Diabetes and Obesity Associated with Poor Food Environments in American Indian Communities: the Tribal Health and Resilience in Vulnerable Environments (THRIVE) Study

Charlotte V Love,[1] Tori E Taniguchi,[1] Mary B Williams,[2] Carolyn J Noonan,[3] Marianna S Wetherill,[4] Alicia L Salvatore,[4] Tvli Jacob,[1] Tamela K Cannady,[5] Joy Standridge,[6] Jennifer Spiegel,[6] and Valarie Blue Bird Jernigan[1]

[1]Center for Indigenous Health Research and Action, University of Oklahoma-Tulsa, Tulsa, OK; [2]Department of Biostatistics and Epidemiology, University of Oklahoma Health Sciences Center College of Public Health, Tulsa, OK; [3]Initiative for Research and Education to Advance Community Health, Washington State University, Seattle, WA; [4]Department of Health Promotion Sciences, University of Oklahoma Health Sciences Center College of Public Health, Tulsa, OK; [5]Choctaw Nation of Oklahoma Health Services Authority, McAlester, OK; and [6]Chickasaw Nation Nutrition Services Department, Ada, OK

ABSTRACT

Background: American Indians (AIs) have significantly higher rates of diet-related chronic diseases than other racial/ethnic groups, and many live in environments with limited access to healthy food.

Objective: As part of the Tribal Resilience in Vulnerable Environments (THRIVE) study, we examined the relations between the perceived food environment, utilization of food retailers, fruit and vegetable intake, and chronic diseases, including obesity, hypertension, and type 2 diabetes among AI adults.

Methods: Through a community-based participatory research partnership, we surveyed a cross-sectional sample of 513 AIs living within the Chickasaw Nation and the Choctaw Nation of Oklahoma.

Results: Only 57% of participants reported that it was easy to purchase fruits and vegetables in their town, and fewer (35%) reported that available fruits and vegetables were of high quality. Additionally, over half (56%) reported traveling ≥20 miles round trip to shop for food. Few participants met the recommended daily intake for fruit (44%) or vegetables (25%). Obesity (55%), hypertension (49%), and diabetes (25%) were commonly reported. Obesity was significantly higher among participants who reported that the price of fruits and vegetables were cost-prohibitive (prevalence proportion ratio (PPR): 1.24; 95% CI: 1.02, 1.50) and those who shopped frequently for food at nontraditional food retailers, such as Dollar Stores (PPR: 1.35; 95% CI: 1.08, 1.69) and small markets (PPR: 1.38; 95% CI: 1.02, 1.86). Diabetes was significantly higher among participants who frequently shopped at convenience stores/gas stations (PPR: 2.26; 95% CI: 1.22, 4.19).

Conclusions: Our study found that the use of nontraditional food retailers, including convenience stores, gas stations, and Dollar Stores, as a regular source of food was associated with obesity and diabetes. These results underscore the importance of interventions to improve rural Tribal food environments. Healthy retail interventions in nontraditional retail settings, such as those implemented through the THRIVE study, may contribute to reducing AI health disparities. *Curr Dev Nutr* 2019;3:nzy099.

Keywords: American Indians, Native Americans, food access, perceived food environment, community-based participatory research, obesity, diabetes

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Address correspondence to CVL (e-mail: charlie.love@okstate.edu).

Abbreviations used: AI, American Indian; BRFSS, Behavioral Risk Factor Surveillance System; CBPR, community-based participatory research; IRB, Institutional Review Board; PPR, prevalence proportion ratio; SNAP, Supplemental Nutrition Assistance Program; THRIVE, Tribal Health and Resilience in Vulnerable Environments; WIC, women, infants, and children.

Introduction

Obesity is a major public health condition that increases the risk of hypertension, type 2 diabetes, cardiovascular diseases, mental illness, certain cancers, and mortality (1). Over 30% of adults in

the US are obese or hypertensive (30.9%), and around 10% have type 2 diabetes (10.5%) (2). In American Indian (AI) populations in Oklahoma, these health conditions are even more pervasive, with rates of obesity (40.6%), hypertension (40.1%), and type 2 diabetes (16.7%) all exceeding those of the US general population (2).

Numerous studies have documented the importance of the food environment, which includes the numbers and types of food stores as well as eating habits of community members, in shaping obesity (3, 4). Food environments in the US vary greatly by community. Traditional food retailers, or stores that sell a variety of food items, such as chain supermarkets, tend to be located in areas of middle- or high-income neighborhoods, whereas nontraditional food retailers, such as smaller, nonchain grocery stores, selling primarily shelf-stable food items and little to no fresh produce, are more prevalent in low-income, racial minority neighborhoods (5). The rurality of a community also influences the food environment. Access to fruits and vegetables is more limited in rural locations than in urban environments (6).

A nationally representative study of recipients of the Supplemental Nutrition Assistance Program (SNAP) found that the proximity of individuals to larger grocery stores, and stores selling more healthful products, was associated with increased consumption of fruits and vegetables (7). Similarly, a study of individual dietary practices in 12 communities across California and Hawaii found the availability of healthful products at both county and zip code level was associated with improved dietary intake (8). These findings emphasize the importance of environmental influences on eating patterns (4, 9); however, few studies have examined the food environments of rural, low-income AI populations and associated eating patterns and health outcomes (10, 11, 14).

The Tribal Health and Resilience in Vulnerable Environments (THRIVE) study was developed by a partnership between researchers at the University of Oklahoma and health planners at the Chickasaw Nation and Choctaw Nation of Oklahoma to improve Tribal food environments. THRIVE, a cluster-controlled trial, was designed to increase the availability and consumption of healthy foods in tribally owned convenience stores located within both Tribal Nations (12). As part of the development of THRIVE, we examined the associations between AI adults' perceptions of their food environment, shopping frequency for food at traditional (e.g., supermarkets, grocery stores) and nontraditional (e.g., convenience stores, Dollar Stores) food retailers, fruit and vegetable intake, and obesity, type 2 diabetes, and hypertension. We summarize these findings in this article.

Methods

Partnership development and setting

The Chickasaw Nation and the Choctaw Nation of Oklahoma together comprise >25% of the state of Oklahoma's land mass and have a combined population of over 70,000 people (12). Together, both Nations own >20 convenience stores located in the southeastern portion of Oklahoma. These convenience stores are similar to nontribally owned convenience stores in size and types of products sold but are owned and operated by Tribal governments and Tribal members receive discounted pricing (13). These convenience stores also have 'hot boxes' selling fried foods and a place to sit and eat your meal, and sell Native products such as chocolates, pecans, and local art, and tobacco products without state sales taxes. Many of the tribally owned stores have small casinos located within the stores (13). These additional features encourage shoppers to spend more time than they would in a regular convenience store (13).

Guided by a community-based participatory research (CBPR) orientation, this Tribal–university partnership comprises health and commerce leaders from both the Chickasaw Nation and Choctaw Nation of Oklahoma and intervention researchers from the Center for Indigenous Health Research and Action at the University of Oklahoma-Tulsa. The partnership began in 2011 and initial years focused on relationship building. In 2013, upon receiving funding from the National Heart, Lung, and Blood Institute for the THRIVE study, the partnership assessed the food environment of the Tribal Nations and prioritized convenience store-based intervention strategies as a result of these initial findings. The partnership expanded to include additional university researchers with expertise in nutrition and epidemiology and Tribal representatives of several departments and divisions, including health promotion, nutritional and clinical services, commerce, marketing, and research. All study procedures and protocols developed as part of THRIVE were reviewed and approved by the University of Oklahoma Health Sciences Center Institutional Review Board (IRB) as well as the Chickasaw Nation IRB, and the Choctaw Nation of Oklahoma IRB. Per Tribal Nation preferences, the Nations are not identified when presenting specific study results.

Study recruitment and data collection

Potential study participants were recruited and screened for eligibility by Tribal employees who were trained on study protocols and procedures. To be eligible, participants had to be 18 y or older, live within one of the two jurisdictional Tribal areas, self-identify as AI or Alaska Native, and shop at tribally owned convenience stores ≥3 times per week. Recruitment methods used included posting information about the project in the Tribal newspapers, sending e-mail announcements using listservs maintained by the Tribal Nations, recruitment booths at health fairs and other Tribal community events, and recruitment booths inside health clinic waiting rooms. Both Tribes also advertised the study through department newsletters, flyers posted at community events, and Tribal websites.

When potential participants expressed interest by contacting study personnel either via phone, e-mail, or in person, enrollment appointments were made to meet at convenience stores, health fairs, or other convenient locations for each participant. Eligible participants were consented and asked to complete a survey either on paper or via an iPad according to participant preference. All participants were mailed a $20 gift card as compensation for their time. A total of 513 AI adults completed the survey. Out of the eligible participants, 91.4% agreed to take the survey.

Measures

Demographic characteristics.

We assessed education by asking, 'what is the highest level of education you have completed?' with response options of '<high school graduate,' 'high school graduate/general education diploma (GED),' 'some college or technical school,' and '4-year college degree or higher.' Employment was assessed by asking, 'which of the following best describes your

current, main daily activities and/or responsibilities?' with response options of '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.' For the analysis, response options were categorized into working full- or part-time or not working full- or part-time. For household income, we asked, '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.' Responses were categorized as: <$20,000, $20,000–39,999, $40,000–79,999, and $80,000+. We measured the number of adults in the home by asking 'including yourself, how many people live in your home who are 18 y old or older?' and the number of people <18 y old in the home by asking 'how many people live in your home who are <18 y old?' Responses for both questions were categorized as: zero (second question only), one, two, and three or more.

Fruit and vegetable intake.

We measured fruit and vegetable intake by asking the Behavioral Risk Factor Surveillance System (BRFSS) 2011 Fruit and Vegetable Module questions 'about how many servings of fruit (including 100% pure fruit juice) do you eat or drink each day?' and 'about how many servings of vegetables (including 100% vegetable juice) do you eat or drink each day?' Response options for both questions included 'none,' '1 serving,' '2 servings,' '3 servings,' and '4+ servings.' Serving sizes of common fruits and vegetables were listed in a table next to the question for reference, i.e., '1 serving of fruit could be: 1 small apple, 1 large banana, 1 large orange, 8 large strawberries, 1 medium pear, 2 large plums, 32 seedless grapes, 1 cup (8oz.) of 100% juice, or ½ cup of dried fruit.' '1 serving of vegetables could be: 3 broccoli spears [12.7 cm long], 1 cup of cooked leafy greens, 2 cups of lettuce or raw greens, 12 baby carrots, 1 medium potato, 1 large sweet potato, 1 large ear of corn, 1 large raw tomato, 2 large celery stalks.' Recommended daily fruit and vegetable intake was defined as ≥2 fruit servings per day and ≥3 vegetable servings per day (14, 15).

Perceived food environment.

We measured perceived access to fruit and vegetables using 5 items adapted from the validated Food Store Environment Survey (16); all 5 questions were adapted to ask about the participant's town instead of community. Participants were asked to assess, using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), the extent to which they agreed with each of the five statements: *1*) 'it is easy to purchase fresh fruits and vegetables in my town,' *2*) 'there is a large selection of fresh fruits and vegetables in my town,' *3*) 'the fruits and vegetables in my town are of high quality,' *4*) 'the cost of fruits and vegetables in my town is expensive,' and *5*) 'the cost of fruits and vegetables in my town has kept me from buying them.' For the analyses, responses were collapsed into 'strongly disagree/disagree,' 'neutral,' and 'strongly agree/agree.'

Utilization of food retailers.

Frequency and location of shopping were assessed by asking 'when you go shopping for food, how often do you go to the following places:' 'grocery store,' 'Walmart,' 'convenience store or gas station (e.g., Travel Plaza),' 'small market (e.g., Braums),' 'Dollar Store,' and 'Farmer's Market.' Responses for each store type were 'never,' 'monthly,' '1–2 times per wk,' or '3 + times per wk.'

Health outcomes.

Diabetes and hypertension were assessed by asking the following self-reported, validated measures, '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/prehypertensive.' We defined a person as having the health condition if they responded 'yes.' We used self-reported height and weight to calculate BMI (measured in kg/m^2) and considered those with a BMI ≥ 30 as obese.

Statistical analysis

Descriptive statistics are reported as means and SDs for continuous variables and percentages for categorical variables. Participant characteristics were compared by Tribe using t-tests for continuous variables and chi-square tests for categorical variables. We used Poisson regression with robust standard error estimates to examine the association of health conditions with perceived food environment, fruit and vegetable intake, and retail food shopping frequency. All models were adjusted for age, sex, education, and Tribe. Results are presented as prevalence proportion ratios (PPRs) with 95% CIs. Estimated percentages and PPR results exclude participants missing adjustment variables. All analyses were conducted using Stata 14 (17).

Results

Demographic characteristics

The mean ± SD age of participants was 43.8 ± 14.9 y and the majority were female (75%), married or living with a partner (60%), and had completed some college or technical school (50%) (**Supplemental Table 1**). Most participants were employed (77%) and had an average household income below $40,000 (57%). Most households included 2 or more adults (74%) and ≥1 person younger than 18 y (58%). However, the number of adults in the home differed between the Tribal Nations. More participants in Nation B reported 3 or more adults living in the home compared with Nation A (30% compared with 13%; $P < 0.01$). Food assistance program participation was low, including 16% for SNAP and 9% for women, infants, and children (WIC). Twenty-six (5%) participants were missing age and/or education, and no participants were missing site or sex.

Fruit and vegetable intake

Overall, about half of the participants (44%) met the recommended daily fruit intake and only one-quarter met the recommended daily vegetable intake (Supplemental Table 1). More participants in Nation B met the recommended daily fruit and vegetable intake compared with those in Nation A (52% compared with 36% ($P < 0.01$); 31% compared with 20% ($P < 0.01$), respectively).

Perceived food environment

Just over half of the participants reported it was easy to purchase fresh fruits and vegetables in their town (57%), and nearly half (43%) reported there was a large selection of fresh fruits and vegetables (**Supplemental**

Table 2). However, only 35% reported the fruits and vegetables were of high quality. Those reporting easier fruit and vegetable purchasing, a larger selection of fruits and vegetables, and fruits and vegetables of higher quality was higher among those in Nation B than Nation A (66% compared with 48% ($P < 0.01$); 53% compared with 33% ($P < 0.01$); and 44% compared with 27% ($P < 0.01$), respectively). Over half of the participants reported the cost of fruits and vegetables was expensive (56%) and 39% reported the cost of fruits and vegetables kept them from buying fruits and vegetables.

Utilization of food retailers

Most participants reported shopping for food at least once per week at traditional food retailers (grocery store (63%) or Walmart (60%)); however, many also reported food shopping at nontraditional food retailers (convenience store/gas station (65%), and a Dollar Store (54%)) (Supplemental Table 2). In addition, almost half of the participants reported shopping monthly for food at a small market (40%), but many reported they never shopped at a Farmer's market (60%). Over half of the participants (56%) reported traveling over 20 miles round trip to shop for food.

Health outcomes

Over half of the participants were classified as obese (55%), almost half reported a high–blood pressure diagnosis (49%), and a quarter had diabetes (25%) (Supplemental Table 1). Adjusted PPRs for health outcomes and perceived food environment, and health outcomes and fruit and vegetable intake are presented in **Supplemental Table 3**. Obesity was higher among participants who reported that the cost of fruits and vegetables was unaffordable (PPR: 1.24; 95% CI: 1.02, 1.50) (Supplemental Table 3). **Supplemental Table 4** presents the association between health outcomes and frequency of food shopping at traditional and nontraditional food retailers. Obesity was significantly lower among participants who shopped for food at traditional food retailers (such as grocery stores) once or twice per week (PPR: 0.72; 95% CI: 0.60, 0.86) and those who never shopped for food at traditional food retailers (PPR: 0.65; 95% CI: 0.45, 0.95) compared with participants who shopped for food at grocery stores monthly. Obesity was also more prevalent among participants who shopped at Walmart (PPR: 1.45; 95% CI: 1.15, 1.82), Dollar Stores (PPR: 1.35; 95% CI: 1.08, 1.69), or a small market (PPR: 1.38; 95% CI: 1.02, 1.86) 3 or more times per week compared with participants who shopped at these stores monthly. Similarly, diabetes was more than twice as prevalent among participants who shopped 3 or more times per week at convenience stores/gas stations (PPR: 2.26; 95% CI: 1.22, 4.19) compared with those who shopped monthly at convenience stores/gas stations. Diabetes was also more prevalent among those who never shopped at small markets compared with those who shopped monthly (PPR: 1.50; 95% CI: 1.05, 2.16). Diabetes was significantly lower among participants who never shopped at grocery stores compared with those who shopped monthly (PPR: 0.40; 95% CI: 0.17, 0.98). Hypertension was not significantly associated with frequency of shopping at any of these food retailers.

Discussion

Our findings describe the use of traditional and nontraditional food retailers and associated health outcomes among AIs in rural Oklahoma. This study is one of the first to examine the relations between reported frequency of shopping at different types of food retailers and nutrition-related chronic disease.

In our study population, fruit and vegetable intake was low with only half of the participants meeting the national recommendation for fruit and roughly one-quarter of the sample meeting the national recommendation for vegetables. The AI study participants reported that access to fruits and vegetables is limited, with roughly one-quarter to one-half reporting that cost, variety, and quality are barriers to purchasing fruits and vegetables. Perceptions of the high cost of fruits and vegetables confirm findings from previous research that found fresh produce costs more in rural communities than urban communities, and that nontraditional retailers in rural communities charge more for healthful foods (22).

We found that high utilization of Walmarts, Dollar Stores, and small markets is associated with obesity. This finding of a positive association between obesity and high frequency of shopping at Walmart is consistent with two other studies that reported similar findings showing positive associations between obesity and grocery store density and proximity to consumer's residences (18, 19). One study showed this association by analyzing publicly available data at the county level within the US (18) and the other using BRFSS data matched with Walmart opening dates and locations (19). In addition, our results are also similar to other studies that found those who live in closer proximity to grocery stores and further from convenience stores tend to have healthier diets and lower rates of obesity (18, 20). For instance, a recent cross-sectional study found that the addition of a grocery store decreases obesity by 7–8% in nonmetropolitan areas (18).

Our study also found that high utilization of convenience stores is associated with diabetes. Although not explored in this study, past research documenting the limited availability of healthy, affordable options in these nontraditional food retail environments (21) indicates the need for healthy retail interventions in these community settings. Since many convenience stores are owned and operated by Tribal Nations in rural Oklahoma, they represent a feasible setting for the development of healthy retail interventions to address AI health disparities.

Given the established benefits of high fruit and vegetable intake in the prevention and management of many chronic conditions, including those that are prevalent in AI populations (23, 24), Tribal health policy-makers should work with communities to further explore and address environmental barriers to meeting this dietary goal. Overcoming the unique barriers to healthy food distribution identified as inadequate refrigerated or freezer space, limited life span of healthier foods compared with less healthy options, and questionable profitability margins for nontraditional food retailers (21) in rural communities (25) will likely require the reform of multi-sector food systems to address rural AI nutrition-related health disparities. This data demonstrates exciting opportunities of self-determination and the use of Tribal leadership to create environments that support the health of Tribal members.

Limitations

This study has several limitations. Although we attempted to recruit a diverse sample of AIs from both Tribal Nations, this was not a random sample. Hence, our findings may not be representative of these Tribal Nations or of other Native or Indigenous populations. In addition,

around three-quarters of the participants were women, so this data is more representative of women.

Our survey collected self-reported measures of fruit and vegetable intake, height, weight, and health conditions. If a diagnosis of hypertension or diabetes exists, self-reported prevalence of diabetes and hypertension diagnoses have been validated (26, 27). However, since our study sample had a low income, participants may have had lower access to healthcare, meaning that they could have the health outcome but never have been diagnosed by a healthcare provider, thus leading to under-reporting of the target health outcomes examined in this study, despite using the validated measure. Future studies could collect biometrics to determine if participants had elevated blood pressures, instead of relying on self-reported measures. This would capture those who have the condition without a diagnosis. Furthermore, the prevalence of low fruit and vegetable intake and obesity may be under-reported (28, 29) in our study sample due to the lack of objective measures. In addition, the tool we used to capture fruit and vegetable intake asked participants to include servings of 100% fruit juice and 100% vegetable juice. Nutrition science has since moved away from including 100% fruit juices as a fruit serving, but rather categorizing them as a separate food group (30). Future studies could use more rigorous dietary intake measures such as 24-h dietary recalls, for example, National Cancer Institute's Automated Self-Administered 24-Hour Dietary Assessment Tool (31).

Additionally, almost 10% of participants chose not to report income information, which limited our ability to adjust for income in our final models. Finally, we did not use an objective measure of the food environment, however, other research indicates perceived access measures had a stronger relation with dietary intake than objective measures (32).

Conclusion

Use of nontraditional food retailers as a regular source of food is associated with increased prevalence of obesity and diabetes. This study contributes evidence to a growing body of research that emphasizes the importance of the food environment as a factor in determining fruit and vegetable intake and nutrition-related chronic diseases, specifically for AIs living in rural Oklahoma. Efforts to improve the proximity, price, quality, and variety of fruits and vegetables in rural locations, could have positive implications on dietary purchasing, as well as reducing obesity and type 2 diabetes rates. Such efforts are already being made in tribally-owned convenience stores in Oklahoma to improve the food environment (13).

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