

Perspectives in Practice

Development, Implementation, and Evaluation of a Computerized Self-Administered Diet History Questionnaire for Use in Studies of American Indian and Alaskan Native People

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ABSTRACT

Collection of dietary intake in epidemiologic studies involves using methods that are comprehensive yet appropriate for the population being studied. Here we describe a diet history questionnaire (DHQ) that was developed using an audio self-administered computer-assisted interview technique. The DHQ was developed for use in a cohort of American Indians and Alaskan Natives with tribal input and area-specific modules to incorporate local food availability. The DHQ includes 54 main food group questions, specific food items within the main food group, and food preparation and general eating practice questions. The questionnaire was programmed to be self-administered using a computer with a touch screen. The average time for the first 6,604 participants to complete the questionnaire was 36 minutes. Almost 100% of participants had complete DHQ data and the average number of food items selected was 70. The methods developed for collection of dietary data appear to be appropriate for the targeted population and may have usefulness for other populations where collecting dietary data in a self-administered format is desirable.

J Am Diet Assoc. 2008;108:101-109.

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0002-8223/08/10801-0002\$34.00/0

doi: 10.1016/j.jada.2007.10.008

Numerous components of diet have been linked to disease. Studies have evaluated total energy as well as contributors to energy (eg, protein, fat, and carbohydrate), types of dietary fat, calcium and vitamin D, folic acid, and B vitamins associated with deoxyribonucleic acid methylation, as well as specific foods and dietary patterns to better understand disease etiology (1-5). Collection of comprehensive dietary data allows researchers to evaluate dietary components that are the focus of many case-control and cohort studies in an effort to better understand the scope of dietary associations with diseases.

In 1947, Bertha Burke suggested that the diet history questionnaire (DHQ) was an important tool to capture comprehensive dietary data in research (6). Burke's DHQ deviated from the more traditional collection of 24-hour recall data in an effort to be able to more correctly classify individual intake and, therefore, associations with disease. The original Burke questionnaire started with an overview of what was eaten during the past 24 hours and continued with frequency of foods eaten during the past 28 days. Detailed information was collected on the previous 24 hours, whereas less detailed information was collected for consumption of foods during the past 28 days. The Chicago Western Electric Study used the Burke DHQ to collect information on the dietary habits of white middle-aged men in the 1960s (7).

Since then several adaptations have been made to the Burke DHQ method for collecting dietary intake data. The Western Electric Study DHQ was the platform for the development of a DHQ for the Coronary Artery Risk Development in Young Adults Study (8). The Coronary Artery Risk Development in Young Adults Study DHQ was further modified to collect information for a 1-year referent period and computerized for interviewer administration (9). Food frequency questionnaires have emerged as a method commonly used to collect categories of foods eaten, usual serving size, and frequency of consumption by obtaining information on all foods in a given list. Several food frequency questionnaires have been developed to correspond with specific population needs (10). The challenge to investigators of diet and disease associations is to utilize methods of data collection that will

yield valid and comprehensive dietary intake that is suitable to the needs of the study population.

Here we describe methods used to develop a self-administered computer-assisted comprehensive DHQ to collect dietary intake data for a prospective study of American Indians and Alaskan Natives (11). One of the goals in developing the DHQ was to be comprehensive yet sensitive to unique dietary patterns that exist among American Indian and Alaskan Native tribes (12). Data included are from the first individuals (N=6,604) who participated in the study from March 2004 through mid-January 2006.

METHODS

Study participants were from a sample of convenience; participants were recruited from tribal meetings, tribal events, flyers, letters, health fairs, and information booths placed where information could be distributed. To be eligible to participate, people had to be older than age 18 years, self-identify as an American Indian or Alaskan Native, and be eligible for health care through the Indian Health Service. Participants were enrolled from the community at three locations in Alaska and two locations in the Navajo Nation (New Mexico and Arizona). Participants interested in joining the study were asked to come to temporary or permanent clinic sites where they signed an informed consent; completed an audio computer-assisted interview; and had body size measurements, blood pressure, and a finger stick blood draw taken. Before data collection began we evaluated the usability of the computerized questionnaire in this population. A summary of this usability work shows that it was well received by study participants (13).

We aimed to develop a DHQ with area-specific modules to enable dietary data collection among various tribes. The framework for the initial food list came from a computer-assisted interview DHQ used in several case-control studies (9). We added foods commonly eaten in Alaska and the Southwestern United States based on use in previous questionnaires used in the population and meetings with tribal people and organizations with experience collecting dietary data in these populations (14-17). The majority of area-specific food items were subsistence foods, including bird eggs, wild birds, gathered berries, muskox, caribou, deer, moose, reindeer, antelope, elk, buffalo, beaver, rabbit or squirrel, seal or walrus, muktuk, seal oil, smoked or dried fish, hooligan or herring, and other fish such as char. Additional regional foods included on the questionnaire were herring eggs, canned or jarred salmon, beach asparagus, seaweed or kelp, wild or gathered greens, blue cornmeal mush, blue cornmeal pancakes, skillet or gabubu bread, and Indian tacos. Tribal members provided feedback on the appropriateness and completeness of foods included in the DHQ. Tribal members also provided feedback on the ease of completing the computerized questionnaire as part of the questionnaire development.

The referent period of the past year was selected to capture the seasonal variation of foods available, especially in Alaska (18). The questionnaire was divided into three components: 54 main food group questions, specific food items within the main food group, and food preparation and general eating practice questions (Figure 1).

During the past year when you ate meat, chicken, game, fish, or wild birds, how often were they fried in fat?
During the past year if you used fat to prepare meat, chicken, game, fish, or wild birds, what type did you usually use?
During the past year how often did you eat the skin when you ate chicken, turkey, or wild birds?
During the past year how often did you eat the fat when you ate beef, pork, or game?
During the past year when you ate vegetables, how often were they cooked with fat?
During the past year if you used fat to prepare vegetables, what type did you usually use?
During the past year when you ate breads, potatoes, rice, or vegetables, how often did you add fat such as butter, margarine, or mayonnaise at the table?
During the past year what type of fat did you usually use as a spread on breads, potatoes, rice, or vegetables at the table?
During the past year how often did you add salt to your food when you were cooking?
During the past year how often did you add salt to your food at the table?
During the past year how often did you eat low-fat dairy products, such as low-fat cheese, cottage cheese, or yogurt?

Figure 1. Questions included in the audio self-administered computer-assisted questionnaire to obtain information on food preparation and general eating practices of a cohort of American Indians and Alaskan Natives.

The questionnaire was programmed to be self-administered using a computer with a touch screen. Each screen contained a "HELP" button that took participants to a pop-up help screen. Help screens defined specific food items and provided additional information about the specific question. Each screen had a "BACK" or "NEXT" option to go back to previous questions or to go on to the next question. Participants could quit the questionnaire by touching a "QUIT" button. Participants used headphones to hear the questionnaire read in English, Yupik, or Navajo using an audio feature to toggle into the language of their choice. Study personnel provided a standardized overview of the study questionnaire and the computer and were available to assist participants if they needed help while completing the questionnaire. Introductory screens were used to explain the purpose of the questionnaire and to provide overall instructions (Figure 2). Three screens were used to capture the different levels of data (Figure 3). Our assessment of the usability of the computerized data collection method has been reported elsewhere (13).

Participants were asked if they ate each major food (eg, eggs) once a month or 12 times per year or more. Only participants who reported eating the food were asked to select the specific food items (eg, omelet or boiled eggs) they ate. Each food item selected was then sequentially queried about whether the food was consumed daily, weekly, monthly, or yearly; how many times (per day, month, or year) they ate the food; and their usual serving size (Figure 3). Three categories of serving sizes for each food item were available, except for alcohol where six categories were used (Table 1). To

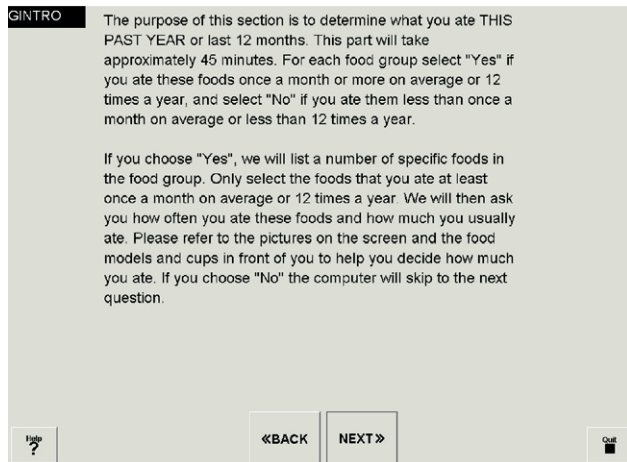


Figure 2. Introduction screen to the audio self-administered computer-assisted questionnaire used to obtain dietary information from a cohort of American Indians and Alaskan Natives.

the right of each numerical serving size unit was a picture of the food item that was custom designed to estimate that portion size (see [Figure 3](#)). Portion size aides such as marked glasses, bowls, plates, cups, and spoons were displayed to assist participants in recalling serving size.

Nutrient Conversion

Food items were converted to nutrients using the Nutrition Data System for Research (database version 4.02_30, 2003, University of Minnesota Nutrition Coordination Center, Minneapolis). Food nutrient codes were selected to best represent the food item denoted on the questionnaire. The few food items not available in the Nutrition Coordinating Center database were assigned a food code at the coordinating center (University of Utah, Salt Lake City) based on local recipes obtained from tribal members.

Other Data

Other parts of the 2- to 3-hour baseline study visit included demographics collection (ie, level of education, age, sex, number of people living in the household, and marital status). Height and weight were measured at the time of the visit as were waist and hip circumferences (11). Blood pressure was measured using an Omron HEM-907 (Omron Healthcare, Inc, Bannockburn, IL) automatic blood pressure measuring device (19). Fasting glucose level and lipid panel data were measured via finger stick using the Cholestech LDX System (Cholestech, Hayward, CA) (20). A detailed computerized health and lifestyle questionnaire included questions about physical activity; medical conditions; family history of several conditions, including cancer, heart disease, and diabetes; reproductive history for women; cancer screening practices; the 12-item short form health survey (21) that was used to determine health status; and use of tobacco and alcohol.



Figure 3. Sample computer screens used by a cohort of American Indians and Alaskan Natives in selecting food items, frequency of consumption, and serving size.

The computerized questionnaire was programmed with the ability to record background information (para-data) while the participant was completing the questionnaire. This provided auxiliary data about the process of data collection using time stamps, keystroke files, and trace files that were used to identify usability issues. Para-data (n=1,247) were collected between March 15, 2004, and July 15, 2005, on the Navajo Nation. These data included time to complete the DHQ questionnaire, number of food items skipped, and number of times the HELP button was used.

Table 1. Default values for small, medium, and large serving size in audio computer-assisted self-administered diet history questionnaire designed for a cohort of Alaskan Native and American Indian subjects

Food category	Small	Medium	Large	Small beverage	Medium beverage	Large beverage
Eggs						
Large	1	2	4			
Cup	0.5	1	2			
Milk (c)	1	1.5	2.5			
Cheese						
oz	1	2.5	5			
Cup	0.5	1	2			
Frozen desserts						
Cup	0.5	1	2			
Pieces	1	2	4			
Bread (slice)	1	2	4			
Rolls (medium)	0.5	1	3			
Pancakes						
Medium	1	2.5	5			
Slice	1	2	4			
Pasta (cup)	1	1.75	4			
Rice (cup)	1	1.75	4			
Cereal						
Cup cooked	0.5	1	2			
Cup dry	1	1.75	3.5			
Crackers (pieces)	3	8	15			
Fruit-flavored juice (cup)	1	2	3			
Juice (cup)	0.75	1.25	2			
Fruit						
Medium	0.5	1	2			
Cup	0.5	1	2			
Pieces	2	5	8			
Cup	1	1.5	3			
Oriental dishes (cup)	1	1.5	3			
Mexican dishes (cup)	1	2	4			
Soup and stew (cup)	1	1.5	4			
Pizza (slice)	1	3	5			
Beef (oz)	3	5	10			
Game (oz)	3	5	10			
Seal or walrus (oz)	3	5	10			
Pork (oz)	3	5	10			
Mutton, lamb, goat (oz)	3	5	10			
Cold cuts						
oz	3	5	8			
Slice	3	5	8			
Organ meats (oz)	3	5	8			
Poultry (oz)	3	5	8			
Fish and shellfish (oz)	3	5	8			
Dried beans (cup)	0.5	1	2			
Vegetables						
Cup	0.5	1	2			
Medium	1	2	4			
Potatoes						
Large	1	1	2			
Cup	0.5	1	2			
Donuts and cake						
Medium	0.5	1	3			
Serving	0.5	1	3			
Pie (serving)	0.6	1.16	1.75			
Cookies (pieces)	2	3.5	6			
Nuts and seeds (cup)	0.25	0.75	1.5			

(continued)

Table 1. Default values for small, medium, and large serving size in audio computer-assisted self-administered diet history questionnaire designed for a cohort of Alaskan Native and American Indian subjects (continued)

Food category	Small	Medium	Large	Small beverage	Medium beverage	Large beverage
Chips and pretzels (cup)	1	2.5	5			
Candy (oz)	1	2	3			
Hot cocoa (cup)	1	1.5	2.5			
Coffee and tea						
fl oz	8	12	20			
Cup	1	1.5	2.5			
Soda (can)	1	1.5	2.5			
Water (cup)	1	1.5	2.5			
Vitamins and minerals (dose)	1	2	3			
Beer (fl oz)	12	30	48	72	144	180
Wine (fl oz)	4	6.5	10.5	18	22	26
Hard liquor (fl oz)	2	3.5	6.5	10.5	17	26

Statistical Methods

All statistical analyses were performed using the SAS statistical package (version 9, SAS Inc, Cary, NC). Age-adjusted mean and standard deviation for nutrients were calculated for the total population, by geographic area, and by sex. We report the distribution of serving sizes selected by sex and by region, and we report dietary diversity captured with the questionnaire. Data from participants who reported fewer than 800 nonalcohol kcal (men) or 600 nonalcohol kcal (women) and more than 8,000 nonalcohol kcal (men) and 6,500 nonalcohol kcal (women) were excluded from nutrient analyses (22-24). We evaluated differences between those whose data were included because they were within the acceptable energy range and those whose data were excluded using the Student *t* test. We evaluated differences in mean across subgroups adjusting for age using analysis of covariance and χ^2 test to evaluate statistically significant differences in proportion. The study was approved by the University of Utah Institutional Review Board, the Alaska Area Institutional Review Board, the Navajo Institutional Review Board, the Indian Health Service Institutional Review Board, and all other participating tribal entities.

RESULTS

The age and sex distribution of the study population was similar to that reported for tribal members from the census in both Alaska and the Southwest (11). Sixty percent of the study population was younger than 45 years of age and 64% were women (Table 2). Approximately 45% had at least some college or technical training beyond high school; 44% were currently married. Only 13.9% of participants came from households of seven or more people. More than half of the population had a body mass index of 30 or more. Eighteen percent of the population reported high nonalcohol energy intake (>8,000 or 6,500 kcal for men and women, respectively) with similar distributions of outliers for Alaska and the Southwest. Participants whose dietary data were at extreme ends of the distribution (>8,000 kcal and <800 kcal for men and >6,500 kcal and <600 kcal for women) were significantly more likely to be younger, male, never married, not currently em-

ployed, and have a lower level of education (Table 2) than those with normal energy intake values. In addition, those who spoke a Native language only were more likely to report extremely high or low levels of energy intake. Although not reaching statistical significance at the 0.05 level, people who reported their health status as either poor or excellent were more likely to report extreme energy intake.

The average number of food items selected was 70 for people with acceptable energy intake and 79 for people with extreme energy intake values (Table 3). The average time to complete the questionnaire did not differ significantly by those with extreme energy intake or by sex. However, older people took longer to complete the questionnaire than younger people ($P<0.01$). Men reported an average of 65.06 food items and women reported 72.31 ($P<0.01$). There was not a significant difference in number of food items reported by age or by region of the country. More people who reported extreme energy intake reported eating a medium or large serving size of foods ($P<0.01$), as did men, younger people and people living in Alaska. People who reported extreme energy values more frequently reported eating foods daily as opposed to monthly or yearly. Similarly, women and participants from Alaska were more likely to report eating foods on a monthly or yearly basis than were men or people living in the Southwestern United States.

DISCUSSION

A DHQ was developed for self-administration to a variety of study participants living in Alaska, the Southwest, and the Plains. The self-administered questionnaire had the advantage of being able to obtain complete information without questions being skipped in a reasonable amount of time (36.4 minutes), with minimal staff time, and with reasonable food item selection (average of 70 food items). The ability to program alerts into the questionnaire enabled more quality control checks than are available on most self-administered questionnaires. In addition, the questionnaire was developed with adequate flexibility to incorporate or omit area-specific foods depending on the study location to maximize comprehensiveness of dietary

Table 2. Description of cohort of Alaskan Native and American Indian people recruited from Alaska and Navajo Centers

Characteristic	All Participants		Acceptable Energy		Extreme Energy		P value ^a
	n	%	n	%	n	%	
Region							
Alaska	2,423	36.7	1,994	82.3	429	17.7	<0.01
Southwestern United States	4,181	63.3	3,313	79.2	868	20.8	
Age							
18-24	1,068	16.2	783	73.3	285	26.7	<0.01
25-35	1,370	20.8	1,068	78.0	302	22.0	
35-44	1,630	24.7	1,323	81.2	307	18.8	
45-54	1,395	21.1	1,136	81.4	259	18.6	
55-64	786	11.9	683	86.9	103	13.1	
65+	355	5.4	314	88.5	41	11.6	
Sex							
Man	2,381	36.1	1,793	75.3	588	24.7	<0.01
Woman	4,223	64.0	3,514	83.2	709	16.8	
Education							
<High school	1,475	22.5	1,060	71.9	415	28.1	<0.01
High school	2,157	33.0	1,671	77.5	486	22.5	
Vocational/technical or some college	2,530	38.9	2,172	85.9	358	14.2	
College graduate	383	5.9	357	93.2	26	6.8	
Marital status							
Married	2,916	41.2	2,417	82.9	499	17.1	<0.01
Separated/divorced	1,347	20.4	1,132	84.0	215	16.0	
Never married	2,329	35.3	1,747	75.0	582	25.0	
Household size							
<3	2,778	42.1	2,278	82.0	500	18.0	<0.01
4-6	2,911	44.1	2,333	80.1	578	19.9	
>7	915	13.9	696	76.1	219	23.9	
Nonalcohol energy							
>8,000 men or >6,500 kcal women	1,211	18.3	NA ^b	NA	NA	NA	NA
<600 kcal men or <800 kcal women	86	1.3	NA	NA	NA	NA	NA
Body mass index							
<25	1,338	20.3	1,011	75.6	327	24.4	<0.01
25-29.9	2,151	32.7	1,774	82.5	377	17.5	
≥30	3,091	52.6	2,504	81.0	587	19	
Language spoken at home							
Both Native and English	3,027	46.3	2,397	79.2	630	20.8	<0.01
English only	2,917	44.6	2,403	82.4	514	17.6	
Native only	593	9.2	454	76.6	139	23.4	
Employment							
Employed during the past year	3,033	46.0	2,527	83.3	506	16.7	<0.01
Not employed during the past year	3,563	54.0	2,772	77.8	791	22.2	
Health status^c							
Excellent	596	9.1	461	77.4	135	22.7	0.06
Very good	1,451	22.1	1,176	81.1	275	19	
Good	2,771	42.2	2,246	81.1	525	19	
Fair	1,502	22.9	1,210	80.6	292	19.4	
Poor	240	3.7	180	75.0	60	25	
Time to complete diet history questionnaire^d							
	1,556	36.4±12.6	1,252	36.1±12.4	304	37.7±13.6	0.06

^aFor difference between participants included and excluded because of amount of energy reported.

^bNA=not applicable.

^cSelf-reported health status as reported on short-form 12-item questionnaire (21).

^dRestricted to 36% of subjects from the Southwestern United States.

Table 3. Description of food items selected by Alaskan Native and Native American study participants stratified by sex, age, region, and whether they reported reasonable energy intake (included) or reported unreasonable energy intake (excluded)

Description	All excluded	All included	Men included	Women included	<50 y included	≥50 y included	Alaska included	Southwest included
n	1,297	5,307	1,793	3,514	3,902	1,405	1,994	3,313
Mean no. of food items selected	79	70	65	72	70	70	69	70
<i>P</i> value ^a	<0.01		<0.01		0.75		0.35	
Serving size selected (%)								
Small	25.9	41.2	29.7	46.5	39.5	46.0	35.7	44.5
Middle	51.7	48.9	55.0	46.2	49.8	46.5	52.3	46.9
Large	22.4	9.9	15.3	7.3	10.7	7.6	12.0	8.6
<i>P</i> value	<0.01		<0.01		<0.01		<0.01	
Foods selected by frequency (%)								
Daily	21.5	9.3	9.8	9.1	8.9	10.4	8.6	9.7
Weekly	42.9	33.9	37.6	32.2	33.8	34.2	32.7	34.5
Monthly	30.6	47.4	45.0	48.5	47.8	46.1	46.5	47.9
Yearly	9.5	9.5	7.7	10.3	9.5	9.3	12.2	7.8
<i>P</i> value	<0.01		<0.01		<0.01		<0.01	
Participants with complete food information (%)								
Yes	99.9	99.9	99.9	99.8	99.9	99.7	100.0	99.8
No	0.2	0.2	0.1	0.2	0.1	0.3	0.0	0.2
<i>P</i>	0.98		0.60		0.13		0.03	
Time to complete questionnaire^b (mean min±standard deviation)								
Average	37.8±13.6	36.1±2.4	36.3±13.3	36.0±11.9	34.1±11.1	41.7±13.9	—	—
<i>P</i> value	0.06		0.75		<0.01		—	

^aCalculated from χ^2 differences in proportions and from *t* test for continuous variables.

^bData restricted to 36% of Southwestern United States participants. Numbers are for everyone (n=1,247), men (n=423), women (n=824); <50 y (n=919); ≥50 y (n=333).

intake reported while minimizing the time of interview. Unusually high energy intakes (>8,000 kcal) were reported by almost 20% of participants suggesting that additional instructions or assistance may be necessary for some individuals. The DHQ presented here is currently being validated.

Our results show comparability between the two centers in terms of nutrient intake and average number of food items selected. The primary difference was that participants from Alaska were more likely to select yearly consumption of foods than were participants from the Southwest. This result suggests greater seasonal variability in food availability between the two regions or a different cultural framework for reporting these foods. Alaskan Native people reported more subsistence foods than American Indian people living in the Southwest, which could help explain this difference.

A major challenge in reporting dietary intake data is estimation of the quantity of foods eaten (8,25,26). In this study, individual pictures for each serving size were designed for specific foods to make the questionnaire more visually appealing. Most participants selected the middle serving size, although an almost equal proportion of women and older individuals selected the small serving size for some foods. Men and younger individuals were more likely to report consuming the large serving of food items than women and older individuals; even so, a large portion size was reported for less than 10% of the items. Others comparing picture vs nonvisual serving size (27)

and digital vs direct portion size (28), observed similar estimations of portion size regardless of method used to obtain portion. Variation in serving size selected shows that most individuals gave thought to their actual serving size and chose their responses accordingly. Nonetheless, those who reported very high energy intake (>8,000 kcal for men and >6,500 kcal for women) were more likely to select a larger serving size.

Inaccurate reporting of dietary intake is a major concern when collecting dietary information. Attempts to classify people by their inaccurate reporting have generally looked at energy intake as a key to poor reporting. High or low energy intake has generally been explored in specific groups within the population like the elderly (29). In this study we had few underreporters based on total energy intake. However, roughly 18% of the population reported dietary intakes that we viewed as improbable based on the high number of nonalcohol kilocalories (>8,000 kcal for men and >6,500 kcal for women). Other studies conducted in Alaska suggest that energy intake is high (15). We identified two groups of people who had difficulty reporting their diets. The first group included younger men and unemployed people who may have paid less attention to instructions or participated in the study because of incentives that included small gifts and small amounts of money to reimburse for travel. The second group of participants included those with a lower level of education and those who spoke their Native language at home; the second group could have

benefited from additional instructions or help. It is difficult to compare these results with those from other studies because most reports do not report the characteristics of over- and underreporters. Unlike most self-administered questionnaires, our participants had to complete an item before moving to the next question. Therefore, we had complete food records for all study participants. Because our DHQ questionnaire was developed with an audio computer-assisted interview to be self-administered, data comparable to those presented here are not available from other studies.

Inaccurate reporting of dietary intake is a major concern when collecting dietary data information.

Understanding the characteristics of reporters of improbable diets can be used to provide better instructions. Instructions that focus on the elements of the DHQ, including food selection, serving size, and frequency of consumption, need to be carefully reviewed. It is possible that individuals who reported extreme energy per day may have reported a summary serving for all of a food eaten throughout the day rather than usual serving consumed at each time. Reducing reporting errors through built-in alerts for improbable answers can be useful in the computerized questionnaire. The program is currently set for alerts to appear only after very high reporting. Additional alerts may identify overreporting errors as they occur.

The computerized DHQ developed for use in the American Indian and Alaskan Native cohort study can be completed by most study participants with minimal time and assistance. The respondent burden was reasonable in terms of time needed to complete the questionnaire compared to the lengthy time required for most interviewer-administered DHQs. Validity and reliability of dietary data are currently being assessed and will provide further insight into the quality of the dietary data obtained from this DHQ. Because the questionnaire is self-administered on a computer, it has potential applicability to Web-based data collection as well as other situations where computers are used to collect data.

This study was funded by grants CA88958 and CA96095 from the National Cancer Institute. The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official view of the National Cancer Institute.

The authors thank the Navajo Nation, the Indian Health Service; the Alaska Native Tribal Health Consortium Board of Directors; Southcentral Foundation; Southeast Alaska Regional Health Consortium; the Yukon-Kuskokwim Health Corporation; the Ft Defiance and Shiprock Health Boards; Franklin Freeland, PhD; Richard Champany, DDS; Ruth Etzel, MD; Joseph Klejka, MD; Kari Lundgren, PA-C; Cindy Schraer, MD; Tribal Advisory Board Members Beverley Pigman, George Ridley, Ileen Sylvester, Tim Gilbert, PhD, and Fritz George; the staff of the Navajo Nation, including

Clarina Clark, Amy Rogers, and Carmen George; and the staff in Alaska, including Diana Redwood, Jason Sandidge, Gretchen Ehrsam Day, Katie Rose Hulett, Sharon Lindley, Cheri Hample, Maybelle Filler, Antoinette Thompson, and Jayleen Wheeler. The authors also thank James Bryner and Kelly Cunningham for computer programming, and KheNi Ma for statistical analyses.

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