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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

Marie K. Fialkowski, M.S.,

Alfred P. Sloan Scholar and Indiana Clinical and Translational Science Institute (CTSI) Trainee Fellow, Department of Health and Kinesiology, Purdue University, 800 West Stadium Ave. West Lafayette, IN 47907-2046, Phone: (765)494-0101, Fax:(765)494-0674

Megan A. McCrory, Ph.D.,

Assistant Professor, Department of Foods and Nutrition/Department of Psychological Sciences, Purdue University, 700 W. State St. West Lafayette, IN 47907-2059, Phone:(765)494-2631, Fax: (765)494-0674

Sparkle M. Roberts, B.A.,

Research Coordinator, Department of Neurology/Division of Neuropsychology, University of Maryland School of Medicine, 110 S. Paca St, 3rd Floor, Baltimore, MD 21201, Phone: (410)328-6297, Fax: (410)328-5874

J. Kathleen Tracy, Ph.D.,

Assistant Professor, Department of Epidemiology and Preventive Medicine, University of Maryland School of Medicine, University of Maryland, Baltimore, Suite 109 Howard Hall, 660 W. Redwood Street, Baltimore, MD 21201, Phone: (410)706-1205, Fax: (410)706-3808

Lynn M. Grattan, Ph.D., and

Associate Professor, Department of Neurology/Department of Epidemiology and Preventative Medicine/Psychiatry, University of Maryland School of Medicine, University of Maryland, Baltimore, 110 S. Paca St, 3rd Floor, Baltimore, MD 21201, Phone: (410)328-6297, Fax: (410)328-5874

Carol J. Boushey, Ph.D., M.P.H., R.D.

Associate Professor, Department of Foods and Nutrition, Purdue University, 700 W State St, West Lafayette, IN 47907-2059, Phone: (765)496-6569, Fax:(765)494-0674

Marie K. Fialkowski: mfialkow@purdue.edu; Megan A. McCrory: mmccror@purdue.edu; Sparkle M. Roberts: SRoberts@som.umaryland.edu; J. Kathleen Tracy: ktracy@epi.umaryland.edu; Lynn M. Grattan: lgrattan@epi.umaryland.edu; Carol J. Boushey: boushey@purdue.edu

Abstract

Background—Accurate assessment of dietary intake is essential for researchers and public health practitioners to make advancements in health. This is especially important in Native Americans who display disease prevalence rates that are dramatically higher than the general U.S. population.

Correspondence to: Carol J. Boushey, boushey@purdue.edu.

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Objective—The objective of this study was to evaluate three dietary assessment tools: 1) dietary records, 2) a food frequency questionnaire (FFQ), and 3) a shellfish assessment survey (SAS) among Native American adults from the Communities Advancing Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort.

Design—CoASTAL was comprised of randomly selected individuals from three tribal registries of Pacific Northwest Tribal Nations. This cross-sectional study used data from the baseline of CoASTAL and was restricted to the non-pregnant adults (18+ yr) who completed the SAS (n=500), a FFQ (n=518), dietary records (n=444), weight measures (n=493), and height measures (n=496). Paired t-tests, Pearson correlation coefficients, and percent agreement were used to evaluate the dietary records and the FFQ with and without accounting for plausibility of reported energy intake (rEI). Sensitivity and specificity as well as Spearman correlation coefficients were used to evaluate the SAS and the FFQ compared to dietary records.

Results—Statistically significant correlations between the FFQ and dietary records for selected nutrients were not the same by gender. Accounting for plausibility of rEI for the dietary records and the FFQ improved the strength of the correlations for percent energy from protein, energy from carbohydrate, and calcium for both men and women. In addition, significant associations between rEI (dietary records and FFQ) and weight were more apparent when using only rEI considered plausible. The SAS was found to similarly assess shellfish consumption in comparison to the FFQ.

Conclusion—These results support the benefit of multiple measures of diet, including regional and culturally specific surveys, especially among Native Americans. Accounting for plausibility of rEI may ensure more accurate estimations of dietary intakes.

Keywords

Native Americans; dietary assessment; convergent validation; shellfish

Introduction

Diet is influential in the maintenance of health and the etiology of disease across many populations including Native Americans and Alaska Natives (NA/AN) (1). With NA/AN displaying a disproportionate burden for chronic diseases such as cardiovascular disease, cancer, and diabetes (2,3), understanding the dietary profile of Native communities will be essential to reversing the current chronic disease trend (4,5). The current consensus on the diet of NA/AN is that, similar to the general U.S. population (6), they are not meeting the recommendations set for a healthy lifestyle (7). For many of the communities assessed, intakes of fat, saturated fat, cholesterol, and sodium exceed dietary guidelines (8-16), which put these communities at an increased risk for chronic diseases such as diabetes and heart disease (17-19).

Obtaining information on the dietary profiles of a population is also important for understanding and characterizing the risk for specific food borne illnesses or toxic exposures such as amnesic shellfish poisoning or exposure to mercury or organophosphates (20,21). Detailed information on the dietary factors that may protect or increase risk of food borne illnesses or toxicity is essential.

One example is the increased risk of ciguatera symptoms when alcohol is added to the diet (22). In addition, the beneficial effects of omega-3 fatty acids with regards to coronary heart disease have been described (18,19,23). Culturally and economically disadvantaged groups, such as Native Americans, are at a higher risk for these kinds of outcomes (2,3,24-26).

Within these communities specific local or regional dietary information needs to be obtained.

In NA/AN populations, the most frequently used methodology to assess diet has been the single 24-hour recall (9,10,13,15,27-31). Studies by Teufel and Dufour (11) in the Hualapai of Arizona and Nobmann and colleagues (32) in Alaska Natives have used multiple 24-hour recalls. Despite their well established use in assessing diet (33), the food frequency questionnaire (FFQ) and dietary records have been used less often. Standard FFQs were used among the Pima Indians (10) and Native American women in California (13). Dietary records have been used among various NA/AN populations (12,14,16,34). The different dietary instruments all have unique strengths and weaknesses. Current trends suggest using a blend of instruments with the idea of maximizing the strengths of each (35). The use of multiple dietary assessment methods has also been uncommon when assessing the NA/AN diet. To date, only two studies have been published in the literature that have used a multiple assessment approach to diet in NA/AN (10,13). Furthermore, no previously published studies within these populations have compared the food and nutrient estimates from different dietary assessment methods. In addition, the exposure to region-specific foods, such as local fish and shellfish has only been assessed with 24-hour dietary recalls and dietary records. Seafood unique to the Pacific Northwest has not been well characterized.

The overall purpose of this study was to assess the convergent validity of three separate dietary assessment tools, the dietary records, FFQ, and a shellfish assessment survey (SAS). The idea of convergent validity is to determine if different measures of an underlying concept agree with each other (i.e., FFQ and SAS) and with a test measure (i.e., dietary records). The hypotheses tested in this study among Pacific Northwest Tribal Nation adults (18+ years) from the Communities Advancing Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort were: 1) a selected number of key nutrient intakes estimated by a FFQ would have a significant correlation with intakes estimated from dietary records; 2) the strength of the association between the FFQ and the dietary records will be strengthened among those individuals classified as having more accurate dietary information; and 3) the FFQ, dietary records, and SAS would similarly identify shellfish and fish consumers.

Methods

Study Sample and Study Design

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. Individuals aged 6 – 10 y and 18 y or older were randomly selected from the three tribal registries for the CoASTAL cohort (n=646). Enrollment for the five-year prospective study began in June 2005. The sample for this cross-sectional analysis was limited to the 525 non-pregnant adults (18+ yr). The SAS was completed by 500 adults (95%), 518 adults completed the FFQ (99%), and dietary records were completed by 444 adults (85%). For the convergence of dietary records and FFQ, those individuals with a complete FFQ, a dietary record for at least one day, and weight and height information collected during their first year (418/525; 80%) were included. The Institutional Review Boards from the University of Maryland and Purdue University approved the study protocol.

All field coordinators were registered Tribal members. Working in partnership with Tribal members, study dietitians conducted day-long training with the field coordinators in administration of the FFQ, distribution of the dietary records (e.g., completeness of food entries, probing, portion size estimation, food preparation methods, accuracy of recording

data) and administration of the SAS. The field coordinators also viewed an instructional video developed by the Polyp Prevention Trial investigators (36) that covered proper completion and checking of a FFQ. An extensive manual was provided. The field coordinator reviewed all completed FFQs, SASs, and dietary records with the participants before the forms were submitted for analysis. Training also included instruction in standardized methods of taking weight and height.

Dietary Assessment Methods

FFQ—Participants completed either the 98.2 or 2005 version of the Block FFQ (33) at entry into the cohort. This is a quantitative FFQ that asks respondents to recall their usual frequency of consumption of specific foods or food groups, as well as select portion size. The period of recall was the year prior to first study visit. Versions of the Block questionnaire have been extensively validated among diverse populations of adults (33,37-44) and has been shown to compare favorably with other FFQ instruments (33). The Block FFQ has the advantage of being a scannable questionnaire. Also available are portion size photos to aid in estimating usual portion size for each food; a method previously shown to assist respondents with this otherwise difficult task (45). For those participants who self-identified limited reading skills, the FFQ was completed by an interview which took 30-60 minutes.

Dietary records—Based on recommendations from Bolland et al. (46), techniques were used to improve accuracy of the information in the dietary records. Field coordinators trained the participants in record keeping techniques using food replicas, bowls, a coffee mug, plastic glasses, and sets of measuring aids. Participants viewed an instructional video developed by the Polyp Prevention Trial investigators (36) that covered food portion size estimation and proper completion of dietary records. 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 were assigned a grouping of days of the week based on the day of their first visit. At least one of the assigned days included a weekend day. This approach was designed to capture seasonal and day of the week variation and decrease respondent fatigue (42). 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). The intakes from the dietary records were calculated as the mean of the number of days reported. At least 2 days were reported by 148 of the men (148/175; 85%) and by 214 of the women (214/243; 88%).

Brief shellfish questionnaire—The SAS was modified for use within the CoASTAL cohort. SAS was adapted from the questionnaire used to assess seafood-related dietary exposures in the Upper St Lawrence River (47) and Prince Edward Island (20). To ensure local and regional specificity to the CoASTAL cohort, the questionnaire was modified based on input from representatives of the Tribal Nations' Fisheries Management Departments. The SAS was piloted on each reservation and modified to reflect local terms for fish, shellfish, and names of beaches. In the final version of the questionnaire, the frequency and preparation of each type of shellfish (e.g., gooey ducks) and fish (e.g., coho salmon) are asked. Participants selected from a list of locations for the harvesting of shellfish. The SAS was developed to be self-administered and scannable. Each participant took 10 to 15 minutes to complete the SAS upon entry into the cohort recalling their most recent seasonal consumption of shellfish.

Anthropometry

Weight and height were measured with the participant wearing lightweight clothing, without shoes, and emptied pockets by trained field coordinators. 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). Body mass index (BMI) was calculated using the formula $\text{wt}(\text{kg})/\text{ht}(\text{m})^2$.

Plausibility determination

Determination of individuals with plausibly reported energy intakes (rEI) were classified using previously developed and described methods (48,49). Briefly, Dietary Reference Intake (DRI) equations were used to calculate predicted energy requirements (pER) (48-50). Physical activity level (PAL) was imputed as low active at 1.12 for women and 1.11 for men. rEI was evaluated as implausible after applying the 1.4 standard deviation (SD) cut-off method to the population sample (48,49). Individuals within ± 1.4 SD were considered to have plausible rEI, those with a SD above +1.4 were considered to be over reporters of energy intake, and those with a SD below -1.4 SD were considered to be under reporters of energy intake.

Statistical Analysis

Ages were calculated from date of birth and date of first visit. For dietary records, the average of available days was calculated for all nutrients. The likelihood of being classified as a plausible reporter or a non-plausible reporter, a plausible or an under reporter, and a plausible or an over reporter between the FFQ and the dietary records were assessed using a McNemar non-parametric test. Any differences between the FFQ versions were compared by gender, by plausibility classification, and by estimated energy intakes using chi-square and multivariate linear regression. No differences were detected; therefore, results from both versions of the FFQ were combined for all analyses. Nutrient intakes as estimated by FFQ were compared to the mean estimated intakes from the dietary records after adjustment for energy using a paired *t*-test. Variables were evaluated for meeting the assumptions of normal distributions. No variables were determined to need transformation.

Pearson correlation coefficients were used to compare estimated nutrients from the FFQ and the mean of the dietary records. To adjust for within-person variation in dietary intake, deattenuated correlation coefficients were calculated using the following formula (51):

$$r_t = r_o \left\{ 1 + [(s_w^2/s_b^2)/n] \right\}$$

where r_t is the true Pearson correlation, r_o is the observed correlation, (s_w^2/s_b^2) is the within-person variance divided by the between-person variance for each dietary item, and n corresponded to the mean number of dietary records completed ($n=3$). Percent agreement was calculated for a selected number of nutrients (percent energy from protein, dietary fiber, iron, and calcium) by gender to assess the correspondence between the FFQ and the dietary records to classify respondents into similar quartiles of intakes.

We compared the prevalence rates of reported shellfish consumption from the SAS, the dietary records, and the FFQ. Sensitivity, specificity, and positive and negative predictive values were computed. Spearman rank correlations were used to assess the correspondence of estimated servings of shellfish. Statistical analyses were completed using Statistical

Package for the Social Sciences (SPSS) 16.0 (Chicago, IL) and Stata 10 SE (Stata Corp, College Station, TX). Results were considered significant at $P < 0.05$, using two-sided tests.

Results

A total of 175 men completed the FFQ, had at least 1 dietary record, and had complete weight and height information. Among non-pregnant women, there were 243. The mean ages of the men and women were $41.5 \text{ y} \pm 14.7$ and $43.0 \text{ y} \pm 14.2$, respectively. Both men and women completed the same mean number of days for dietary records (3 dietary records ± 1 , SD). More men were classified as plausible rEI for the dietary records (89/175, 51%) than for the FFQ (71/175, 41%), but these differences were not significant ($p = 0.067$). Despite, a higher frequency of men being over reporters using the FFQ (24/175; 14%) than the dietary records (8/175; 5%), these differences were not significantly different ($p = 0.067$). The same was true for those men considered under reporters for the FFQ (80/175; 46%) and the dietary records (78/175; 45%). About 20% of the men ($n = 37$) were classified as plausible rEI for both the FFQ and the dietary records. For women, the proportion of plausible rEI for the dietary records was 60% (147/243) and this proportion was significantly higher ($p = 0.037$) than the FFQ at 50% (122/243). A significantly higher proportion ($p = 0.037$) of the women (41/243; 17%) who completed a FFQ were considered to be an over reporter in comparison to the dietary records (18/243; 7%). A similar proportion of women (33%; 80/234) were considered to be an under reporter for the FFQ in comparison to the dietary records (32%; 78/243). About 28% of the women ($n = 68$) were classified as plausible rEI for both the FFQ and the dietary records.

Table 1 presents the mean pER and the mean dietary intakes for energy, macronutrients, dietary fiber, and selected vitamins and minerals as estimated by the FFQ and the dietary records. For both men and women, the estimates for protein, total fat, polyunsaturated fat, cholesterol, vitamin C, folate, and iron were significantly different between the two dietary assessment methods. Women had significant differences between estimates for energy and monounsaturated fat, as well. In contrast, when the analysis was limited to plausible rEI, only estimates for vitamin C and folate were significantly different between the men and the women. Estimated intakes for protein, saturated fat, polyunsaturated fat, cholesterol, and iron intakes differed significantly between the FFQ and dietary records for the plausibly reporting women.

Table 2 presents the comparison of intakes between the FFQ and the dietary records based on deattenuated Pearson correlation coefficients. Among those nutrients selected for analysis, accounting for the plausibility of rEI improved strength of correlation for percent energy from protein, percent energy from carbohydrate, cholesterol, and calcium for both men and women for each method. Additionally for women, percent energy from saturated fat, percent energy from monounsaturated fat, folate, and iron strength of correlation improved. Based on this analysis, only percent energy from protein, percent energy from carbohydrate, dietary fiber, and calcium displayed a consistent correlation among the groups. However, when examining the correlation of rEI with an objective measure such as measured weight (kg) and BMI, accounting for plausibility of rEI for both genders changed the association from no association to a statistically significant, strong association for both men and women. The statistically significant association between rEI and pER was further strengthened after accounting for plausibility (see Table 3).

Percent agreement between identical quartiles for three nutrients (percent energy from protein, calcium, and iron) and dietary fiber were determined between the FFQ and the mean of the dietary records for both men and women. Percent agreement for percent energy from protein was 31% whereas agreement within plus or minus one quartile was 67% for the men.

Percent agreements for the women were 32% and 75%, respectively. Percent agreement for dietary fiber was 33% for the men and 26% for the women. Agreement within plus or minus one quartile for fiber was 71% for the men and 73% for the women. Percent agreement for iron was 34% and 31%, respectively, for men and women whereas within plus or minus one quartile was 73% for men and 70% for women. Men had better percent agreement (35%) for calcium in comparison to women (29%). However, agreement within plus or minus one quartile was better for the women (75%) than for the men (71%).

The evaluation of reported consumption of shellfish and seafood between the dietary records, the FFQ, and the SAS is presented in Table 4. The prevalence of reported consumption of seafood, shellfish, clams, and clam chowder was highest in the FFQ and the SAS (77 – 98%) in comparison to the dietary records (18 – 53%). The sensitivity of the SAS was excellent in comparison to the FFQ and low in comparison to the dietary records. Classification of people as high consumers of seafood, shellfish, clams, and clam chowder in the SAS was similar to both the dietary records and the FFQ (positive predictive value 0.76 – 0.99).

The Spearman correlations between the SAS and the dietary records and FFQ are shown in Table 5. The FFQ and the SAS were found to be significantly correlated in assessing frequency and amount of consumption of clams. SAS did not correlate well with the dietary records.

Discussion

Our study is the first to evaluate the convergent validity between an FFQ, dietary records, and a brief shellfish questionnaire within a Native American population. In this sample, the estimates for energy dependent variables, cholesterol, dietary fiber, and calcium were similar between the FFQ and the dietary records. On the other hand, estimates for percent energy from monounsaturated fat and iron were not similar between the two methods for both the men and the women. The SAS performed well in comparison to both the FFQ and the dietary records. Given the proximity to the coast, seafood is of significant historical, cultural, and dietary importance to these Tribal Nations. The utility of this questionnaire would be of significant public health importance given the modern risks and benefits associated with seafood consumption.

Accounting for plausibility of rEI resulted in greater agreement between the diet assessment methods. In comparison to men, women seemed to show improvement in more nutrients in method agreement when plausibility of rEI was taken into account. This may support previous findings that women have described their food sufficiently well as compared to energy estimated by doubly labeled water (52). The energy dependent nutrients, cholesterol, dietary fiber, and calcium showed improved agreement between assessment methods when accounting for plausibility for EI. The same phenomena occurred when correlations of energy intake were compared with the objective measures of body weight and BMI. The significant associations found for energy intake with body weight and BMI when accounting for plausibility of rEI reconfirms previous findings in the literature (49,53).

For certain nutrients, the FFQ and the dietary records were highly correlated and distributed individual's intakes equivalently. However, the absolute intakes between the two methods could be significantly different. Since the FFQ represents a closed list of foods and the food records report actual foods eaten on recording days, these differences likely reflect that these methods do not assess the same points in time and the same concepts of intakes (54). An example of this observation is percent energy from protein which was found to have a significant, positive correlation between the dietary records and FFQ. However, percent

energy from protein estimated from the FFQ and the dietary records were significantly different.

More individuals were classified as having plausible rEI for the dietary records compared to the FFQ. One would expect the dietary record to be a more accurate measure of intake in comparison to the FFQ (55). The FFQ is designed to rank individuals as low or high consumers rather than provide exact nutrient intakes (56). Although there were a larger number of individuals classified as having plausible rEI for the dietary records, this did not always translate to better agreement between the dietary record and the FFQ.

Our study cannot determine which method is more accurately measuring truth. There is only an indication that the dietary records may perform better with regards to energy intake based on the results of the correlation between rEI and body weight or rEI and BMI. Body weight is an objective indicator that one would expect to have a positive relationship to energy intake (57). Previous reports among adolescents noted that individuals found to be underreporters using one method were likely to underreport using another dietary assessment method (58,59). We found the similar phenomenon in our study. Men and women who were classified as underreporters using the FFQ did not differ from those classified as underreporters based on the dietary records. Therefore, when little information about a group's dietary intake exists, a combination of methods estimating actual and usual intakes may provide researchers with more accurate information on a broader spectrum of dietary intakes.

In previous studies, under reporting has been a more frequent occurrence than over reporting, especially in women (60-64). However, in the CoASTAL cohort a fairly large proportion of women were considered to be over reporters in comparison to previous findings among non-Native women (61,62). This finding may suggest that the pressure to hide eating habits may be lower in this population. Cassidy (65) described these observations as reflecting a culture closer to its roots and the sentiment that food abundance is a symbol of wealth. The assumption that few women are over reporters may not be correct with diverse groups.

These results also support that the SAS performs similarly to the FFQ in capturing the high consumers of shellfish in the CoASTAL cohort. When the objective is to measure absolute rather than relative intake, for example, to compare with dietary recommendations, the dietary records would be the preferred method (66). Since the likelihood of daily consumption of shellfish is low, the frequency of intake of shellfish may be missed with 1-4 days of dietary records throughout the year. However, when attempting to estimate relative exposures, in this case consumption of shellfish, the SAS and the FFQ perform equally well and both would be appropriate to evaluate shellfish relative intakes. Economically, the SAS is less expensive to administer and analyze compared to the FFQ. In addition, the burden on the respondent is less which can contribute to improved participant cooperation which may translate to better accuracy.

Increased seafood consumption has been promoted for its health benefits (23). However, in recent decades there is increasing concern regarding the safety of consuming seafood. This is largely due to wide spread contamination and development in coastal areas and the dramatic increase in the number of harmful algal blooms in oceans throughout the world (67). The diets of coastal groups such as those in the CoASTAL cohort rely on seafood as a subsistence part of their diets. Fish and shellfish are a major dietary food source of cultural and historical importance. Public health measures, such as the SAS developed for the CoASTAL cohort, are important to evaluating the exposure risk within vulnerable

populations. An understanding of the level of exposure within these communities is important for public health measures to maintain a balance.

There are strengths of our study to further elaborate. Despite the burden associated with keeping records, 85% of the adults did complete at least one day or more and the majority (87%) completed 2 or more 2 days. Our study design called for completing up to four non-consecutive dietary records spaced over the course of one year which may have reduced respondent fatigue. The strong participation rate may also be a result of community-wide involvement. Secondly, we assessed the correlation between the FFQ and the dietary records with available objective measures (pER, lab-measured weight, and lab-measured height) and found that both methods performed well for plausible reporters. Thirdly, the SAS was modified from a previously used seafood questionnaire that successfully measured important seafood exposures (20,47). Since this questionnaire was used in locations very different from the Pacific Northwest (Prince Edward Island and Upper St Lawrence River Lakes), it was important use terms describing seafood found locally in the Pacific Northwest, as well as being consistent with local vernacular. The modifications of the SAS evolved from comparing pilot responses with the expert opinions of Natural Resources and Fisheries biologists within the tribes who regularly monitor available resources and harvesting patterns for purposes of fish and shellfish safety and sustainability. Face validity was obtained by administering the SAS to Tribal members (representing multiple generations), reviewing comments with our NA team of seafood and shellfish experts, and making modifications as indicated. This study represents one step along the way toward establishing the utility of questionnaires that can be applied to seafood exposures that have both positive and negative relationships to health (18-23).

Although the FFQ has been administered in diverse populations, the CoASTAL cohort is a unique coastal Native American community. However, the FFQ was not modified to include foods traditionally consumed within the CoASTAL cohort thus there may be an underreporting of foods consumed regularly such as specific types of seafood. Based on our analyses, we do not believe that administering two different versions of the FFQ to the CoASTAL cohort significantly affected our results. The administration of the SAS, which was tailored to include local foods, provided the capacity to assess specific seafood items of the CoASTAL cohort. Therefore, rather than taking on the difficult task of developing a FFQ to assess the diet of a specific coastal population, it may be more efficient and culturally relevant to develop a brief questionnaire specific to that population to supplement missing information.

Conclusions

In conclusion, this is the first study to evaluate the convergent validity of common dietary assessment methods (FFQ, dietary records, and a brief shellfish questionnaire) among Native Americans. We found that when assessing the shellfish consumption of the CoASTAL cohort, the SAS is able to comparably estimate the relative intakes of shellfish in comparison to other standard measures of relative intake. We also found that accounting for plausibility of rEI may ensure a more accurate estimate of dietary intakes. Dietary assessment methods will likely always have some level of error and the type of error differs between methods. Therefore, based on our findings we recommend that multiple dietary assessment methods be used to assess the dietary intakes of any population.

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Table 1

Mean predicted energy requirements (pER) and mean dietary intakes based on the food frequency questionnaire (FFQ) compared to the mean dietary intakes of the dietary records for adult men and women (18 + y) participating in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort^x

Variable ^y	FFQ				Dietary records (up to 4 days)			
	Plausible reports, men ^z (n=37)		Plausible reports, women ^z (n=68)		Plausible reports, men ^z (n=37)		Plausible reports, women ^z (n=68)	
	All men (n=175)	All women (n=243)	All men (n=175)	All women (n=243)	All men (n=175)	All women (n=243)	All men (n=175)	All women (n=243)
	Mean (SD)							
pER	2860 (348)	2263 (289)	2258 (280)	2860 (348)	2954 (350)	2263 (289)	2258 (280)	2954 (350)
Energy (kcal)	2524 (2126)	2216 (1677) ^c	2119 (506)	2264 (1086)	2773 (591)	1887 (675) ^c	2040 (392)	2773 (591)
% energy PRO	15 (3) ^a	14 (3) ^c	13 (3) ^d	17 (4) ^a	15 (3)	15 (4) ^c	16 (3) ^d	15 (3)
% energy CHO	48 (8)	50 (8)	51 (7)	47 (9)	47 (9)	50 (9)	49 (8)	47 (9)
% energy TFA	37 (6) ^a	37 (7) ^c	37 (6)	36 (7) ^a	37 (5)	36 (7) ^c	37 (6)	37 (5)
PRO (g)	95 (92) ^a	77 (70) ^c	71 (26) ^d	90 (45) ^a	105 (29)	72 (27) ^c	80 (20) ^d	105 (29)
CHO (g)	298 (243)	274 (190)	267 (71)	266 (134)	319 (76)	231 (89)	247 (65)	319 (76)
TFA (g)	106 (91) ^a	92 (77) ^c	87 (26)	93 (51) ^a	116 (31)	77 (33) ^c	84 (21)	116 (31)
SFA (g)	33 (28)	28 (24)	27 (9) ^d	31 (18)	38 (11)	25 (12)	28 (8) ^d	38 (11)
PUFA (g)	23 (21) ^a	22 (18) ^c	21 (7) ^d	18 (11) ^a	23 (9)	16 (9) ^c	17 (7) ^d	23 (9)
MUFA (g)	41 (36)	35 (30) ^c	33 (11)	36 (21)	45 (13)	29 (13) ^c	32 (9)	45 (13)
Cholesterol (mg)	360 (323) ^a	269 (246) ^c	258 (124) ^d	364 (263) ^a	473 (292)	288 (182) ^c	307 (148) ^d	473 (292)
Dietary fiber (g)	17 (14)	16 (12)	16 (6)	15 (7)	18 (8)	14 (6)	16 (6)	18 (8)
Vitamin C (mg)	128 (118) ^a	121 (94) ^c	115 (59) ^d	68 (60) ^a	77 (59) ^b	72 (54) ^c	80 (57) ^d	77 (59) ^b
Folate (µg)	296 (228) ^a	290 (216) ^c	278 (140) ^d	414 (221) ^a	465 (133) ^b	376 (168) ^c	421 (156) ^d	465 (133) ^b
Iron (mg)	17 (15) ^a	14 (11) ^c	14 (6) ^d	17 (8) ^a	19 (6)	15 (7) ^c	17 (7) ^d	19 (6)
Calcium (mg)	875 (764)	808 (623)	811 (349)	764 (524)	927 (329)	669 (371)	771 (334)	927 (329)

^xEnergy adjusted means from the FFQ and the dietary records (within a row) sharing the same superscript differ significantly ($P<0.05$) as defined by: a = all men; b = plausible reports, men; c = all women; d = plausible reports, women

^yPRO=protein; CHO=carbohydrate; TFA=total fat; SFA=saturated fat; PUFA=polyunsaturated fat; MUFA=monounsaturated fat

^zPlausible reports limited to those considered to have plausible reported energy intakes (rEI) in both the FFQ and the dietary records

Table 2

Deattenuated Pearson correlation coefficients^a of dietary intakes between the food frequency questionnaire (FFQ) and the mean of dietary records (DR) completed by adult men and women (18 + y) participating in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort

Variable	All FFQ vs. all DR		Plausible FFQ vs. plausible DR	
	Men(n=175)	Women (n=243)	Men (n=37)	Women (n=68)
Energy (kcal)	0.24**	0.13	0.22	0.05
% energy protein	0.23**	0.33**	0.45**	0.45**
% energy carbohydrate	0.31**	0.29**	0.50**	0.39**
% energy total fat	0.10	0.26**	0.14	0.23
% energy saturated fat	0.17**	0.32**	0.31	0.34**
% energy polyunsaturated fat	0.13	0.05	0.15	0.16
% energy monounsaturated fat	0.01	0.21**	0.00	0.28*
Cholesterol (mg)	0.22*	0.23**	0.41*	0.31*
Dietary fiber (g)	0.38**	0.41**	0.39*	0.36**
Vitamin C (mg)	0.24**	0.34**	0.28	0.23
Folate (µg)	0.03	0.21**	0.17	0.38**
Iron (mg)	0.14	0.29**	0.06	0.57**
Calcium (mg)	0.27**	0.34**	0.51**	0.45**

^a Pearson correlation coefficient did not differ markedly from Deattenuated Pearson correlation coefficient so values are not shown

* $P < 0.05$,

** $P < 0.01$

Table 3

Pearson correlation coefficients of reported energy intakes (rEI) as estimated by the food frequency questionnaire (FFQ) or up to 4 days of dietary records (DR) in comparison to predicted energy requirements (pER; kcal), weight (kg), and body mass index (BMI) by plausible reporting among adult men and women (18 + y) participating in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort

	Plausible rEI			
	All men	All women	Men	Women
	FFQ		FFQ	
	n=175	n=243	n=71	n=122
pER (kcal)	0.19 [*]	0.14 [*]	0.54 ^{**}	0.56 ^{**}
Weight (kg)	0.02	0.10	0.38 ^{**}	0.50 ^{**}
BMI	0.04	0.11	0.28 ^{**}	0.42 ^{**}
	DR		DR	
	n=175	n=243	n=89	n=147
pER (kcal)	0.18 [*]	0.20 [*]	0.52 ^{**}	0.52 ^{**}
Weight (kg)	0.08	0.13	0.48 ^{**}	0.45 ^{**}
BMI	0.04	0.08	0.41 ^{**}	0.36 ^{**}

^{*} $P < 0.05$,

^{**} $P < 0.01$

Table 4

Sensitivity, specificity, positive predictive value and negative predictive value of seafood and shellfish servings according to the brief shellfish questionnaire (Shellfish Assessment Survey; SAS), the food frequency questionnaire (FFQ), and the dietary records (DR) completed by adults (18 + y) participating in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort

	DR n=444	FFQ n=518	SAS n=500	Sensitivity		Specificity		Positive predictive value		Negative predictive value	
				DR	FFQ	DR	FFQ	DR	FFQ	DR	FFQ
				n (%)							
Reported consumption of:
Seafood	234 (53)	501 (98)	424 (96)	0.54	0.99	0.84	0.32	0.99	0.97	0.08	0.55
Shellfish	114(26)	423 (84)	359 (83)	0.30	0.87	0.90	0.35	0.93	0.87	0.22	0.35
Clams	114(26)	...	363 (82)	0.29	...	0.89	...	0.92	...	0.22	...
Clam Chowder	71 (18)	...	307 (77)	0.18	...	0.82	...	0.76	...	0.23	...

Table 5

Spearman correlations between self-reported seafood and shellfish intake from the brief shellfish questionnaire (Shellfish Assessment Survey; SAS), the food frequency questionnaire (FFQ), and the dietary records (DR) completed by adults (18 + y) participating in the Communities Advancing the Studies of Tribal Nations Across the Lifespan (CoASTAL) cohort

Tool	Frequency measure	DR			FFQ			SAS	
		Servings of shellfish/day	Amount of shellfish/day	Amount of clams/day	Frequency of Portions of shellfish/day	shellfish/day	Meals/season with clams	Clams/season	
DR	Servings of shellfish/day	...	...	...	...	...	...	0.03	
	Amount of clams/day	...	...	...	...	...	...	0.02	
FFQ	Frequency of shellfish/day	...	...	...	...	...	0.13**	...	
	Portions of shellfish/day	...	...	...	...	...	...	0.20***	
SAS									
	Meals/season with clams	...	...	...	0.13**	...	...	...	
	Clams/season	0.03	0.02	0.02	...	0.20***	...	...	

** $P < 0.01$,

*** $P < 0.001$