Research Editorial

American Indian Diets and Nutritional Research: Implications of the Strong Heart Dietary Study, Phase II, for Cardiovascular Disease and Diabetes

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This editorial review focuses on nutrition as a factor for the rise of American Indian cardiovascular disease (CVD) and diabetes. Based on the Strong Heart Dietary Study, Phase II (SHDS-II), Stang and colleagues (1) found that nutrient intakes varied little between the three American Indian populations in Arizona, Oklahoma, and the Dakotas and the national averages of the third National Health and Nutrition Survey (NHANES III). Although they recommend increases in dietary intake of B vitamins, antioxidants, and nutrients to reduce CVD, the dietary data did not account for the dramatic increase in heart disease or diabetes. Building on these findings, this editorial suggests new research questions, methodological refinements, and policy implications for future nutritional research.

The Strong Heart Study (SHS) provides a unique opportunity to understand the role of a wide range of factors for American Indian health. Many published reports from the SHS have appeared in the literature over the past decade. The study by Stang and colleagues primarily reports on dietary data collected during Phase II of the Strong Heart Study conducted in 1993-1995. The authors compare these data to dietary intakes of a national cohort of similarly aged adults who participated in the NHANES III, Phase I, which occurred at approximately the same time as the SHDS-II.

This editorial review places the work of Stang and colleagues into the larger context of American Indian health and diet, the longitudinal studies of the SHS, and the social history of indigenous peoples of the Americas. Throughout, there are suggestions for new research questions and methodological refinements for future nutritional research. The focus is on three primary areas: (a) nutrition as a factor in CVD and its comorbidities, (b) cultural and methodological issues for future studies of American Indian diets, and (c) practical implications for nutritional science.

American Indians have been relatively free from CVD compared with other populations. In the mid-1980s, for the first time since data were collected, heart disease mortality rates for Indians aged 45 to 64 years exceeded those for same-aged persons in the US all-races population (2-4). This increase prevalence heightens the importance of studies attempting to understand the American Indian lifestyles, environments, and genetic risk factors for CVD.

Reporting on Phase II of the Strong Heart Study (SHS) in this issue of the *Journal*, Stang and colleagues discuss the dietary intakes of nutrients thought to modify the risk of CVD among members of 13 tribal nations in three regions of the United States: North and South Dakota, Arizona, and Oklahoma (1). Arizona is represented by the Pima/Maricopa Indians living along the Gila River. For Oklahoma, the tribes are the Plains Apache, Fort Sill Apache, Caddo, Comanche, Delaware, Kiowa, and Wichita of southwestern Oklahoma. The Dakotas are represented by the Pine Ridge Oglala, the Cheyenne River Sioux in South Dakota, and the Spirit Lake Sioux in North Dakota (5).

The SHS is the first large, standardized, and longitudinal study devoted specifically to American Indian health. Clinical examinations and interviews provided data on a wide array of health issues. The sample was designed to be representative of the populations between ages 45 and 74 years (6). Initially conducted in 1989-1991, the Strong Heart Study, Phase I (SHS-I) was followed 4 years later in 1993-1995 by Phase II (SHS-II) (6). With cooperation of the tribal nations, and the Indian Health Service, 88% of the surviving cohort was followed up in Phase II. Phase II included 3,638 of the 4,549 Phase I participants. The dietary component known as the *Strong Heart Dietary Study Phase II* (SHDS-II) includes 3,482 or 96% of the total Phase II participants. This notably high participation rate makes the results of this study even more valuable for the American Indian community and their future health.

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Table. Comparison of male energy intakes (kcal) in Phase I and Phase II of the Strong Heart Study

	Arizona		Oklahoma		Dakotas	
	Mean kcal (±SD[a])	Median kcal	Mean kcal (±SD)	Median kcal	Mean kcal (±SD)	Median kcal
Phase I[b] 1989-1991	1,958 (987)	1,735	1,831 (1,015)	1,311	1,873 (1,183)	1,635
Phase II[c] 1993-1995	1,907 (913)	1,765	2,067 (938)	1,947	1,942 (1,012)	1,777

[a]SD=standard deviation.
[b]Data from: Zephier EM, Ballew C, Mokdad A, Mendlein J, Smith C, Yeh JL, Lee E, Welty TK, Howard B. Intake of nutrients related to cardiovascular disease risk among three groups of American Indians: The Strong Heart Dietary Study (page 513, Table 4). *Prev Med.* 1997;26:508-515.
[c]Data from: Stang J, Zephier EM, Story M, Himes JH, Yeh JL, Welty T, Howard BV. Dietary intakes of nutrients thought to modify cardiovascular risk from three groups of American Indians: The Strong Heart Study, Phase II (Table 2). *J Am Diet Assoc.* 2005;105:1895-1903.

NUTRITION AS A FACTOR IN CVD AND ITS COMORBIDITIES

Stang and colleagues report a number of significant findings. Males consumed greater amounts of energy and nutrients, and energy and fat intakes decreased with age. Carbohydrate and sodium intakes were higher among participants compared with NHANES III estimates. Most importantly for understanding risks for CVD, Stang and colleagues identified low intakes of folate and vitamins A and C for women and vitamins A, B-6, and E for men. Overall, few differences in dietary intake were noted among the three regional populations and between the SHDS-II participants and the national averages for the NHANES III participants. Stang and colleague's most notable conclusion is that energy intake differences between NHANES III and SHDS-II participants are not consistent with the dramatic increase in CVD and associated comorbidities of the participants. Energy intakes (kcal) for males were lower then the NHANES III cohort, yet rates of obesity were significantly higher among SHDS-II participants. For women, energy intakes were similar between SHDS-II and NHANES III; however, rates of obesity among SHDS-II women were more then twice as high. Simply stated, these dietary data do not account for the dramatic increase in heart disease, obesity, or diabetes.

The Strong Heart Study provides a unique opportunity to understand the role of a wide range of factors for American Indian health.

A longitudinal perspective on energy intake can be gained by combining Stang and colleague's findings with the earlier publications on Phase I of the SHS, especially Howard and colleagues, who reported on the prevalence of CVD (3), and Zephier and colleagues who reported on the nutrient intakes related to CVD (6). The Table compares the energy intakes of males in Phase I and II. Both phases reported less energy consumption compared with the national averages of NHANES III participants (6). The mean for NHANES III, Phase I men was 2,254 kcal, whereas the SHDS Phase I American Indian men consumed a full 300 to 400 kcal less then the national average. Phase II kilocalories were slightly greater than Phase I; however, they were still lower than the NHANES III, Phase I mean. Stang and colleagues do not report the mean and median for the total study population. Based on the three-region data reported, Phase II men consumed a mean of 1,972 kcal compared with the 2,254 kcal NHANES III, Phase I men. This estimate indicates that, on average, the American Indian men consumed approximately 12% fewer kilocalories of food then the national average. For women, energy rates were similar to NHANES III, Phase I.

This analysis reveals a critical question. The three American Indian populations consumed 12% fewer kilocalories than the average US population over this 4-year time period, yet the study population significantly gained in CVD and diabetes. Both Stang and colleagues and Howard and colleagues in the SHS Phase I (3) associate the increasing rates of CVD with the exceedingly high rates of diabetes in these American Indian communities. Obesity, because of the overconsumption of energy and low activity levels, has been considered a strong predictor of diabetes and related vascular disorders since West's multinational studies in the 1970s (7). From the Table, we can see that, on average, male energy consumption increased from Phase I to Phase II. Arizona males decreased 51 kcal, whereas Oklahoma increased 236, and the Dakotas increased 69 kcal. These small changes in energy intake do not explain the astounding increases in CVD and diabetes. Welty and colleagues (8) report that, for all the study participants in the 4 years from SHS Phase I to Phase II, the prevalence of definite hypertension increased from 7% to 9%; diabetes increased from 6% to 12%. The total percentage of women with diabetes increased from 52.7% to 61.3% of the entire population. In other populations with advancing age over 60 years, there are small decreases or no change in BMI (9). For the entire SHS II cohort, weight, body mass index (BMI), and percentage body fat decreased slightly from Phase I to II. However, this can be accounted for by the significant weight loss of the large number of participants with diabetes who lost a mean of 1.9 kg. Those with normal glucose tolerance had a significant mean weight gain of 1.4 kg (8). Nondiabetics continue to gain weight even though they consume fewer kilocalories than the NHANES III participants.

These data indicate the importance of variables other than dietary energy intake in explaining the increasing rates of CVD and its comorbidities among American In-

dians. Low activity levels and genetics should be considered, as should new theories such as prenatal malnutrition (10) or historical trauma (11). SHDS-II participants 45 years and older reflect the morbidity results of decades of dietary intakes. With onset of diabetic-related morbidities at 30 and 40 years old, body weights then usually level or decrease. This suggests future studies using SHS dietary data controlling for diabetic, nondiabetic, and new onset diabetics. Alcohol intake could also be further studied because moderate alcohol intake can reduce risk for CVD, whereas greater amounts reduce bioavailability of B vitamins including folic acid.

Over the past 20 years, aggressive intervention programs have been implemented in Indian Health Services clinics. Large portions of their budgets go to diabetes-related programs such as nutrition education, the most costly of which is kidney dialysis. The rise in CVD since the 1980s may be the outcome of better health management programs that reduced morbidity and mortality from diabetes-related disorders, such as renal disease, gangrene, and others. With these disorders under better control, the survivors may be exhibiting other chronic conditions and less fatal diabetes-related complications, resulting in increased prevalence of CVD.

CULTURAL AND METHODOLOGICAL ISSUES FOR FUTURE STUDIES OF AMERICAN INDIAN DIETS

Stang and colleagues have made a significant contribution by documenting nutrient intake estimates at the aggregate group level related to the risks for CVD. This is one of the most important roles for the nutritional sciences. An additional role of nutrition research is to report on the actual foods contributing to the higher or lower intakes of the nutrients identified for CVD risk. Future studies using the SHS dietary interview data could report on the similarities and differences in the actual foods reported. In this way, the benefits derived from this costly, large scale, and longitudinal study would be even more understandable and useful to American Indians, nutrition educators, and health professionals.

To enhance the usefulness to American Indian people and other ethnic groups, future nutrition research needs to develop and refine more focused and culturally specific research methods that can account for traditional foods, traditional food categories, seasonality, composite foods, and variety of food preparation methods. Subsistence and traditional foods confound the measures in the 24-hour recall instruments standardized on non–American Indian populations. When nutrition data are reported on the basic components of vitamins, protein, and carbohydrates based on the US Department of Agriculture (USDA) National Nutrient Data Bank (12) and compared with Dietary Reference Intakes (13), or NHANES III, it not surprising that Stang and colleagues report few differences in dietary intake between the national averages and the American Indian diets. Most of the foods consumed by American Indians are from the same multinational food corporations distributing food products to all Americans and, increasingly, the world. The global food distribution system's effect on homogenizing local dietary intake is well documented in this study.

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A cultural and historical context is necessary to understand American Indian diets and CVD. In the 1860s and 1870s, the Pima of the Southwest, the Kiowa and Comanche of the Southern Plains, and the Dakota of the northern Plains were forced militarily to live on the reservation lands least desired by white settlers and much smaller than their original subsistence areas. Once on reservations, Christian missionaries and US military agents forced them to lose their language, religion, and traditional political systems. They were greatly restricted in their use of the natural environment and the plants and animals that were the basis of their subsistence economy and ways of life (14). In near-starvation conditions, the US government began providing food rations consisting primarily of cattle for meat, flour, bacon, salt, sugar, coffee, and lard. Food and cooking utensils were contracted from private companies and shipped long distances via trains and wagons. It was routine for rations to arrive irregularly and in poor condition. Children were removed from their families and stayed 9 months of the year in distant boarding schools at which they ate "white man's" foods; males were taught agricultural skills, and girls were trained in kitchen and cooking skills. Rations were withheld from families who continued to practice traditional dances, religion, and medicine. Not until the 1940s did American Indians transition from undernutrition to overnutrition. During the 1930s and 1940s, a shift occurred from self-produced agricultural foods to a cash economy and the purchase of store-bought processed foods. In Oklahoma, this is evidenced by a demographic change from homes on dispersed farmsteads to homes along roads and the further reduction of activity levels by a technological transition from walking and horse-drawn wagons to riding in cars and trucks. Diabetes was unknown among Oklahoma Native Americans prior to 1940, yet, with this transition to modernization, we see the increase of diabetes and associated vascular disorders (15,16). Since then, government food commodity programs, never meant as a complete diet, continue to influence greatly their food choices. Given this cultural and dietary history, it is not surprising that nutritional studies will find American Indians using the basic food products common to most Americans. It is from these basic food products now provided through multinational companies and global commodity chains that American Indians in the continental United States prepare and cook their foods. Their diets reflect this history of resource disenfranchisement and modernization, yet tribal cooks still consider certain foods as "Indian." The way these basic food products are combined and prepared makes them American Indian foods.

Standardized surveys and methods lack the cultural sensitivity to capture tribal food distinctions; thus, American Indian diets are being lost from the scientific record.

The predefined categories in the 24-hour recall survey instruments and associated databases are designed to report on nutrients and food groupings. Survey respondents report what they ate; however, this information is then categorized and standardized using a database with estimated nutritional values. To capture subsistence and traditional foods, additional food items need to be added to the standardized interview schedule and database. The USDA is now collecting and analyzing food samples from selected reservations and Alaska communities. The USDA American Indian/Alaska Native Foods Database is planned to be available in 2006 (17). It is not apparent from Stang and colleagues, nor the two cited methods articles, how traditional foods were accommodated (5,6).

American Indian nutrient intakes appear similar to the national norms. One possible reason could be due to the research process not accounting for tribal and cultural distinctions. To be more useful to American Indian people, nutrition research needs to develop more focused and culturally specific research methods that can account for traditional foods, traditional food categories, composite foods, and variety of food preparation methods.

Standardized surveys and methods lack the cultural sensitivity to capture tribal food distinctions; thus, American Indian diets are being lost from the scientific record.

The three American Indian regions included in this study have similar yet different diets, food beliefs, and behaviors. The recognition of American Indian food categories and beliefs are an important way to design more culturally specific and thus more valid dietary collection methods. The respondents' language and traditional food categories influence the recording of diets at the interview point of data collection, thereby influencing the nutrient analysis derived from the data. Working with the Sandy Lake Cree, Gittelesohn and colleagues found that local concepts of food and illness dichotomized into "Indian" and "white man's" groupings, with "Indian" foods perceived as healthful and "white man's" foods as unhealthful (18). A similar dichotomy of "white man" and "Indian" foods is part of the Dakota belief systems (19), as it is for the Pima (20). Garro's refinement of cultural consensus methods is useful for American Indian food and disease categories (21).

An example of a composite food that is a challenge for nutrition researchers is "fry bread," a food item pervasive among American Indians throughout North America (22). Ballew and colleagues report on the challenge of the Navajo Health and Nutrition Study's interviewers to elicit detailed descriptions of each reported Navajo taco (23). Indian fry bread, like pizza, is an example of emerging local foods that combine and recombine global food products into complex composite meals confounding nutritional surveys.

Seasonality is another issue confounding nutrition surveys. The SHDS-II is based on one 24-hour dietary recall interview for each participant conducted Monday through Friday. Only the Navajo had year-round interviews; the other two sites only interviewed in the summer—June to September (6). The reliance on a single data collection period limits the understanding of annual seasonal variations in food consumption. Not only is there seasonality in the harvest of foods, which influences the kinds of fresh fruits and vegetables available, but, in northern climates, the seasons affect the costs of food, transportation, storage, and shelf life. Combined with the remoteness and the small size of reservation stores, these seasonal factors limit the variety of food available at any one time. Seasonality is of special importance when trying to understand tribal communities that grow their own food, hunt, or fish. Subsistence hunting and fishing continues to be a major portion of the diet in Alaskan tribal communities. Using 24-hour recalls and the Block Food Frequency Tool (24) in five Alaskan communities, we found that these survey instruments do not capture subsistence foods that are harvested and consumed during a very short period of time in the year (25). Seasonality is also imposed by federal and state hunting and fishing laws, further limiting the fresh foods on which subsistence-based communities rely. These seasonal peaks in subsistence food resources are averaged out during the statistical analysis of 24-hour recall surveys, especially if the surveys are conducted a few at a time throughout the year or all at one time. Taylor and colleagues' identification of core and secondary foods is a promising way to focus on the important foods in American Indian diets (26).

Seasonality of the quantity and quality of American Indian food consumption is also influenced by the timing of their religious and ceremonial cycles. Many of these occur on weekends. When 24-hour recall interviews are conducted Monday through Friday, the consumption of food at these tribal events would be recorded only on Mondays. Sun dances, sweat lodges, and church meetings are focal points of Dakota communities (27). Likewise, the Kiowa, Comanche, Caddo, and Delaware of Oklahoma are the originators of the Native American Church, the largest intertribal religion in the United States and Canada. These are not only religions, they are also health care delivery systems (28). Both Dakota and Oklahoma tribal members are key leaders of the intertribal powwows celebrated throughout the country. Each of these traditions considers food to be sacred. At their annual or weekly gatherings, food is a major focal point. Food not consumed is taken home, thereby serving as a community food distribution system. These annual and weekly cycles of food consumption and redistribution could be better recorded with culturally sensitive nutritional methods that take weekly and seasonal variations into consideration.

The way American Indians prepare and cook food varies from tribe to tribe; some prefer fried food, whereas others prefer boiled, pressure-cooked, or even microwave-cooked food. Researchers should take care in the assessment of American Indian food preparation methods when utilizing the standardized 24-hour recall instruments. More research in this area would provide insight on what impact these differences may have on American Indian health.

With the rapid modernization and globalization of food

products, nutritional methods need to differentiate among locally produced and prepared foods rather than reducing them to commonalities of mere nutrients (29). Documenting nutrient intake estimates related to the risks for CVD is one of the most important roles for the nutritional sciences. An additional role of nutrition research is to report and analyze the similarities and differences of what foods were actually consumed; in this way, the benefits derived from the large scale, longitudinal, and costly Strong Heart Study would be even more understandable and useful to American Indians, nutrition educators, and health professionals.

PRACTICAL IMPLICATIONS FOR NUTRITIONAL SCIENCE

American Indian communities are increasingly challenging the usefulness of scientific research. After a quarter century of diabetes research, the Pima are publicly questioning how all this "scientific" research has benefited them. Many researchers' careers and their institutions have benefited, and knowledge of diabetes has grown, but the epidemic continues to affect the daily life of the Pima (30,31). In this community, with the world's highest diabetes prevalence, Kozak characterizes the Pima's predominate perception as "surrendering to diabetes." Diabetes is "inevitable," "uncontrollable," "inherited," and eventually "fatal" (32). A widespread explanation among American Indians for diabetes, CVD, and related "white man diseases" is that they are because of "Historical Trauma"—the long history of domination and oppression. Identity crises, demoralization, and on-going emotional traumas are considered the result of multiple generations of historical trauma. Similar to posttraumatic stress syndrome, the Lakota Maria Yellow Horse Brave Heart maintains that historical trauma results in diabetes and an array of white man diseases (11). Although this may be uncomfortable to non–American Indians, it is an emerging explanation being considered by American Indian health professionals. It is of utmost importance that nutrition researchers make it their responsibility to take special efforts to ensure that their findings are accessible and usable by the communities they use for scientific research.

Stang and colleagues focus the implications of their CVD research on nutrition education, counseling, marketing, and public education. They suggest education and counseling on ways to increase dietary intake of B vitamins, antioxidants, and nutrients, as well as increasing fruit, vegetables, whole grains, and traditional tribal foods. At the community level, social marketing campaigns or other public education programs should be developed and distributed to tribal communities.

American Indian health care providers and nutrition educators have actively pursued ways to educate and counsel American Indians on health and diet for decades. A focus on the individual patient through dietary education and counseling in the clinical setting is not making a large difference in reducing these health disparities. Onset of diabetes is now occurring in American Indian children. American Indian people face extreme poverty, unemployment, and environmental pollution of the soil and water (33). American Indians on reservations and in remote communities do not have a wide array of food choices enabling them to change their diets, even if they so chose.

The effects of social history on the etiology and epidemiology of CVD and diabetes must be considered within the American Indian experiences of cultural expansionism and colonial occupation. Contemporary daily life of American Indians continues to be greatly affected by access to affordable and quality food. Food is absolutely necessary for a healthful lifestyle; it greatly influences emotional experiences and is at the crux of the networks of community identity, spirituality, and wellness. By working closely with tribal communities, scientists can empower American Indians to regain control of their health, spiritual knowledge, and emotional liberty. American Indian communities are beginning to develop innovative programs to promote physical and emotional wellness. Gittelsohn and colleagues provide a model for community level nutrition involvement by weaving together indigenous beliefs and practices with those of biomedical practitioners (18). Working with the Sandy Lake Cree, an Ojibwa-Cree community in northern Ontario, the authors used applied ethnographic research for understanding the belief systems that affect activity and dietary behaviors. Ferreira and Lang's anthology also includes several models of community programs that incorporate tribal perspectives regarding access to good food, respect for cultural traditions, and integrative therapies as basic human rights (34).

Contemporary daily life of American Indians continues to be greatly affected by access to affordable and quality food.

Nutritionists at the local policy level can influence companies, stores, government agencies, schools, university dormitories, cafeterias, and other organizations to make wise decisions affecting the availability of quality food and drink and the daily activity of people through the design of buildings, gardens, and recreational areas. At the community level, there is a need to address the underlying societal causes through a transformation of thinking about transportation, environment, work facilities, education, health, and food policies, as well as social and economic policies. One of the greatest challenges is that these efforts require coordinated action from all relevant sectors of the nation, society, and local community (35). At the national and state level, nutritionists can influence policies that enable dependent sovereign Indian Nations access to land and water resources for traditional subsistence farming, ranching, hunting, and fishing. At the population level, the global epidemic of obesity, which increases the risk of CVD and diabetes, reflects a set of profound societal changes including modernization, economic transition to market economies, urbanization, changing occupational structures, and globalization of food markets. Recognition of these structural transformations is necessary for understanding the decrease in physical activity and overconsumption of energy-dense, high-fat foods that fall short in micronutrients.

By not attending to the environmental and structural changes needed to encourage and support behavior

change, an overreliance on individual dietary education has occurred. Also evident is the lack of commitment to action from all relevant sectors of society. Change can only be accomplished with a multisectorial and broad-based public health approach to prevention (35).

By promoting the positives of "healthy communities" and by addressing the necessary structural changes, rather than the negatives of "disease prevention," and "individual regimens," American Indian community empowerment could reduce the pandemic of chronic diseases associated with the industrial lifestyle (36). Although it is imperative that diet and CVD risk be emphasized in nutrition education and counseling of American Indians, it is critically important that efforts be focused on the larger issues: (a) empowering tribal communities and leadership with nutritional knowledge presented in understandable and culturally appropriate ways; (b) increasing the number of American Indians in health professions, including nutrition; (c) influencing accessibility to economic and healthful choices of foods in community stores; (d) collaborating with church cooks and tribal religious leaders; (e) enhancing activity levels with design of transportation systems, work, and exercise facilities; (f) promoting the redevelopment of traditional subsistence farming, gardening, ranching, hunting, and fishing; and (g) coordinating actions and policies with the relevant sectors of the national, state, and local community.

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