Differences in Food Environment Perceptions and Spatial Attributes of Food Shopping Between Residents of Low and High Food Access Areas

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ABSTRACT

Objective: To explore potential differences in food shopping behaviors and healthy food availability perceptions between residents living in areas with low and high food access.

Design: A cross-sectional telephone survey to assess food shopping behaviors and perceptions. Data from an 8-county food environment field census used to define the Centers for Disease Control and Prevention (CDC) healthier food retail tract and US Department of Agriculture Economic Research Service food desert measure.

Participants: A total of 968 residents in 8 South Carolina counties.

Main Outcome Measures: Residents' food shopping behaviors and healthy food availability perceptions.

Analysis: Linear and logistic regression.

Results: Compared with residents in high food access areas, residents in low food access areas traveled farther to their primary food store (US Department of Agriculture Economic Research Service: 8.8 vs 7.1 miles, $P = .03$; CDC: 9.2 vs 6.1 miles, $P < .001$), accumulated more total shopping miles per week (CDC: 28.0 vs 15.4 miles; $P < .001$), and showed differences in perceived healthy food availability ($P < .001$) and shopping access ($P < .001$).

Conclusions and Implications: These findings lend support to ongoing community and policy interventions aimed at reducing food access disparities.

Key Words: healthy food access, food environment, food shopping behaviors, food access disparities (*J Nutr Educ Behav*. 2014;46:241-249.)

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INTRODUCTION

The rise in obesity rates in the US has been a driving force of research into "obesogenic environments."[1-3] Several studies have found that a large number of fast-food restaurants and few grocery stores in a resident's food environment were associated with a higher odds of obesity among area residents, although the relationship varied between metro and nonmetro areas.[4,5] Policy makers in the US have questioned the extent to which healthy foods are easily accessible and available.[6] The US Department of Agriculture (USDA) Economic Research Service (ERS) has reported that limited access to major food outlets such as grocery stores and supermarkets affects over 23.5 million people living in 6,529 different Census tracts.[7,8] In an updated USDA ERS report based on 2010 Census and supermarket data, this statistic increased to 29.7 million people, who lived in a low-income area > 1 mile from a supermarket.[9] Several community food access (CFA) measures have been created to identify and quantify areas that are considered to have low access to healthier food retailers. The 2009 and 2013 Centers for Disease Control and Prevention (CDC) *State Indicator Report on Fruits and Vegetables*[10,11] categorized each state's Census tracts based on the presence or absence of retailers that are considered healthy: as a healthier food retail tract (HFRT) or non–healthier food retail tract (non-HFRT). The 2009 USDA ERS *Access to Affordable and Nutritious Food—Measuring and Understanding Food Deserts and Their Consequences: Report to Congress*[12] identified areas with limited access to nutritious foods and classified each Census tract

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as a food desert (FD) or non–food desert (non-FD) based on its median family income and supermarket access. This was recently updated in the Food Access Research Atlas in March, 2013.[8]

To the authors' knowledge, these measures of CFA have not been studied with respect to food shopping behaviors or residents' perceptions of food retail access. The only descriptive study of USDA ERS FDs to date focused on socioeconomic characteristics.[7] Understanding residents' perceptions of their food environment gives insights into their subjective attitudes and experiences, which in turn can influence shopping and ultimately health behaviors.[13]

The purpose of this study was to explore differences in healthy food availability perceptions and spatial attributes of food shopping between residents of low vs high food access areas. Shopping behaviors were defined as actions related to residents' food shopping travel and time, such as distance to the nearest shopping store and total number of shopping miles per week. This is different from in-store behaviors such as types of foods purchased and purchasing frequency, with which the study was not concerned. The hypotheses were that residents of low access areas would rate their healthy food availability and food shopping access as poorer, travel further distances to their primarily used food store, take fewer shopping trips per week, accrue more total shopping miles per week, and be more likely to shop at a supercenter and less likely to shop at the nearest store.

METHODS

Study Area and Food Environment Database

To recreate the food access measures in the sample, the researchers used data from a previously conducted field census of retail food outlets in 8 South Carolina counties, covering 169 Census tracts.[14] This dataset was managed with ArcGIS 10.1 (Esri, Redlands, CA, 2012) and included geospatial information and store type attributes on all retail food outlets located in 1 urban and 7 rural counties. Of the 2,208 total food outlets, 102 supermarkets and large grocery stores were used to derive the CFA measures.

Community Food Access Measures

Using the data described above[14] and 2010 US Census data,[15] the 2 measures of CFA were replicated for the study area.

The CDC HFRT measure identifies whether a Census tract has a supermarket, large grocery store, warehouse club, or fruit and vegetable market within the tract or within 0.5 miles of the boundary.[10] Supermarkets are defined as food stores with ≥ 50 annual payroll employees, whereas large grocery stores have 10–49 employees. To compare the CDC definition with the USDA ERS definition described subsequently, the focus was on non-HFRTs. The replication of this measure relied on supermarkets, large grocery stores, and fruit and vegetable markets, and used 2010 Census geographies, identifying 49 of 169 Census tracts as non-HFRTs.

For the USDA ERS FD measure, a Census tract was identified as a low-income tract if it met the US Treasury Department's New Market Tax Credit program eligibility criteria (ie, a poverty rate of at least 20%, a median family income < 80% of the statewide median family income for tracts in non-metropolitan areas, or a median family income < 80% of the metropolitan area median family income for tracts in metropolitan areas).[8,12] The Census tract also had to be low-access, such that at least 500 residents or 33% of the tract population resided > 1 mile from a supermarket in an urban tract or > 10 miles in a rural tract, based on Euclidean distance. The USDA ERS defined a supermarket as a retailer that must have at least $2 million in annual sales and contain the major food departments.[8,12] To evaluate the access and income criterion, population and economic data were derived from the 0.5 × 0.5-km gridded population estimates. The replication of this measure identified 38 of 169 Census tracts as FDs and relied on supermarkets, large grocery stores, and warehouse clubs and 2010 census geographies.

Both CFA measures were replicated based on accurate ground-truthed data[14,16] instead of using the secondary commercial databases underlying the agency publications.[9,10] This was because the food environment data were more accurate[14,17] and collected closer in time (ie, 2009) to the point of data collection on the study sample (ie, 2010). In addition, a 10-mile buffer corridor was created around the study area, using InfoUSA (Papillion, NE) and Dun & Bradstreet (Short Hills, NJ) commercial data, to account for edge effects owing to food stores that could lie outside the boundaries of the study area.

Study Sample

The University of South Carolina Institutional Review Board reviewed and approved the study's protocol. Data on residents' perceptions and shopping behaviors were obtained via telephone interviews of 968 residents of the 8 counties. The University of South Carolina Survey Research Laboratory sampled 2,477 phone numbers, which were a simple random sample of publicly available listed phone numbers, representing households of 64 zip codes in the 169 Census tracts. Respondents had to be ≥ 18 years of age and the primary food shopper of the household, speak English, and reside within the study area boundaries. The estimated response rate, after using American Association for Public Opinion Research Response Rate Formula 4,[18] was 47.1%. Respondent data were geocoded and linked to the geo-spatial data, so that each participant was assigned to her or his residential Census tract's designation according to the USDA ERS[8] and CDC.[10]

Assessment of Food Shopping Behaviors and Perceptions of Healthy Food Availability

Study respondents were asked to name their primary food store and describe the store type, their reasons for shopping at that store, and how often they shopped. The primary food stores were identified in a food environment database.[14] The researchers used ArcGIS 10.1 to compute road network distances in miles and determine whether respondents shopped at the nearest food store. Shopping miles per week were computed by multiplying the shopping frequency with the distance to the primarily used food store times 2. Supercenter use was defined as shopping at a primary retail establishment that sold both food and general merchandise, such as Wal-Mart.[19]

Perceptions of healthy food availability and shopping access were assessed with 4 questions.[20] Specifically, respondents were asked about (1) the selection and (2) quality of fresh fruits and vegetables, (3) the selection of low-fat products, and (4) the lack of access to adequate food shopping in their neighborhood (defined as 1 mile or a 20-minute walk from their home). Responses were coded on a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) for Questions 1–3, and from 1 to 4 (1 = very serious problem; 2 = somewhat serious problem; 3 = minor problem; 4 = not really a problem) for Question 4. These questions have been shown to have high test-retest reliability statistics (based on interclass correlations and Phi coefficients) in the study population, ranging from 0.55 to 0.71 for the perceptions of the food environment and from 0.51 to 0.83 for the perceived presence of food outlets.[20] The first 3 perception questions were reverse-coded and transformed to a point scale of 0–4, in which a higher number indicated stronger agreement with availability. A composite score ranging from 0 to 12 was created. The food shopping access question was assessed on a point scale of 0–3, in which a higher number indicated better access.

Statistical Analysis

Distance to primarily used food store and shopping frequency per week were winsorized at the 95th and 99th percentiles, respectively, to address extreme outliers and skewness. A universal exclusion variable removed individuals with missing data on any of the study variables, which resulted in a final sample size of 685 participants. There were no significant differences in sociodemographic characteristics (such as race, age, and education level) between the original and final study samples. Race was coded as 0 (non-Hispanic white) and 1 (other races). All statistical analyses were conducted with SAS (version 9.3, Cary, NC, 2011). Bonferroni-adjusted alpha levels were set for all statistical tests.

Ordinary least squares regression provided estimates of the unstandardized regression coefficients, P values, and overall model R^2 for continuous outcomes. Point estimates, including unstandardized regression coefficients (βs), were used to examine differences in adjusted means for all continuous outcome variables, while controlling for other predictors. The authors calculated Cohen's δ, an effect size measure that indicates a standardized magnitude of the observed difference between access groups, so they could compare residents' mean shopping behaviors and food perceptions across study variables. Cohen's δ cutoffs are defined as follows: $< .2$ indicates a small effect size, .5 indicates a moderate effect size, and $> .8$ indicates a large effect size.[21] Assumptions for ordinary least squares regression models were examined; no violations were noted. Logistic regression provided unstandardized regression coefficients, P values, odds ratios, and corresponding 95% confidence intervals for the categorical outcomes.

RESULTS

Of the study sample of 685, 117 participants lived in Census tracts identified as USDA ERS FDs, and 284 in CDC non-HFRTs. Most study participants were non-Hispanic white (65.8%) and female (77.7%), had a high school degree (35.6%), owned a personal vehicle (94.0%), were married (64.1%), lived in a non-urban area (81.2%), did not receive food assistance (90.4%), and had an average age in the late 50s and an annual household income of \$40,000–\$49,900. Differences in characteristics between residents of low and high food access areas were observed for (1) urban residence (non-HFRT vs HFRT: 3.5% vs 29.7%; $P < .001$), (2) marital status (non-HFRT vs HFRT: 59.2% vs 67.6%; $P = .02$), (3) high school education (non-HFRT vs HFRT: 42.6% vs 30.7%; $P < .001$), and (4) race/ethnicity (FD vs non-FD: 55.6% vs 68.0%, $P = .01$; non-HFRT vs HFRT: 60.9% vs. 69.3%, $P = .02$). Table 1 displays the sociodemographic characteristics of the final study samples.

Table 2 lists descriptive characteristics of food shopping behaviors and food environment perceptions. In this unadjusted analysis, the differences between residents of FDs vs non-FD were distance to primary used food store (11.4 vs 9.6 miles), distance to the nearest food store (8.2 vs 5.4 miles), and food shopping access score, a measure of perception (1.7 vs 2.1). Substantial differences in 3 of the shopping behaviors and all measures of perceptions of the food environment were observed for residents of non-HFRTs vs HFRTs. Using Bonferroni-adjusted alpha levels of .005 (.05/11), the difference in distance to primarily used food store under the USDA ERS measure was no longer significant.

Table 3 shows results of multivariate models, controlling for demographic and socioeconomic characteristics. Residents of FDs traveled significantly farther distances to their primarily used food store (8.8 vs 7.1 miles). However, after applying the Bonferroni correction in which the adjusted alpha level became .007, the distance to the primarily used food store was no longer statistically significantly different between residents of FDs and non-FDs. No significant differences in the frequency of shopping (1.8 vs 1.9 times per week), likelihood of shopping at the nearest store (odds ratio [OR] = 1.0; 95% confidence interval [CI], 0.3–3.8), total shopping miles per week (26.7 vs 19.2 miles), or likelihood of supercenter use (OR = 0.7; 95% CI, 0.4–1.1) were found. Residents of FDs rated their food shopping access as significantly poorer (of 2.0 vs 2.4) than residents of non-FDs, but their healthy food availability rating (6.9 vs 7.6) was not significantly different. The Cohen's δ statistic showed moderate effect sizes for the significant

Table 1. Descriptive Characteristics Among Residents of Low and High Food Access Areas

		US Department of Agriculture Economic Research Service 2013 Measure		Centers for Disease Control and Prevention 2013 Measure	
Characteristic	**Study Sample (n = 685)**	**Food Desert (n = 117)**	**Non–Food Desert (n = 568)**	**Non–Healthier Food Retail Tract (n = 284)**	**Healthier Food Retail Tract (n = 401)**
Non-Hispanic white, %	65.8	55.6	68.0	60.9	69.3
Income, mean (per $1,000)	40–49.9	40–49.9	40–49.9	40–49.9	40–49.9
Female, %	77.7	82.1	76.8	76.4	78.6
Urban, %	18.8	18.0	19.0	3.5	29.7
Education, %					
Less than high school	11.1	11.1	11.1	13.0	9.7
Grade 12 or General Education Diploma	35.6	39.3	34.9	42.6	30.7
Some college	27.2	19.7	28.7	22.2	30.7
College graduate	26.1	29.9	25.4	22.2	28.9
Living with partner, %	64.1	65.0	63.9	59.2	67.6
Household size, mean	2.5	2.6	2.5	2.5	2.5
Vehicle ownership, %	94.0	93.2	94.2	91.9	95.5
Supplemental Nutrition Assistance Program participation, %	9.6	8.6	9.9	11.3	8.5
Age, y (mean)	56.6	56.7	56.5	56.3	56.7

differences (0.17–0.36), and the total explained variation ranged from 1.5% to 16.0%.

Table 4 presents results of parallel analyses, focusing on the CDC non-HFRT designation. Residents of non-HFRTs traveled significantly farther to their primarily used food store (9.2 vs 6.1 miles), accrued significantly more total shopping miles per week (28.0 vs 15.4 miles), and had significantly lower perceptions for their healthy food availability (of 6.6 vs 8.0) compared with residents of HFRTs. The Cohen's δ statistic showed moderate effect sizes (0.27–0.39) and the total explained variation ranged from 1.7% to 18.2%. No differences in residents' food shopping access rating (of 2.2 vs 2.4), frequency of shopping (1.8 vs 2.0 times per week), likelihood of supercenter use (OR = 1.2; 95% CI, 0.9–1.8), and likelihood of shopping at the nearest store (OR = 0.5; 95% CI, 0.2–1.6) were found. As in Table 3, the Bonferroni correction was applied but there was no change in significant differences.

> Residents from low food access areas have poorer perceptions of their food environment and travel farther to their primary food store.

DISCUSSION

To the authors' knowledge, this is the first study to document significant differences in food shopping behaviors and healthy food availability perceptions between residents of low and high food access areas, using measures of CFA developed by 2 US federal agencies. The researchers found evidence in support of the hypotheses that residents of CDC non-HFRTs would express lower ratings for the availability of healthy foods in their neighborhood, travel farther distances to their primarily used food store, and accrue more total shopping miles per week. There was also evidence to support the hypothesis that residents of USDA ERS FDs would express lower shopping access than residents of non-FDs. No significant differences between low and high access residents were found in terms of likelihood of supercenter use, shopping at the nearest store, or shopping frequency.

The limited population-based research on food shopping behaviors to date has focused on low-income populations or recipients of food assistance.[12,22-26] For instance, a USDA ERS report indicated that 87% of Supplemental Nutrition Assistance Program participants spent their redemptions in supermarkets.[12] The National Food Stamp Program Survey reported that supermarkets were used as the main food store by nearly 90% of all survey respondents.[23] Although the current research study included only approximately 10% Supplemental Nutrition Assistance Program participants, about 92% of the study sample conducted their primary grocery shopping at supermarkets, large grocery stores, and supercenters. This study is consistent with earlier reports indicating that the primary food store

Table 2. Spatial Attributes of Food Shopping Behaviors and Perceptions of Food Environment of Residents of Low vs High Food Access Areas (n = 685)

	US Department of Agriculture Economic Research Service 2013 Measure			**Centers for Disease Control and Prevention 2013 Measure**		
	Food Desert (n = 117)	**Non–Food Desert (n = 568)**	***P***	**Non–Healthier Food Retail Tract (n = 284)**	**Healthier Food Retail Tract (n = 401)**	***P***
	Mean (SD) or Percentage			**Mean (SD) or Percentage**		
Shopping behavior[a]						
Distance to primarily used food store, miles	11.4 (8.0)	9.6 (8.2)	.034	12.7 (7.1)	8.0 (8.4)	< .001
Median, IQR	10.8, 12.9	7.9, 10.1		11.8, 9.1	5.4, 8.9	
Shopping frequency, per wk	1.8 (1.8)	2.0 (2.2)	.534	1.8 (1.9)	2.1 (2.3)	.157
Median, IQR	1.0, 1.0	1.0, 1.0		1.0, 1.0	1.0, 2.0	
Total shopping miles, per wk	39.1 (62.8)	31.7 (41.2)	.110	42.6 (51.8)	26.0 (39.4)	< .001
Median, IQR	21.5, 35.4	19.5, 30.8		28.0, 36.6	13.8, 25.0	
Distance to nearest store, miles	8.2 (5.5)	5.4 (4.2)	< .001	8.9 (4.2)	3.7 (3.4)	< .001
Median, IQR	8.3, 10.0	4.8, 5.9		8.3, 5.8	2.4, 4.6	
Supercenter use (%)	22.2	28.5	.164	29.9	25.7	.220
Shopping at nearest store (%)	2.6	2.5	.950	1.8	3.0	.307
Perception measure[b]						
Healthy food availability in neighborhood (0–12)	5.7 (3.5)	6.3 (3.6)	.081	5.2 (3.4)	7.0 (3.4)	< .001
Fruit and vegetable selection (0–4)	1.9 (1.4)	2.1 (1.4)	.176	1.7 (1.4)	2.4 (1.3)	< .001
Fruit and vegetable quality (0–4)	2.0 (1.3)	2.2 (1.3)	.131	1.8 (1.3)	2.4 (1.2)	< .001
Low-fat selection (0–4)	1.8 (1.3)	2.0 (1.3)	.072	1.6 (1.2)	2.2 (1.3)	< .001
Food shopping access (0–3)	1.7 (1.2)	2.1 (1.1)	< .001	1.9 (1.2)	2.2 (1.0)	< .001

IQR indicates interquartile range.
[a]*t* test for continuous variables and chi-square test for categorical variables were used; [b]The Healthy Food Availability in Neighborhood variable was a composite score evaluated on a point scale of 0–12 and created from responses to the 3 questions with point scales of 0–4, with a higher number indicating stronger agreement. The Food Shopping Access measure was assessed on a point scale of 0–3, with a higher number indicating less of a problem.
Note: Bonferroni-adjusted alpha level was (.05/11) = .005.

is generally not the most proximal.[27,28] These findings suggest that lack of access to a supermarket is not necessarily a major factor in residents' food shopping behaviors. For those shopping at supermarkets, in-store factors, including availability of certain products and price, may be more relevant.[28,29]

The study provides empirical evidence that residents of low access Census tracts travel > 3 miles farther to their primarily used food store and accrue more total shopping miles per week than those living in high access areas. Although these differences may seem small, the fact that shopping occurs about twice a week implies that on aggregate, residents of low food access areas are spending significantly more travel time for grocery shopping and have markedly higher fuel expenses. Bawa and Ghosh[30] developed a model of household grocery shopping behavior. Under the assumption that the household makes rational decisions, the model posits that a household will aim to meet its consumption needs while minimizing both the travel cost and inventory cost. Applied to the study's data, the model of Bawa and Ghosh suggests that households in low access areas would decrease their shopping frequency to make up for the increased travel expenditures. The data do not support this hypothesis, because shopping frequency was similar for low and high access area residents. In the study, residents were asked about their primary mode of transportation to the food store; 94% used a personal vehicle. There may be a possible relationship between vehicle ownership and being able to get to the food store easily, which could explain the similar shopping frequency in low and high access area residents.

Table 3. Differences in Spatial Attributes of Food Shopping Behaviors and Perceptions of Food Environment Between Residents of USDA ERS FDs vs. Non-FDs (n = 685)

	Model Parameters[a]			Estimated Mean and Effect			
Outcome	**β (SE)**	**Odds Ratio (95% Confidence Interval)**	***P***	**USDA ERS FD (Estimated Mean)**	**USDA ERS Non-FD (Estimated Mean)**	**Adjusted Mean Difference**	**Cohen's δ[b]**
Shopping behavior							
Distance to primarily used food store, miles	1.70 (0.78)		.030	8.8	7.1	1.7	0.22
Shopping frequency, per wk	−0.11 (0.22)		.618	1.8	1.9	−0.1	0.05
Total shopping miles, per wk	7.52 (4.57)		.100	26.7	19.2	7.5	0.17
Supercenter use		0.69 (0.43–1.13)	.139	77.8[d]	71.5[d]	6.3	0.99
Shopping at nearest store		1.05 (0.29–3.83)	.947	97.5[d]	97.4[d]	0.1	0.29
Perception measure							
Healthy food availability in neighborhood	−0.65 (0.35)		.062	6.9	7.6	−0.7	0.19
Perception of food shopping access	−0.37[c] (0.11)		< .001	2.0	2.4	−0.4	0.36

FD indicates food desert; USDA ERS, US Department of Agriculture Economic Research Service.
[a]Betas and standard errors are from ordinary least squares regression models, and odds ratios and 95% confidence intervals are from logistic regression models; [b]Calculated as the (mean of low access – mean of high access) / root mean square error; [c]Significant under Bonferroni-adjusted alpha level of (.05/7) = .007; [d]Values represent the percentage of "yes" responses for both supercenter use and shopping at nearest store outcomes.
Note: Multivariate models were adjusted for race/ethnicity, sex, age, education, income, marital status, urbanicity status, vehicle ownership, household size, and Supplemental Nutrition Assistance Program participation.

> Improved public transportation and more proximal food stores may save time and money for those in areas with low access to healthier food retail outlets.

Furthermore, the study found significant differences in perceptions of food shopping access (USDA ERS FD) and availability of healthy foods (CDC non-HFRT) between residents of low and high access areas. Previous studies[31,32] showed that residents' food environment–related perceptions were influenced by neighborhood characteristics such as supermarket density. The current study suggests that residents of low access areas are aware of the lower availability of healthy foods and poorer food shopping access. In this sense, this study provides evidence for the face-validity of the measures of CFA developed by the USDA and CDC.

To deal with possible error resulting from the multiple comparison tests that were conducted for each measure, the authors used Bonferroni correction. After applying this correction, one of the shopping behaviors under the USDA ERS measure, distance to primarily used food store, was no longer significant in both the unadjusted (Table 2; adjusted α = .005) and adjusted analyses (Tables 3 and 4; adjusted α = .007). Perhaps with a larger study sample, a more definitive picture could have been seen. This variable was significant under the CDC measure, so it still provides useful information regarding residents' shopping behaviors.

There are some differences in how both measures of CFA identify low food access. The CDC HFRT measure focuses on Census tracts and whether a supermarket lies within their boundaries, whereas the USDA ERS FD measure focuses on low-income Census tracts that have low access to supermarkets. Although the FD and non-HFRT definitions in the study area do not necessarily overlap geographically,[33] the current study suggests a general consistency in identifying areas in which residents are disadvantaged with respect to food shopping opportunities.

There are several limitations to this study. Although the results are likely generalizable to the southeastern US, further examination of both measures in other geographic locations would be worthwhile. Second, because of the geographically based study design, listed landline phone numbers including addresses were sampled, which resulted in a middle-aged and older population of women

Table 4. Differences in Spatial Attributes of Food Shopping Behaviors and Perceptions of Food Environment Between Residents of Centers for Disease Control and Prevention Non–Healthier Food Retail Tract vs Healthier Food Retail Tracts (n = 685)

	Model Parameters[a]			Estimated Mean and Effect			
Outcome	**β (SE)**	**Odds Ratio (95% Confidence Interval)**	***P***	**Centers for Disease Control and Prevention Non–Healthier Food Retail Tract (Estimated Mean)**	**Centers for Disease Control and Prevention Healthier Food Retail Tracts (Estimated Mean)**	**Adjusted Mean Difference**	**Cohen's δ[b]**
Shopping behavior							
Distance to primarily used food store, miles	3.01[c] (0.62)		< .001	9.2	6.1	3.1	0.37
Shopping frequency, per wk	−0.16 (0.18)		.374	1.8	2.0	−0.2	0.07
Total shopping miles, per wk	12.60[c] (3.68)		< .001	28.0	15.4	12.6	0.27
Supercenter use		1.22 (0.85–1.77)	.276	71.4[d]	72.8[d]	−1.4	0.29
Shopping at nearest store		0.52 (0.17–1.59)	.248	97.8[d]	97.5[d]	0.3	0.15
Perception measure							
Healthy food availability in neighborhood	−1.39[c] (0.28)		< .001	6.6	8.0	−1.4	0.39
Perception of food shopping access	−0.16 (0.09)		.071	2.2	2.4	−0.2	0.14

FD indicates food desert.

[a]Betas and standard errors are from ordinary least squares regression models, and odds ratios and 95% confidence intervals are from logistic regression models; [b]Calculated as (mean of low access – mean of high access) / root mean square error; [c]Significant under Bonferroni-adjusted alpha level of (.05/7) = .007; [d]Values represent the percentage of "yes" responses for both supercenter use and shopping at nearest store outcomes.

Note: Multivariate models were adjusted for race/ethnicity, sex, age, education, income, marital status, urbanicity status, vehicle ownership, household size, and Supplemental Nutrition Assistance Program participation.

who were significantly more likely to be responsible for a household's food shopping and food preparation, compared with men.[1,34] Thus, the results may not extend to households relying exclusively on cell phones, which are known to be more frequent in younger age groups.[35] Another limitation was that the study sample was limited to English speakers and did not represent the part of the population that does not speak English. This may have caused some selection bias and affected the results, if the study sample was not representative of the general population. The study also did not collect data using travel diaries or global positioning system devices for multiple days, which would have allowed characterization of travel space and time.[26,36] The limited population used in the study may cause some concern. A larger sample size would have been preferred, but the initial sample size had to be reduced to deal with missing data. A minor limitation was that the food environment data was collected in 2009, and thus was a little older than the data collection on the study sample, which was completed in 2010. A final limitation was that participants of African American (n = 222), Hispanic (n = 2), and other race/ethnicity (n = 10) were combined into 1 category and race/ethnicity was coded as non-Hispanic white (n = 451) vs other.

> A person's food environment should be taken into account when dietary recommendations are made.

A strength of the study is that because the food access measures were derived from ground-truthed data, identification of the low and high access areas was substantially more valid than if it had relied on unvalidated food outlet data.[37] Finally, the study area contained both urban and rural areas, and thus expanded generalizability beyond previous research that largely focused on urban areas.

IMPLICATIONS FOR RESEARCH AND PRACTICE

The study's findings provide support for the need for current policies aimed at improving healthy food access for vulnerable populations, especially those living in disadvantaged low access areas and relying on food assistance. Meaningful differences in distance traveled to primary food store and perceptions of access were found between residents of low and high access areas. If the findings are replicated with national data, policy makers may want to consider providing food assistance recipients in low access areas with additional resources to cover the higher expenditures incurred through farther travel to their main food store. Alternatively, consideration could be given to improving public transportation and developing more proximal retail opportunities. Finally, when health care providers make recommendations regarding diet and lifestyle choices, they may want to consider their patients' food environment.

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