27. Huang TTK, Roberts SB, Howarth NC, et al. Effect of screening out implausible energy intake reports on relationships between diet and BMI. Obes Res. 2005; 13:1205–1217. [PubMed: 16076990]
28. Institute of Medicine Food and Nutrition Board. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients). Washington, DC: National Academy Press; 2005.
29. Hoffmann K, Schulze MB, Schienkiewitz A, et al. Application of a new statistical method to derive dietary patterns in nutritional epidemiology. Am J Epidemiol. 2004; 159:935–944. [PubMed: 15128605]
30. Nettleton JA, Steffen LM, Schulze MB, et al. Associations between markers of subclinical atherosclerosis and dietary patterns derived by principal components analysis and reduced rank regression in the Multi-Ethnic Study of Atherosclerosis (MESA). Am J Clin Nutr. 2007; 85:1615–2165. [PubMed: 17556701]
31. Hoffmann K, Boeing H, Boffetta P, et al. Comparison of two statistical approaches to predict all-cause mortality by dietary patterns in German elderly subjects. Br J Nutr. 2005; 93:709–716. [PubMed: 15975171]
32. Schulz M, Nothlings U, Hoffmann K, et al. Identification of a food pattern characterized by high-fiber and low-fat food choices associated with low prospective weight change in the EPIC-Potsdam Cohort. J Nutr. 2005; 135:1183–1189. [PubMed: 15867301]
33. Birketvedt GS, Aaseth J, Florholmen JR, et al. Long-term effect of fibre supplement and reduced energy intake on body weight and blood lipids in overweight subjects. Acta Medica. 2000; 43:129–132. [PubMed: 11294130]
34. Lissner L, Heitmann BL, Bengtsson C. Low-fat diets may prevent weight gain in sedentary women: Prospective observations from the population study of women in Gothenburg, Sweden. Obes Res. 1997; 5:43–48. [PubMed: 9061715]
35. Liu S, Willett WC, Manson JE, et al. Relation between changes in intakes of dietary fiber and grain products and changes in weight and development of obesity among middle-aged women. Am J Clin Nutr. 2003; 78:920–927. [PubMed: 14594777]
36. Ludwig DS, Pereira MA, Kroenke CH, et al. Dietary fiber, weight gain, and cardiovascular disease risk factors in young adults. J Am Med Assoc. 1999; 282:1539–1546.
37. Mueller-Cunningham WM, Quintana R, Kasim-Karakas SE. An ad libitum, very low-fat diet results in weight loss and changes in nutrient intakes in postmenopausal women. J Am Diet Assoc. 2003; 103:1600–1606. [PubMed: 14647085]
38. Paeratakul S, Popkin BM, Keyou G, et al. Changes in diet and physical activity affect the body mass index of Chinese adults. Int J Obes Relat Metab Disord. 1998; 22:424–431. [PubMed: 9622339]

39. Sherwood NE, Jeffery RW, French SA, et al. Predictors of weight gain in the Pound of Prevention Study. Int J Obes Relat Metab Disord. 2000; 24:395–403. [PubMed: 10805494]
40. Heidemann C, Hoffmann K, Spranger J, et al. A dietary pattern protective against type 2 diabetes in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Potsdam Study cohort. Diabetologia. 2005; 48:1126–1134. [PubMed: 15889235]
41. McNaughton SA, Mishra GD, Brunner EJ. Food patterns associated with blood lipids are predictive of coronary heart disease: The Whitehall II study. Br J Nutr. 2009; 102:619–624. [PubMed: 19327192]
42. Hoffmann K, Zyriax BC, Boeing H, et al. A dietary pattern derived to explain biomarker variation is strongly associated with the risk of coronary artery disease. Am J Clin Nutr. 2004; 80:633–640. [PubMed: 15321803]
43. Weikert C, Hoffmann K, Dierkes J, et al. A homocysteine metabolism-related dietary pattern and the risk of coronary heart disease in two independent German study populations. J Nutr. 2005; 135:1981–1988. [PubMed: 16046726]
44. Heroux M, Janssen I, Lam M, et al. Dietary patterns and the risk of mortality: Impact of cardiorespiratory fitness. Int J Epidemiol. 2010; 39:197–209. [PubMed: 19380370]
45. Tooze JA, Midthune D, Dodd KW, et al. A new statistical method for estimating the usual intake of episodically consumed foods with application to their distribution. J Am Diet Assoc. 2006; 106:1575–1587. [PubMed: 17000190]
46. Drogan D, Hoffmann K, Schulz M, et al. A food pattern predicting prospective weight change is associated with risk of fatal but not with nonfatal cardiovascular disease. J Nutr. 2007; 137:1961–1967. [PubMed: 17634271]
47. Balder HF, Virtanen M, Brants HAM, et al. Common and country-specific dietary patterns in four European cohort studies. J Nutr. 2003; 133:4246–4251. [PubMed: 14652380]
48. van Dam RM, Rimm EB, Willett WC, et al. Dietary patterns and risk for type 2 diabetes mellitus in U.S. men. Ann Intern Med. 2002; 136:201–209. [PubMed: 11827496]
49. Newby PK, Weismayer C, Akesson A, et al. Longitudinal changes in food patterns predict changes in weight and body mass index and the effects are greatest in obese women. J Nutr. 2006; 136:2580–2587. [PubMed: 16988130]
50. Fung TT, Rimm EB, Spiegelman D, et al. Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. Am J Clin Nutr. 2001; 73:61–67. [PubMed: 11124751]
51. Murtaugh MA, Herrick JS, Sweeney C, et al. Diet composition and risk of overweight and obesity in women living in the Southwestern United States. J Am Diet Assoc. 2007; 107:1311–1321. [PubMed: 17659896]
52. Reedy J, Wirfält E, Flood A, et al. Comparing 3 dietary pattern methods—cluster analysis, factor analysis, and index analysis—with colorectal cancer risk. Am J Epidemiol. 2010; 171:479–487. [PubMed: 20026579]
53. Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. J Am Med Assoc. 2008; 299:2401–2405.
54. Moeller SM, Reedy J, Millen AE, et al. Dietary patterns: Challenges and opportunities in dietary patterns research an Experimental Biology workshop, April 1, 2006. J Am Diet Assoc. 2007; 107:1233–1239. [PubMed: 17604756]
55. Millen BE, Quatromoni PA, Copenhafer DL, et al. Validation of a dietary approach for evaluating nutritional risk: The Framingham Nutrition Studies. J Am Diet Assoc. 2001; 101:187–194. [PubMed: 11271691]
56. Kant AK. Dietary patterns and health outcomes. J Am Diet Assoc. 2004; 104:615–635. [PubMed: 15054348]
57. Mahabir S, Baer DJ, Giffen C, et al. Calorie intake misreporting by diet record and food frequency questionnaire compared to doubly labeled water among postmenopausal women. Eur J Clin Nutr. 2006; 60:561–565. [PubMed: 16391574]
58. Champagne CM, Bray GA, Kurtz AA, et al. Energy intake and energy expenditure: a controlled study comparing dietitians and non-dietitians. J Am Diet Assoc. 2002; 102:1428–1432. [PubMed: 12396160]

59. Stang J, Zephier EM, Story M, et al. Dietary intakes of nutrients thought to modify cardiovascular risk from three groups of American Indians: The Strong Heart Dietary Study, Phase II. J Am Diet Assoc. 2005; 105:1895–1903. [PubMed: 16321595]
60. Ballew C, White LL, Strauss KF, et al. Intake of nutrients and food sources of nutrients among the Navajo: Findings from the Navajo Health and Nutrition Examination Survey. J Nutr. 1997; 127:2085S–2093S. [PubMed: 9339174]
61. Smith CJ, Nelson RG, Hardy SA, et al. Survey of the diet of Pima Indians using quantitative food frequency assessment and 24-hour recall. J Am Diet Assoc. 1996; 96:778–784. [PubMed: 8683009]
62. Teufel NI, Dufour DL. Patterns of food use and nutrient intake of obese and non-obese Hualapai Indian women of Arizona. J Am Diet Assoc. 1990; 90:1229–1235. [PubMed: 2398214]
63. Harland BF, Smith SA, Ellis R, et al. Comparison of the nutrient intakes of blacks, Siouan Indians, and whites in Columbus County, North Carolina. J Am Diet Assoc. 1992; 92:348–350. [PubMed: 1313056]
64. Ikeda JP, Murphy S, Mitchell RA, et al. Dietary quality of Native American women in rural California. J Am Diet Assoc. 1998; 98:812–884. [PubMed: 9664925]
65. Bell RA, Shaw HA, Dignan MB. Dietary intake of Lumbee Indian women in Robeson County, North Carolina. J Am Diet Assoc. 1995; 95:1426–1428. [PubMed: 7594148]
66. Risica PM, Nobmann ED, Caulfield LE, et al. Springtime macronutrient intake of Alaska Natives of the Bering Straits region: The Alaska Siberia Project. Int J Circumpolar Health. 2005; 64:222–233. [PubMed: 16050316]
67. Nobmann ED, Ponce R, Mattil C, et al. Dietary intakes vary with age among Eskimo adults of Northwest Alaska in the GOCADAN Study, 2000–2003. J Nutr. 2005; 135:856–862. [PubMed: 15795447]
68. Nobmann ED, Lanier AP. Dietary intake among Alaska native women residents of Anchorage, Alaska. Int J Circumpolar Health. 2001; 60:123–137. [PubMed: 11507961]
69. Bingham SA, Cassidy A, Cole TJ, et al. Validation of weighed records and other methods of dietary assessment using the 24 h urine nitrogen technique and other biological markers. Br J Nutr. 1995; 73:531–550. [PubMed: 7794870]

Table 1

The 42 food groups derived from the dietary records used in reduced rank regression (RRR) analysis

Food Group	Food
Fish	Fresh, smoked, fried, and canned; halibut, tuna, cod, and other fish
Shellfish	Fresh, fried, and canned; crabs, scallops, and shrimp
Clams	Razor, steamers, manila, butter, and other types of clams
Salmon	Salmon
Red meat	All preparations; beef, pork, veal, lamb, and organ meats
Game meat	Elk and venison
Poultry	All preparations; chicken, duck and turkey
Processed meats	Luncheon meats, bacon, ham, hot dog, and sausage
Legumes	Legumes, beans, soy bean, and soybean products
Eggs	Eggs
Nuts and seeds	All types of nuts, seeds, and peanut butter
Low-fat dairy	Skim or reduced fat milk, yogurt, cheese, and cream
High-fat dairy	Whole milk, yogurt, cheese, and cream
Meal replacement	Slim fast shakes, ensure, all types of meal replacements
Dairy dessert	Pudding and frozen dairy
Margarine	Margarine; full and reduced fat
Butter	Butter; full and reduced fat
Miscellaneous fats	Gravy and lard
Vegetable oils	Vegetable oils
Alcohol	Alcohol
Coffee	Coffee
Tea	Tea
Fruit juices	Orange, apple, cranberry, grape
Fruit	Apple, banana, oranges, applesauce, pears, strawberries, cantaloupe, watermelon, grapes, raisins, peaches, pineapple, blueberries
Other vegetables	Lettuce, green beans, onions, carrots, celery, broccoli, mixed vegetables, green pepper, cucumber, mushrooms, cauliflower
Tomato	Tomatoes and tomato juice
White potatoes	White potatoes
Fried potatoes	Fried potatoes and vegetable savory snack
Starchy vegetables	Corn, peas
Snack foods	Popcorn, chips, crackers, and pretzels
Sweets	Sugar, syrup, honey, jams, sauces, non-chocolate candy, frosting and glazes
Refined grains	Flours, breads, corn muffins, tortillas, and buckskin bread
Whole grains	Flours, breads, corn muffins, and tortillas
Pasta	Pasta
Desserts	Cakes, cookies, pies, pastries, doughnuts, snack bars, chocolate, and fry bread
Condiments	Regular fat
Lite condiments	Reduced fat and reduced calorie
Miscellaneous foods	Pickled foods and soup broth

Food Group	**Food**
Sweetened drinks	Soft drinks, water, and fruit drinks
Unsweetened drinks	Soft drinks, water, and fruit drinks
Cereals	Sweetened
Cereals	Unsweetened

Table 2

Characteristics of adults participating in the CoASTAL cohort with complete weight, height, and diet information

	Total (n=418)		Plausible (n=236)	
Variables	**Mean**	**SD**	**Mean**	**SD**
Age (years)	42	14	42	14
Height (cm)	166	10	166	10
Weight (kg)	87	20	85	20
BMI (kg/m^2)	31	7	31	7
	Number	%[†]	Number	%[†]
Female	243	58	147	62
Age categories (years)				
18–30	102	24	58	25
31–50	205	49	120	51
51–70+	111	27	58	25
Employed	213	51	130	55
Education level				
Less than high school	94	23	46	20
High school	153	37	87	37
Some college	143	34	86	36
Bachelor’s degree or higher	28	7	17	7
Current smokers	199	48	115	49
Weight status				
Overweight/obese (BMI ≥ 25)	353	84	196	83
Obese (BMI >30)	214	51	117	50

[†] Percents may not add up to 100 due to rounding

Table 3

Factor loading matrix and percent of variance explained for adults (18+ years) participating in the CoASTAL cohort who completed dietary records[†]

	Total (n=418)				Plausible group (n=236)			
Food groups	**Fruit & Sweet drinks**	**Vegetables, fruit & whole grains**	**High fat & sugar**	**% variance explained**	**Vegetarian & grains**	**Healthy**	**Sweet drinks**	**% variance explained**
Fish			−0.23	6.8			−0.21	5.4
Game meat			−0.22	6.8				···
Alcohol			−0.60	47.5			−0.66	56.8
Salmon			−0.22	7.2			−0.28	9.8
Sweetened drinks	0.37	−0.43	0.22	47.4	0.30	−0.41	0.23	44.0
Unsweetened drinks		0.23		7.6		0.21		7.1
Butter	−0.25		0.21	11.5	−0.21			8.5
Fried potatoes			0.23	8.4				···
Desserts			0.23	8.4				···
Fruit juices (citrus and non- citrus)				···		−0.21		7.7
Fruit (citrus and non-citrus)	0.20	0.36		23.8		0.35		23.5
Legumes, beans, soy beans		0.37		23.6	0.24	0.34		28.7
Tomato (including juice)				···	0.24			9.1
Nuts, seeds, peanut butter		0.23		13.9		0.29		18.1
Vegetables		0.35		18.5		0.29		14.1
Whole grains		0.26		11.4				···
Unsweetened cereals				···	0.29			15.4
Refined grains				···		−0.23		9.6
Pasta				···	0.29			11.6
Red meat	−0.37			17.3	−0.38		−0.23	24.0
Processed meats	−0.29			9.8	−0.21			6.8
Eggs	−0.34			12.3	−0.33			13.8
High-fat dairy	−0.20			6.1				···
% variance explained	43.7	22.2	4.3	Σ = 70.3	52.4	24.1	5.9	Σ = 82.3

[†] Factor loadings < |0.20| are not shown

Table 4

The relationship of dietary patterns as quartiles and body mass index (BMI) or obesity among non-pregnant men (18+ years) participating in the CoASTAL cohort [†‡]

	Men (n=175)			
Vegetables, fruit & whole grains pattern	Quartile 1[§]	Quartile 2	Quartile 3	Quartile 4[‖]
BMI (β)[¶]	(ref)	−1.64	−4.30[***]	0.99
Mean BMI (SD)[††]	31.5 (5.5) ^{w}	29.9 (6.3) ^{w,x}	27.2 (4.9) ^{y}	32.5 (6.1) ^{w,z}
Obesity (OR)[‡‡]	(ref)	0.53	0.27[**]	0.96

OR=odds ratio, NS = not significant

[†] No significant relationship was apparent in the total sample therefore data are not shown

[‡] All models adjusted for age, education, employment, and smoking

[§] Quartile 1 corresponds to the lowest dietary pattern intake

[‖] Quartile 4 corresponds to the highest dietary pattern intake

[¶] β coefficient represents mean difference from quartile 1

[††] Values within a row with different superscripts indicate significantly different ($P < 0.05$) means from one another

[‡‡] Obesity defined as a BMI ≥ 30

[**] $P < 0.01$,

[***] $P < 0.001$

Table 5

The relationship of dietary patterns as quartiles and body mass index (BMI) or obesity among non-pregnant adults (18+ years) participating in the CoASTAL cohort who plausibly reported their energy intake [†‡]

	All (n=236)			
Healthy pattern	Quartile 1[§]	Quartile 2	Quartile 3	Quartile 4[//]
BMI (β)[¶]	(ref)	0.69	−0.31	2.81[*]
Mean BMI (SD)[††]	30.1 (5.7) ^{x}	30.9 (6.7) ^{x}	29.9 (7.5) ^{x,y}	33.0 (7.6) ^{z}
Obesity (OR)[‡‡]	(ref)	NS	NS	NS
	Women (n=147)			
Healthy pattern	Quartile 1[§]	Quartile 2	Quartile 3	Quartile 4[//]
BMI (β)[¶]	(ref)	2.09	0.60	5.07[**]
Mean BMI (SD)[††]	29.4 (6.0) ^{x}	31.8 (6.4) ^{x}	30.1 (7.3) ^{x,y}	34.2 (8.4) ^{z}
Obesity (OR)[‡‡]	(ref)	NS	NS	NS
Sweet drinks pattern	Quartile 1[§]	Quartile 2	Quartile 3	Quartile 4[//]
BMI (β)[¶]	(ref)	−2.70	−3.63[*]	−3.39
Mean BMI (SD)[††]	34.7 (8.0) ^{x}	31.1 (7.2) ^{x}	30.4 (7.4) ^{y}	31.1 (6.8) ^{x}
Obesity (OR)[‡‡]	(ref)	NS	NS	NS

OR=odds ratio, NS = not significant

[†] No significant relationship was apparent in men therefore data are not shown

[‡] All models adjusted for age, education, employment, and smoking

[§] Quartile 1 corresponds to the lowest dietary pattern intake

[//] Quartile 4 corresponds to the highest dietary pattern intake

[¶] β coefficient represents mean difference from quartile 1

[††] Values with different superscripts indicate significantly different ($P < 0.05$) means from one another

[‡‡] Obesity defined as a BMI ≥ 30

[*] $P < 0.05$,

[**] $P < 0.01$

Table 6

Adjusted odds ratios of dietary patterns derived from the dietary records meeting Dietary Reference Intakes (DRI) among non-pregnant adults (18+ years) participating in the CoASTAL cohort [†]

	Total (n=418)						Plausible group (n=236)					
Model[‡]	Fruit & sweet drinks		Vegetables, fruit & whole grains		High fat & sugar		Vegetarian & grains		Healthy		Sweet drinks	
Meeting TF AMDR (OR)	Q2	3.1^{**}	Q2	0.6	Q2	1.3	Q2	3.0	Q2	0.4^{*}	Q2	0.5
(20–35 % of energy intake)	Q3	9.1^{***}	Q3	0.9	Q3	0.9	Q3	16.0^{***}	Q3	0.6	Q3	0.3^{*}
	Q4	18.3^{***}	Q4	0.8	Q4	0.7	Q4	59.8^{***}	Q4	0.4^{*}	Q4	0.5
Meeting SF AMDR (OR)	Q2	4.8^{**}	Q2	0.9	Q2	0.8	Q2	1.7	Q2	0.6	Q2	0.5
(<10 % of energy intake)	Q3	14.5^{***}	Q3	1.4	Q3	0.6	Q3	11.2^{***}	Q3	0.7	Q3	0.3^{**}
	Q4	22.8^{***}	Q4	1.6	Q4	0.3^{***}	Q4	12.8^{***}	Q4	0.7	Q4	0.3^{**}
Meeting Fiber AI (OR)	Q2	0.4	Q2	0.5	Q2	1.7	Q2	1.6	Q2	0.0	Q2	0.6
(21–38 g/d)	Q3	0.8	Q3	0.0	Q3	1.9	Q3	1.6	Q3	0.0	Q3	0.3
	Q4	0.9	Q4	6.1^{**}	Q4	2.2	Q4	2.7	Q4	0.0	Q4	0.1^{*}

TF = total fat; AMDR = Acceptable Macronutrient Distribution Range; OR = odds ratio; Q2 = Quartile 2; Q3 = Quartile 3; Q4 = Quartile 4; SF = saturated fat; AI = Adequate Intake

[†] All models adjusted for age, education, employment, and smoking

[‡] Quartile 1 = reference

[*] $P < 0.05$,

[**] $P < 0.01$,

[***] $P < 0.001$