Food Insecurity and Chronic Diseases Among American Indians in Rural Oklahoma: The THRIVE Study

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Objectives. To examine food insecurity and cardiovascular disease–related health outcomes among American Indians (AIs) in rural Oklahoma.

Methods. We surveyed a cross-sectional sample of 513 AI adults to assess food insecurity domains (i.e., food quality and quantity) and obesity, diabetes, and hypertension.

Results. Among AIs surveyed, 56% reported inadequate food quantity and 62% reported inadequate food quality. The unadjusted prevalence of diabetes (28.4% vs 18.4%), obesity (60.0% vs 48.3%), and hypertension (54.1% vs 41.6%) was higher among participants with inadequate food quantity than among those with adequate food quantity. These associations did not reach statistical significance after adjustment for age, gender, study site, education, and income. The unadjusted prevalence of obesity (60.7% vs 45.8%), diabetes (27.3% vs 18.8%), and hypertension (52.5% vs 42.5%) was higher among those with inadequate food quality than among those with adequate food quality, even after adjustment for age, gender, study site, education, and income.

Conclusions. Tribal, federal, and state policymakers, as well as businesses and nonprofit organizations, must collaboratively take aggressive action to address food insecurity and its underlying causes, including improving tribal food environments, reducing barriers to healthy foods, and increasing living wages. (*Am J Public Health.* 2017;107:441–446. doi: 10.2105/AJPH.2016.303605)

See also Galea and Vaughan, p. 363.

Food insecurity is defined as the limited or uncertain availability of nutritionally adequate and safe foods.[1] In 2014, approximately 14% of households in the United States experienced food insecurity,[2] and studies report that these rates are even higher within American Indian (AI) communities. Using data from the 2000–2010 Current Population Survey, we examined food insecurity among AIs living on and off reservations and found that, during this period, nearly 30% of AI households experienced food insecurity compared with 16% of non–AI households.[3] Our analysis of California Health Interview Survey data found that 38.7% of AIs in California were food insecure.[4] Other studies have found that food insecurity is as high as 43% among reservation households in Montana and South Dakota.[5,6]

Poverty is closely connected to food insecurity[7]; however, several studies have shown that, even after adjusting for income, food insecurity remains an independent risk factor for chronic disease.[8–12] Data from the National Health and Nutrition Examination Survey found that food-insecure participants were twice as likely as food-secure participants to be obese and more likely to have diabetes, even after adjusting

for body mass index.[9,12] Low-income diabetic adults in food-insecure households also had poorly controlled diabetes more often than did their food-secure counterparts (70% vs 46%).[12] Children who are food insecure are also more likely to be overweight and obese.[13,14]

Food assistance programs, such as the Supplemental Nutrition Assistance Program (SNAP) and the SNAP for Women, Infants, and Children (WIC), alone do not substantially improve food insecurity.[3–5] Furthermore, participation in the US Department of Agriculture's Food Distribution Program on Indian Reservations, a monthly program that provides canned and packaged commodity foods to tribal communities with limited access to SNAP, has been thought to create unhealthy food preferences and diet-related diseases within AI communities.[15,16] Our own study examining the redemption rates of WIC cash value vouchers provided to WIC recipients to encourage vegetable and fruit intake found that reservation-based WIC clinics had significantly lower cash value voucher redemption than did non–reservation-based clinics.[17] Furthermore, the presence or absence of a supermarket or grocery store on or near the reservation did not influence cash value voucher redemption rates. This finding suggests that deeper social–environmental

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factors—such as cultural and social norms, food preferences, and even discriminatory practices by non-AI store owners, who community members report often raise prices for AIs, refuse to look up SNAP- and WIC-eligible foods, and even refuse to sell to AIs—may contribute to AI food insecurity.[18]

Although growing evidence suggests that AIs experience food insecurity at substantially greater rates than do non-AIs, few or no studies have assessed the association between food insecurity and obesity, diabetes, and hypertension among AIs, despite rates of these conditions that exceed those of other racial/ethnic groups.[19] The Tribal Health and Resilience in Vulnerable Environments, or THRIVE, study, which is funded by the National Heart, Lung, and Blood Institute, is a randomized control trial of "healthy makeovers" in tribally owned and operated convenience stores in the Chickasaw Nation and Choctaw Nation of Oklahoma. The study aims to increase healthy food access and availability in rural tribal communities, with a primary outcome being the increase of vegetable and fruit intake among AIs in rural Oklahoma. We have reported survey findings from the first aim of the THRIVE study to assess food insecurity and prevalence of obesity, diabetes, and hypertension among AIs in the Chickasaw Nation and Choctaw Nation of Oklahoma.

METHODS

A community-based participatory research orientation guided all aspects of our study. A 23-member steering committee guided this tribal–university partnership, which was initiated in 2012. The steering committee comprised university researchers with previous experience conducting community-based participatory research (n = 5) and key stakeholders from both tribes who represented a range of tribal service sectors, including health promotion (n = 3), nutritional and clinical services (n = 6), tribal institutional review boards and research divisions (n = 4), and tribal economic (n = 3) and tribal marketing divisions (n = 2). Members of the steering committee met in person monthly or more often throughout the study at tribal facilities. At various times throughout the study, additional stakeholders, including

government leadership, attended select meetings to provide consultation and guidance. The development of partnership processes and study methods were informed by partners' previous community-based participatory research with tribes in Oklahoma and elsewhere.[20]

To inform the development of this baseline survey, the principal investigator, a Choctaw Nation citizen and the lead author of this article (V. B. J.), presented key questions from various national health surveys such as the 18-item US Department of Agriculture Household Food Security Survey[21] and the national Behavioral Risk Factor Surveillance Study[22] as well as surveys from smaller studies conducted with other AI communities. Survey questions were discussed and selected on the basis of existing standardized questionnaires, modified in language or in length if necessary, to be implemented within both nations.

Setting

The Chickasaw Nation and the Choctaw Nation of Oklahoma, both located in the southeastern portion of Oklahoma, are similar in size, population, and rurality. The Chickasaw Nation occupies 7270 square miles (~10% of the area of Oklahoma), with a total population of 277 416, of whom 32 312 (12%) are AI.[23] The Choctaw Nation of Oklahoma occupies 10 602 square miles (~15% of the area of Oklahoma), with a total population of 224 472, of whom 39 984 (18%) are AI.[23] These tribal nations, once reservations, are now classified as Tribal Jurisdictional Areas by the US government.

Poverty rates for all residents of the Chickasaw Nation (15.3%) and the Choctaw Nation of Oklahoma (20.7%) are higher than is the national poverty rate of 13.8%.[23] In 2014, the Choctaw Nation of Oklahoma was designated 1 of 20 "promise zones" by President Barack Obama. This initiative provides federal support to high-poverty communities to create jobs, increase economic activity, improve educational outcomes, and increase access to housing.

Recruitment and Data Collection

Trained tribal staff in community locations selected by tribal research partners recruited

survey participants and screened them for eligibility. Community locations included tribal community centers, health clinics, tribal convenience stores, health fairs, and tribal cultural fairs and festivals. To be eligible, participants had to be at least aged 18 years, live within the jurisdictional areas of the 2 tribal nations, and self-identify as AI or Alaska Native.

Participants elected whether they wanted to complete a paper survey or an electronic survey via iPad. All participants completed informed consent before beginning the survey and were mailed a $20 gift card afterward. A total of 513 AI adults completed the survey between April through May 2015. Among individuals approached and identified as eligible to participate, 91.4% agreed to take the survey.

Measures

Health outcomes. We assessed diabetes and hypertension by asking, "Have you ever been told by a doctor, nurse, or other health professional that you have diabetes/high blood pressure?" Response options included "yes," "yes but I am female and was told only during pregnancy," "no," and "told that I was borderline diabetic/pre-hypertensive." We considered only "yes" responses endorsement of the health condition. We determined obesity from body mass index calculated from self-reported height and weight. We considered those with a body mass index equal to or above 30 kilograms per meters squared to be obese.

Food insecurity domains. To assess food insecurity, we used 2 questions from the Six-Item Short Form of the Household Food Security Scale[24]: (1) "How often was the following true for you and your household in the last 12 months? The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more." This question has a sensitivity of 82% and a specificity of 95% for food insecurity.[25] We considered participants who answered "often true" or "sometimes true" as opposed to "never true" to this statement to have "inadequate food quantity." (2) "How often was the following true for you and your household in the last 12 months? (I/we) couldn't afford to eat healthy meals." We considered participants who answered "often true" or "sometimes true" as

opposed to "never true" to this statement to have "inadequate food quality."

Demographic characteristics. We determined age by asking, "How old are you?" Participants provided a number as a response. We assessed education with the question "What is the highest level of education you have completed?" Participants selected one of the following responses: "no formal schooling," "less than high school diploma or less than equivalency/GED," "high school diploma or equivalency/GED," "some college or some technical college," "associate's degree or technical college degree," or "four-year college, bachelor's degree or higher."

We assessed household income by asking, "What was the total combined income of your household in the past year, including income from all sources, such as wages, salaries, Social Security or retirement benefits, help from relatives and so forth? Please choose total income before taxes." Participants selected 1 of 14 response options ranging from "Under $5,000" to "$100,000 or above"; we assessed intermediate values in $5000 or $10 000 increments. "Don't know" was also a response option, and we coded those values as missing.

We assessed employment status by asking, "Which of the following best describes your current, main daily activities and/or responsibilities?" Participants selected one of the following response options: "working full-time," "working part-time," "unemployed or laid off," "student," "homemaker or raising children," "do not work due to health reasons/disabled," and "retired." We assessed the number of people living in a participant's household by 2 separate items: "Including yourself, how many people live in your home who are 18 years old or older?" and "Including yourself, how many people live in your home who are less than 18 years old?" Participants selected a response ranging from "1" to "10 or more" for the former and from "0" to "10 or more" for the latter.

We assessed participation in the assistance programs considered in this study through 2 separate yes or no items: "Are you receiving SNAP (Supplemental Nutrition Assistance Program) or food distribution program groceries (i.e., food stamps or commodities)?" and "Are you on WIC?" We collapsed categories for demographic characteristics with many response options to minimize the occurrence of small cell size.

Statistical Analysis

We used Poisson regression with robust SE estimation to compute prevalence ratios (PRs) and 95% confidence intervals (CIs) to examine the association between inadequate food quantity, inadequate food quality, and health outcomes. We have reported the unadjusted prevalence of each health outcome according to the status for food quantity and food quality. We adjusted models for age, gender, study site, education, and household income. We have presented PRs for all variables included in the models, but inadequate food quantity and quality were the exposures of primary interest.

We used multiple imputation to impute data for all variables in this analysis because of concern for potential bias in the results if data were not missing completely at random. Most variables were missing observations for less than 1% of the sample, but 2.7% were missing obesity, 4.9% were missing age, and 9.2% were missing income. Overall, 15.8% of the sample was missing data for 1 or more variables in the analysis. We used multiple imputation by chained equations[26] because that method allows us to specify bounds on the imputation of variables that can only take on specific values, such as the binary health outcomes.

The imputation model used all variables from the regression analyses and auxiliary variables including employment status, whether the home was owned or being bought by the participant or someone else in the household, the number of persons living in the household, and participation in 2 different food assistance programs. We conducted imputation of 10 data sets and the Rubin rule to compute combined point estimates, and we used SEs to account for variability stemming from the imputation process.[27] We also performed a complete case analysis as a sensitivity analysis. We performed all analyses, including multiple imputation, using Stata version 12 (StataCorp LP, College Station, TX).

RESULTS

The mean age of participants was 44 years, and 75% were female (Table 1). The majority of participants had completed at least some college or technical school (64%) and were employed (77%). More than half of participants had a household income in the past year of less than $40 000 (58%). Most households included 2 or more adults (74%) and at least 1 person younger than 18 years (58%). Participation in food assistance programs ranged from 9% for WIC to 16% for SNAP.

The majority of participants (56%) responded to the statement assessing inadequate food quantity, "the food we bought just didn't last, and we didn't have money to get more" as often true (18%) or sometimes true (38%; Table 1). The majority of participants (62%) also reported inadequate food quality by agreeing that the statement "(I/we) couldn't afford to eat healthy meals" was often true (24%) or sometimes true (38%).

The unadjusted prevalence of diabetes (28.4% vs 18.4%), obesity (60.0% vs 48.3%) and hypertension (54.1% vs 41.6%) was higher among participants with inadequate food quantity than among those with adequate food quantity (Table 2). The association of inadequate food quantity with increased prevalence of diabetes (PR = 1.40; 95% CI = 1.00, 1.99; P = .057), obesity (PR = 1.15; 95% CI = 0.96, 1.38; P = .128), and hypertension (PR = 1.20; 95% CI = 1.00, 1.44; P = .055) did not reach statistical significance after adjustment for age, gender, study site, education, and household income.

Similarly, the unadjusted prevalence of diabetes (27.3% vs 18.8%), obesity (60.7% vs 45.8%), and hypertension (52.5% vs 42.5%) was higher among participants who reported inadequate food quality than among those with adequate food quality. The associations between inadequate food quality and increased prevalence of diabetes (PR = 1.48; 95% CI = 1.04, 2.11; P = .028), obesity (PR = 1.28; 95% CI = 1.07, 1.54; P = .007), and hypertension (PR = 1.25; 95% CI = 1.04, 1.51; P = .016) were statistically significant even after adjustment for sociodemographic characteristics. Table 2 also presents the association between the health conditions and sociodemographic characteristics for all models. Results from a complete case sensitivity analysis showed small differences in comparison with the imputation analysis (Tables A and B, available as supplements to

TABLE 1—Participant Characteristics of American Indians From 2 Tribal Nations, Aged 18–88 Years: Oklahoma, 2015

Characteristic	% (95% CI)
Demographics	
Female	75 (71, 79)
Completed education	
< high school graduate	6 (4, 8)
High school graduate or general equivalency diploma	30 (26, 34)
Some college or technical school	30 (26, 34)
Associate's or technical college degree	21 (17, 24)
4-y college degree or higher	14 (11, 17)
Household income in past year, $	
< 20 000	28 (24, 32)
20 000–39 999	30 (26, 35)
40 000–79 999	27 (22, 30)
≥ 80 000	15 (12, 19)
Employed full or part time	77 (23, 81)
Number of people in home ≥ 18 y	
1	26 (22, 30)
2	52 (48, 57)
≥ 3	22 (18, 25)
Number of people in home < 18 y	
0	42 (38, 46)
1	22 (18, 26)
2	21 (17, 24)
≥ 3	15 (12, 18)
Food assistance program participation	
Supplemental Nutrition Assistance Program or food distribution program	16 (13, 19)
Women, Infants, and Children	9 (6, 11)
Food insecurity domain	
Inadequate food quantity[a]	
Often true	18 (15, 21)
Sometimes true	38 (34, 43)
Never true	44 (39, 48)
Inadequate food quality[b]	
Often true	24 (20, 27)
Sometimes true	38 (33, 42)
Never true	38 (34, 43)

Note. CI = confidence interval. The sample size was n = 513.

[a]"How often was the following true for you and your household in the last 12 months? The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more."

[b]"How often was the following true for you and your household in the last 12 months? (I/we) couldn't afford to eat healthy meals."

the online version of this article at http://www.ajph.org).

DISCUSSION

The prevalence of inadequate food quantity and quality among AIs surveyed was 56% and 62%, respectively. Although measurement of food insecurity differs across studies, the magnitude of the differences in food insecurity rates among the US population as a whole and that among AIs remains striking. These findings support the literature suggesting that the depth and severity of food insecurity varies significantly across AI communities and may not be fully captured by large national surveys.[2–4] For example, analysis of data from the Current Population Survey Food Security Supplement revealed that the prevalence of food insecurity among AI/Alaska Natives was 4 times the rate of that found among the US general population (14%)[2] and substantially higher than rates identified among AIs nationally (30%)[3] or on reservations (43%).[5,6,28] Additionally, this study is the first, to our knowledge, to report associations between food insecurity and obesity, diabetes, and hypertension among AIs. These findings are consistent with other studies that have reported an association between food insecurity and chronic disease in non–AI populations.[8–12]

Steering committee members prioritized inadequate food quality as being highly indicative of food insecurity in these tribal communities, and inadequate food quality was indeed strongly associated with chronic disease, even after adjustment for select demographics. Survey respondents who reported inadequate food quality also more often reported diabetes, hypertension, and obesity than did those who reported adequate food quality, and this finding has clear disease management implications. Because of the high prevalence of these conditions in AI communities, food insecurity is a fundamental determinant of population health.

The stronger association linking inadequate food quality with chronic disease, compared with inadequate food quantity, adds to the literature that suggests perceptions and behaviors related to food insecurity vary from 1 culture to the next[29,30] and that the choice of food insecurity measures may influence the association between food insecurity and chronic disease in racially/ethnically diverse populations.[29–31] For instance, it is well known that significant differences in response patterns exist between households with and without children,[32] and other studies have shown differences across cultures in terms of seasonal food insecurity[33] and household coping strategies[34] that may influence responses to food security assessments.

Limitations

This study has important limitations. First, although tribal staff made every effort to survey diverse samples across both tribal nations, the sample is not random and therefore limits generalizability even within the tribes from which the data were collected. For example, among those who participated in this survey, 64% reported having had at least some college education, suggesting that this sample may be better educated than the general tribal population. However, vocational technology training was included with college in this survey; therefore, it is possible that many of these individuals have technical degrees, some of which can be completed during high school. The overall proportion of individuals with an actual 4-year college degree is quite low. Nonetheless, such a discrepancy is particularly relevant for assessing the prevalence of food insecurity, as food insecurity would likely be even higher in a less educated sample.

Additionally, these data are self-reported; therefore, verification of the diagnoses of obesity, diabetes, or hypertension was not possible. Furthermore, we collected data only at a single time point and thus we cannot make any deductions about causality.

Another limitation is that the study included only 2 questions from the Six-Item Short Form of the Household Food Security Scale.[24] We made this decision on the basis of recommendations from study steering committee members who felt that administering the full scale was burdensome and that the 2 questions selected best captured the experience of food insecurity within these tribal nations. One of the questions used "the food we bought just didn't last, and we didn't have money to get more," which has an estimated sensitivity of 82% and a specificity of 95% for food insecurity[25]; thus, this question more often correctly identifies food-secure households than food-insecure households. Therefore, the use of this single

TABLE 2—Association Between Inadequate Food Quantity, Inadequate Food Quality, and Health Conditions Among American Indians From 2 Tribal Nations: Oklahoma, 2015

Variable	Diabetes	Obesity	Hypertension
Food quantity			
Adequate food quantity, unadjusted prevalence, % (95% CI)	18.4 (13.3, 23.5)	48.3 (41.7, 55.0)	41.6 (35.1, 48.1)
Inadequate food quantity, unadjusted prevalence, % (95% CI)	28.4 (23.2, 33.7)	60.0 (54.3, 65.8)	54.1 (48.3, 59.9)
Regression results, PR (95% CI)			
Inadequate food quantity	1.40 (1.00, 1.99)	1.15 (0.96, 1.38)	1.20 (1.00, 1.44)
Age	1.04 (1.03, 1.05)	1.01 (1.00, 1.01)	1.03 (1.02, 1.03)
Male	0.89 (0.63, 1.28)	0.93 (0.76, 1.12)	1.28 (1.08, 1.53)
Study site	1.02 (0.76, 1.37)	0.93 (0.79, 1.09)	1.06 (0.90, 1.24)
Education	0.96 (0.83, 1.13)	0.96 (0.89, 1.04)	0.93 (0.86, 1.01)
Income	0.94 (0.77, 1.16)	0.94 (0.85, 1.04)	0.95 (0.86, 1.06)
Food quality			
Adequate food quality, unadjusted prevalence, % (95% CI)	18.8 (13.3, 24.3)	45.8 (38.7, 52.8)	42.5 (35.6, 49.5)
Inadequate food quality: unadjusted prevalence, % (95% CI)	27.3 (22.4, 32.3)	60.7 (55.2, 66.2)	52.5 (46.9, 58.0)
Regression results, PR (95% CI)			
Inadequate food quality	1.48 (1.04, 2.11)	1.28 (1.07, 1.54)	1.25 (1.04, 1.51)
Age	1.04 (1.03, 1.05)	1.01 (1.00, 1.01)	1.03 (1.02, 1.03)
Male	0.90 (0.63, 1.29)	0.94 (0.78, 1.14)	1.29 (1.08, 1.53)
Study site	1.01 (0.75, 1.35)	0.92 (0.79, 1.07)	1.05 (0.89, 1.23)
Education	0.96 (0.82, 1.12)	0.96 (0.89, 1.04)	0.93 (0.86, 1.01)
Income	0.93 (0.76, 1.14)	0.94 (0.86, 1.04)	0.95 (0.86, 1.05)

Note. CI = confidence interval; PR = prevalence ratio. The sample size was n = 513.

item to identify "inadequate food quantity" may underestimate the prevalence of food insecurity. Finally, 15% of the data important for these analyses were missing from collected surveys. We performed multiple imputation to correct for selection bias owing to potentially informative missing data; however, additional studies are needed to confirm these findings.

In many AI and Alaska Native communities, industrially produced and commercially available foods provide only 1 measure of food security, because many communities still rely on harvesting wild foods and hunting and gathering practices that have both cultural as well as subsistence purposes.[18,35] These foods and their consumption are not always tracked by conventional food security measures nor are food-sharing practices that exist in many AI communities. A 2005 US Department of Agriculture report said that, although a majority of AI community residents rely on the commodity foods programs, as well as other food assistance programs, including WIC, these programs are insufficiently funded, contributing

to food insecurity and the consumption of low-cost, poor quality foods. Additionally, the report cites the lack of traditional foods included in commodity packages and the relationship of food assistance programs to tribal norms such as sharing food and respect for elders as tribal concerns that influence food security and should be further studied.[36]

Indeed the food environments in sovereign tribal nations remain poorly understood. Large supermarkets are rare in these communities, and many AIs purchase food from convenience stores.[18] Rural and reservation communities have limited availability of fresh vegetables and fruit, and these foods often cost more than in nonreservation communities.[18,37] Thus not only limited access—but also the high costs of foods—are likely contributing to food insecurity in AI communities.[18,37] Additional research is needed to better understand how social, environmental, and political contexts contribute to food insecurity in sovereign nations and to test strategies to effectively address and eliminate disparities.

Conclusions

The widespread prevalence of food insecurity, the inability to afford healthy foods, and the associated rates of obesity, diabetes, and hypertension have major public health and social policy implications. Food insecurity reduces the efficacy of obesity prevention and diabetes management efforts and contributes to poor health among both children and adults. More precise and culturally tailored measures of food insecurity that capture the unique relationship to tribal food programs, traditional food practices, and household food sharing in AI communities, as well as the structural and environmental barriers to healthy food access in tribal food environments, are needed to eliminate chronic disease disparities among AIs. *AJPH*

CONTRIBUTORS
V. Blue Bird Jernigan conceptualized and supervised the study. M. S. Wetherill, A. L. Salvatore, and D. Buchwald assisted in the writing. J. Hearod and T. Jacob assisted with data collection and data analysis. T. Cannady, M. Grammar, J. Standridge, J. Fox, J. Speigel, and A. Wiley collected data and contributed to the interpretation of the results and the writing of the article. C. Noonan led the data analysis.

HUMAN PARTICIPANT PROTECTION
This study was reviewed and approved by the institutional review boards of the University of Oklahoma Health Sciences Center, Chickasaw Nation, and Choctaw Nation of Oklahoma.

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