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

Inderbir Sohi, MSPH[1], **Bethany A. Bell, PhD**[2], **Jihong Liu, ScD**[1], **Sarah E. Battersby, PhD**[3], and **Angela D. Liese, PhD**[1,4]

[1]Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, Columbia, SC

[2]College of Education, University of South Carolina, Columbia, SC

[3]Department of Geography, University of South Carolina, Columbia, SC

[4]Center for Research in Nutrition and Health Disparities, University of South Carolina, Columbia, SC

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 eight-county food environment field census used to define the CDC (Centers for Disease Control and Prevention) healthier food retail tract and USDA ERS (United States Department of Agriculture Economic Research Service) food desert measure.

Participants—968 residents in eight South Carolina counties.

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

Analysis—Linear and logistic regression.

Results—Compared to residents in high food access areas, residents in low food access areas traveled further to their primary food store (USDA ERS: 8.8 vs. 7.1 miles, p=0.03; CDC: 9.2 vs. 6.1 miles, p<0.001), accumulated more total shopping miles per week; CDC 28.0 vs. 15.4 miles, p<0.001) and showed differences in perceived healthy food availability (p<0.001) and shopping access (p<0.001).

Corresponding Author: Angela D. Liese, Department of Epidemiology and Biostatistics,Center for Research in Nutrition and Health Disparities, Arnold School of Public Health, University of South Carolina, 915 Greene Street, Columbia, SC, 29208, liese@sc.edu, Phone: (803) 777-9414, Fax: (803) 777-2524.

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

Keywords

Healthy food access; food environment perceptions; food shopping behaviors; food access disparities

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 non-metro areas.[4,5] US policymakers have questioned the extent to which healthy foods are easily accessible and available.[6] The US Department of Agriculture 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 more than 1 mile from a supermarket.[9] Several community food access (CFA) measures have been created to identify and quantify areas that are considered as having low access to healthier food retailers. The 2009 and 2013 CDC (Centers for Disease Control and Prevention) *State Indicator Report on Fruits and Vegetables* 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).[10,11] The 2009 USDA ERS *Access to Affordable and Nutritious Food—Measuring and Understanding Food Deserts and Their Consequences: Report to Congress* identified areas with limited access to nutritious foods and classified each Census tract as a food desert (FD) or non-food desert (non-FD) based on its median family income and supermarket access.[12] This has recently been updated in the Food Access Research Atlas in March 2013.[8]

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 versus 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 which the study was not concerned with. 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 utilized 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, data from a previously conducted field census of retail food outlets in eight South Carolina counties, covering 169 Census tracts, were utilized.[14] This dataset was managed with ArcGIS 10.1 and included geospatial information and store type attributes on all retail food outlets located in seven rural and one urban county. 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 two 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 a fruit and vegetable market within the tract or within 0.5 miles of the boundary.[10] Supermarkets are defined as food stores with 50 or more annual payroll employees, while large grocery stores have 10 to 49 employees. In order to compare the CDC's definition with the USDA ERS' definition described below, the focus was on non-HFRTs. The replication of this measure relied on supermarkets, large grocery stores and fruit and vegetable markets, and utilized 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, i.e. a poverty rate of at least 20%, a median family income less than 80% of the statewide median family income for tracts in non-metropolitan areas, or a median family income less than 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 more than 1 mile from a supermarket in an urban tract or more than 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 0.5km×0.5km 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 (i.e. 2009) to the point of data collection on the study sample (i.e. 2010). Additionally, a 10-mile buffer corridor was created around the study area, using InfoUSA and Dun & Bradstreet

commercial data, to account for edge effects due to food stores that could lie outside the boundaries of the study area.

Study Sample

The study's protocol was reviewed and approved by the University of South Carolina (USC) Institutional Review Board. Data on residents' perceptions and shopping behaviors were obtained via telephone interviews of 968 residents of the eight counties. The USC 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 or older, the primary food shopper of their household, speak English and reside within the study area boundaries. The estimated response rate, after using the American Association for Public Opinion Research Response Rate Formula 4,[18] was 47.1%. The respondent data were geocoded and linked to the geo-spatial data, so that each participant was assigned to her/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] ArcGIS 10.1 was used to compute road network distances in miles and determine whether they shopped at their nearest food store. Shopping miles per week were computed by multiplying the shopping frequency with the distance to the primarily utilized food store times two. Supercenter utilization 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 four questions.[20] Specifically, they asked about (a) the selection and (b) quality of fresh fruits and vegetables, (c) the selection of low fat products, and (d) the lack of access to adequate food shopping in the respondent's neighborhood (which was defined as a mile or 20 minute walk from their home). The responses were coded on a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) for questions a–c, and from 1 to 4 (1 = very serious problem, 2 = somewhat serious problem, 3 = minor problem, 4 = not really a problem) for the question d. 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 three perception questions were reverse-coded and transformed to a 0 to 4 point scale, with a higher number indicating stronger agreement with availability. A composite score ranging from 0 to 12 was created. The food shopping access question was assessed on a 0 to 3 point scale, with a higher number indicating better access.

Statistical Analysis

Distance to primarily utilized food store and shopping frequency per week were winsorized at the 95th percentile and 99th percentile, respectively, to address extreme outliers and

skewness. A universal exclusion variable removed individuals with missing data on any of the study variables, resulting in a final sample size of 685 participants. There were no significant differences in the socio-demographic characteristics (such as race, age and education level) between the original and final study sample. Race was coded as 0 (non-Hispanic white) and 1 (other races). All statistical analyses were conducted with SAS (Version 9.3, Cary, NC). Bonferroni-adjusted alpha levels were set for analyses shown in Table 2, 3, and 4.

Ordinary Least Squares regression provided estimates of the unstandardized regression coefficients, *p*-values and overall model R^2 for the continuous outcomes. Point estimates, including unstandardized regression coefficients (bs), were used to examine differences in adjusted means for all continuous outcome variables, while controlling for other predictors. Cohen's *d*, which is an effect size measure that indicates a standardized magnitude of the observed difference between access groups was calculated so comparisons could be made in residents' mean shopping behaviors and food perceptions across the study variables. Cohen's *d* cutoffs are defined as: factors < 0.2 indicates a small effect size, 0.5 indicates a moderate effect size and >0.8 indicates as large effect size.[21] The 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%), 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%), had an average age in the late 50s, and an annual household income of $40,000 to $49,900. Differences in characteristics between residents of low and high food access areas were observed for (a) urban residence (non-HFRT vs. HFRT: 3.5% vs. 29.7%, $p<0.001$), (b) marital status (non-HFRT vs. HFRT: 59.2% vs. 67.6%, $p=0.024$), (c) high school education (non-HRFT vs. HRFT: 42.6% vs. 30.7%, $p<0.001$), and (d) race/ethnicity (FD vs. non-FD: 55.6% vs. 68.0%, $p=0.010$; non-HFRT vs HFRT: 60.9% vs. 69.3%, $p=0.022$). Table 1 displays the socio demographic characteristics of the original and final study sample.

Descriptive characteristics of food shopping behaviors and food environment perceptions are shown in Table 2. In this unadjusted analysis, the differences between residents of FDs vs. non-FD were distance to primary utilized 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 three 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 0.0045 (=0.05/11), the difference in distance to primarily utilized food store under the USDA ERS measure was no longer significant.

Results of multivariate models controlling for demographic and socioeconomic characteristics are shown in Table 3. Residents of FDs traveled significantly further distances to their primarily utilized food store (8.8 vs. 7.1 miles). However, after applying the Bonferroni correction where the adjusted alpha level became 0.007, distance to primarily utilized 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 (OR=1.0; 95% CI 0.3–3.8) or total shopping miles per week (26.7 vs. 19.2 miles) or likelihood of supercenter utilization (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 *d* statistic showed moderate effect sizes for the significant differences (0.17 to 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 further to their primarily utilized 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 to residents of HFRTs. The Cohen's *d* statistic showed moderate effect sizes (0.27 to 0.39) and the total explained variation ranged from 1.7% to 18.2%. No differences in resident's food shopping access rating (of 2.2 vs. 2.4), frequency of shopping (1.8 vs. 2.0 times per week), likelihood of supercenter utilization (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 any significant differences.

DISCUSSION

At the current time, 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 two US federal agencies. Evidence was found 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 utilized food store and accrue more total shopping miles per week. There was also evidence that supported 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 utilization, 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 SNAP 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] While the current research study only included approximately 10% SNAP participants, it was similarly found that 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 is generally not the most proximal.[27,28] These findings suggest that lack of access to a supermarket is not necessarily a major factor on 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 more than 3 miles further to their primarily utilized food store and accrue more total shopping miles per week than those living in high access areas. While 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 developed a model of household grocery shopping behavior.[30] 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, Bawa and Ghosh's model would suggest 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 as shopping frequency was very similar in low and high access area residents. In the study, residents were asked about their primary mode of transportation to the food store and it was found that 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.

The study furthermore 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] have shown that residents' food environment-related perceptions were influenced by neighborhood characteristics such as supermarket density. The present 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 Bonferroni correction was used. After applying this correction, one of the shopping behaviors under the USDA ERS measure, distance to primarily utilized food store, was no longer significant in both the unadjusted (Table 2, adjusted $\alpha = 0.0045$) and adjusted analyses (Table 3 and 4, adjusted $\alpha = 0.007$). 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 very 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. Even though the FD and non-HFRT definitions in the study area do not necessarily overlap geographically,[33] the present paper 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. While the results are likely generalizable to the southeastern US, further examination of both measures in other geographic locations would be worthwhile. Secondly, due to the geographically-based study design, listed landline phone numbers including addresses were sampled, resulting in a middle-aged and older population of women who are significantly more likely to be responsible for a household's food shopping and food preparation compared to 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 not representative of the part of the population that are non-English speakers. 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 GPS devices for multiple days that would have allowed characterization of travel space and time.[26,36] The limited population used in the study may cause some concern. While a larger sample size would have been preferred, 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 one category and race/ethnicity was coded as Non-Hispanic White (n=451) versus other.

Among the strengths of the study is that because the food access measures were derived from ground-truthed data, the identification of the low and high access areas is substantially more valid than if it had relied on unvalidated food outlet data.[37] Lastly, the study area contained both urban and rural areas and thus expands generalizability beyond previous research which has 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, policymakers 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. Lastly, when health care providers make recommendations on diet and life style choices, they may want to consider their patients' food environment.

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REFERENCES

1. Lake AA, Hyland RM, Mathers JC, Rugg-Gunn AJ, Wood CE, Adamson AJ. Food shopping and preparation among the 30-somethings: whose job is it? (The ASH30 study). British Food Journal. 2006; 108:475–486.
2. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. JAMA. 2010; 303:235–241. [PubMed: 20071471]
3. Rodriguez, G.; Sjoberg, A.; Lissner, L.; Moreno, LA. Epidemiology of obesity in children and adolescents. Springer; 2011. Food patterns and nutrient intake in relation to childhood obesity; p. 329-346.
4. Ahern M, Brown C, Dukas S. A national study of the association between food environments and county-level health outcomes. J Rural Health. 2011; 27:367–379. [PubMed: 21967380]
5. Spence JC, Cutumisu N, Edwards J, Raine KD, Smoyer-Tomic K. Relation between local food environments and obesity among adults. BMC Public Health. 2009; 9:192. [PubMed: 19538709]
6. Power ML. The human obesity epidemic, the mismatch paradigm, and our modern "captive" environment. Am J Hum Biol. 2012; 24:116–122. [PubMed: 22287210]
7. Dutko, P.; Ver Ploeg, M.; Farrigan, T. [Accessed on 10-25-2013] Characteristics and Influential Factors of Food Deserts. Available at: http://www.ers.usda.gov/publications/err-economic-research-report/err140.aspx
8. USDA Food Access Research Atlas. U.S. [Accessed on 3-22-2013] Department of Agriculture, Economic Research Service. Available at: http://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas.aspx
9. Ver Ploeg, M.; Breneman, V.; Dutko, P.; Williams, R.; Snyder, S.; Dickinson, C.; Kaufman, P. [Accessed on 9-4-2013] Access to affordable and nutritious food: updated estimates of distance to supermarkets using 2010 data. 2012. Available at: http://www.ers.usda.gov/publications/err-economic-research-report/err143.aspx
10. State Indicator Report on Fruits and Vegetables, 2013. [Accessed on 9-2-2013] Centers for Disease Control and Prevention. Available at: http://www.cdc.gov/nutrition/downloads/State-Indicator-Report-Fruits-Vegetables-2013.pdf
11. State Indicator Report on Fruits and Vegetables, 2009. [Accessed on 10-25-2010] Centers for Disease Control and Prevention. Available at: http://www.fruitsandveggiesmatter.gov/downloads/StateIndicatorReport2009.pdf
12. Ver Ploeg, M.; Breneman, V.; Farrigan, T.; Hamrick, K.; Hopkins, D.; Kaufman, P. [Accessed on 5-10-2010] Access to affordable and nutritious food: measuring and understanding food deserts and their consequences: report to congress. 2009. Available at: http://www.ers.usda.gov/Publications/AP/AP036/
13. Gustafson AA, Sharkey J, Samuel-Hodge CD, et al. Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. Public Health Nutr. 2011; 14:1032–1038. [PubMed: 21324229]
14. Liese AD, Colabianchi N, Lamichhane A, et al. Validation of Three Food Outlet Databases: Completeness and Geospatial Accuracy in Rural and Urban Food Environments. American Journal of Epidemiology. 2010; 172:1324–1333. [PubMed: 20961970]
15. United States Census 2010. [Accessed on 4-19-2013] United States Census Bureau. Available at: http://www.census.gov/2010census
16. Liese AD, Hibbert JD, Ma X, Bell BA, Battersby SE. Where are the food deserts? A comparison of policy-relevant measures of community food environment in South Carolina. Journal of Hunger & Environmental Nutrition. 2014 In Press.
17. Powell LM, Han E, Zenk SN, et al. Field validation of secondary commercial data sources on the retail food outlet environment in the U.S. Health Place. 2011; 17:1122–1131. [PubMed: 21741875]

18. American Association for Public Opinion Research. Standard Definitions, Final Dispositions of Case Codes and Outcome Rates for Surveys. American Association for Public Opinion Research. Available at: http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions%20&Template=/CM/ContentDisplay.cfm&ContentID=1819.
19. North American Industry Classification System (NAICS). [Accessed on 9-5-2013] US Census Bureau. Available at: http://www.census.gov/epcd/www/naics.html
20. Ma X, Barnes TL, Freedman DA, Bell BA, Colabianchi N, Liese AD. Test-retest reliability of a questionnaire measuring perceptions of neighborhood food environment. Health Place. 2013; 21:65–69. [PubMed: 23434497]
21. Null hypothesis testing and effect sizes. Statistics for Psychology. Statistics for Psychology. Available at: http://staff.bath.ac.uk/pssiw/stats2/page2/page14/page14.html.
22. Jilcott SB, McGuirt JT, Carr LJ, Wu Q, Keyserling TC. Associations between Body Mass Index, Shopping Behaviors, Amenity Density, and Characteristics of the Neighborhood Food Environment among Female Adult Supplemental Nutrition Assistance Program (SNAP) Participants in Eastern North Carolina. Ecology of Food and Nutrition. 2013; 51:526–541.
23. Ohls, JC.; Ponza, M.; Moreno, L.; Zambrowski, A.; Cohen, R. [Accessed on 6-15-2013] Food stamp participants' access to food retailers. United States Department of Agriculture. 1999 Jul. Available at: http://www.fns.usda.gov/sites/default/files/retailer.pdf
24. Moore LV, Diez Roux AV, Nettleton JA, Jacobs DR Jr. Associations of the local food environment with diet quality--a comparison of assessments based on surveys and geographic information systems: the multi-ethnic study of atherosclerosis. Am J Epidemiol. 2008; 167:917–924. [PubMed: 18304960]
25. Hirsch JA, Hillier A. Exploring the role of the food environment on food shopping patterns in Philadelphia, PA, USA: a semiquantitative comparison of two matched neighborhood groups. Int J Environ Res Public Health. 2013; 10:295–313. [PubMed: 23343984]
26. Gustafson A, Christian JW, Lewis S, Moore K, Jilcott S. Food venue choice, consumer food environment, but not food venue availability within daily travel patterns are associated with dietary intake among adults, Lexington Kentucky 2011. Nutr J. 2013; 12:17. [PubMed: 23360547]
27. Hillier A, Cannuscio CC, Karpyn A, McLaughlin J, Chilton M, Glanz K. How far do low-income parents travel to shop for food? Empirical evidence from two urban neighborhoods. Urban Geogr. 2011; 32:712–729.
28. Drewnowski A, Aggarwal A, Hurvitz PM, Monsivais P, Moudon AV. Obesity and supermarket access: proximity or price? Am J Public Health. 2012; 102:e74–e80. [PubMed: 22698052]
29. Krukowski RA, West DS, Harvey-Berino J, Elaine Prewitt T. Neighborhood Impact on Healthy Food Availability and Pricing in Food Stores. J Community Health. 2010; 35:315–320. [PubMed: 20127506]
30. Bawa K, Ghosh A. A model of household grocery shopping behavior. Marketing letters. 1999; 10:149–160.
31. Moore LV, Diez Roux AV, Brines S. Comparing Perception-Based and Geographic Information System (GIS)-based characterizations of the local food environment. J Urban Health. 2008; 85:206–216. [PubMed: 18247121]
32. Blitstein JL, Snider J, Evans WD. Perceptions of the food shopping environment are associated with greater consumption of fruits and vegetables. Public Health Nutr. 2012; 15:1124–1129. [PubMed: 22348332]
33. Liese AD, Barnes TL, Lamichhane AP, Hibbert JD, Colabianchi N, Lawson AB. Characterizing the food retail environment: Impact of count, type and geospatial error in two secondary data sources. Journal of Nutrition Education and Behavior. 2013; 45:435–442. [PubMed: 23582231]
34. Dholakia RR, Pedersen B, Hikmet N. Married males and shopping: are they sleeping partners. International Journal of Retail & Distribution Management. 1995; 23:27–33.
35. Blumberg, SJ.; Luke, JV. [Accessed on 8-27-2012] Wireless Substitution: Early Release of Estimates From the. National Health Interview Survey, January - June 2009. Centers for Disease Control and Prevention. Available at: http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless200912.pdf.

36. Zenk SN, Schulz AJ, Matthews SA, et al. Activity space environment and dietary and physical activity behaviors: a pilot study. Health Place. 2011; 17:1150–1161. [PubMed: 21696995]

37. McKinnon RA, Reedy J, Morrissette MA, Lytle LA, Yaroch AL. Measures of the Food Environment A Compilation of the Literature, 1990–2007. Am J Prev Med. 2009; 36:124–133.

Practice Points

1. Residents from low food access areas have poorer perceptions of their food environment and travel further to their primary food store.
2. A person's food environment should be taken into account when dietary recommendations are made.
3. 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.

Table 1

Descriptive characteristics among residents of low and high food access areas.

Characteristics	Study Sample n=685	USDA ERS 2013 Matrix		CDC 2013 Matrix	
		FD n=117	Non-FD n=568	Non-HFRT n=284	HFRT n=401
Non-Hispanic White,%	65.8	55.6	68.0	60.9	69.3
Income, Mean	40–49.9K	40–49.9K	40–49.9K	40–49.9K	40–49.9K
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 GED	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
SNAP Participation,%	9.6	8.6	9.9	11.3	8.5
Age, Mean	56.6	56.7	56.5	56.3	56.7

*Means listed for continuous variables. Percentages listed for categorical variables.

FD, Food Desert; HFRT, Healthier Food Retail Tract; SNAP, Supplemental Nutrition Assistance Program; GED, General Education Development.

Table 2

Food shopping behaviors and perceptions of food environment of residents of low versus high food access areas (n=685)

	Mean (SD) or Percentage					
	USDA ERS 2013 Matrix			CDC 2013 Matrix		
	FD n=117	Non-FD n=568	*p*	Non-HFRT n=284	HFRT n=401	*p*
Shopping Behaviors[a]						
Distance to Primarily Utilized Food Store (miles)	11.4 (8.0)	9.6 (8.2)	0.034	**12.7 (7.1)**	**8.0 (8.4)**	**<.0001**
Median, IQR	10.8, 12.9	7.9, 10.1		11.8, 9.1	5.4, 8.9	
Shopping Frequency (per week)	1.8 (1.8)	2.0 (2.2)	0.534	1.8 (1.9)	2.1 (2.3)	0.157
Median, IQR	1.0, 1.0	1.0, 1.0		1.0, 1.0	1.0, 2.0	
Total Shopping Miles (per week)	39.1 (62.8)	31.7 (41.2)	0.110	**42.6 (51.8)**	**26.0 (39.4)**	**<.0001**
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)**	**<.0001**	**8.9 (4.2)**	**3.7 (3.4)**	**<.0001**
Median, IQR	8.3, 10.0	4.8, 5.9		8.3, 5.8	2.4, 4.6	
Supercenter Utilization (%)	22.2	28.5	0.164	29.9	25.7	0.220
Shopping at Nearest Store (%)	2.6	2.5	0.950	1.8	3.0	0.307
Perception Measures *						
Healthy Food Availability in Neighborhood (0–12)	5.7 (3.5)	6.3 (3.6)	0.081	**5.2 (3.4)**	**7.0 (3.4)**	**<.0001**
Fruit & Vegetable Selection (0–4)	1.9 (1.4)	2.1 (1.4)	0.176	**1.7 (1.4)**	**2.4 (1.3)**	**<.0001**
Fruit & Vegetable Quality (0–4)	2.0 (1.3)	2.2 (1.3)	0.131	**1.8 (1.3)**	**2.4 (1.2)**	**<.0001**
Low Fat Selection (0–4)	1.8 (1.3)	2.0 (1.3)	0.072	**1.6 (1.2)**	**2.2 (1.3)**	**<.0001**
Food Shopping Access (0–3)	**1.7 (1.2)**	**2.1 (1.1)**	**<0.001**	**1.9 (1.2)**	**2.2 (1.0)**	**<.0001**

[a] T-test for continuous variables and chi-square test for categorical variables.

* The Healthy Food Availability in Neighborhood variable was a composite score evaluated on a 0 to 12 point scale and created from responses to the three questions with 0 to 4 point scales, with a higher number indicating stronger agreement. The Food Shopping Access measure was assessed on a 0 to 3 point scale, with a higher number indicating less of a problem.

* Bonferroni adjusted alpha level is (0.05/11) = 0.0045.

FD, Food Desert; HFRT, Healthier Food Retail Tract; IQR, Interquartile Range; SD, Standard Deviation.

Table 3

Differences in spatial attributes of food shopping behaviors and perceptions of food environment between residents of USDA ERS FDs versus non-FDs (n=685)

Outcomes	Model Parameters			Estimated Mean and Effect			
	β (SE)[a]	OR (95% CI)	*p*	USDA ERS FD (estimated mean)	USDA ERS Non-FD (estimated mean)	Adjusted Mean Difference	Cohen's *d*[b]
Shopping Behaviors							
Distance to Primarily Utilized Food Store (miles)	1.70 (0.78)		0.030	8.8	7.1	1.7	0.22
Shopping Frequency (per week)	−0.11 (0.22)		0.618	1.8	1.9	−0.1	0.05
Total Shopping Miles (per week)	7.52 (4.57)		0.100	26.7	19.2	7.5	0.17
Supercenter Utilization		0.69 (0.43, 1.13)	0.139	77.8[c]	71.5	6.3	0.99
Shopping at Nearest Store		1.05 (0.29, 3.83)	0.947	97.5[c]	97.4	0.1	0.29
Perception Measures							
Healthy Food Availability in Neighborhood	−0.65 (0.35)		0.062	6.9	7.6	−0.7	0.19
Perception of Food Shopping Access	**−0.37 * (0.11)**		**<.0001**	2.0	2.4	−0.4	0.36

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

*Bonferroni adjusted alpha level is (0.05/7) = 0.007.

[a]Standardized regression coefficients (i.e., betas), standard errors, and the beta 95% confidence intervals from OLS regression models for continuous outcomes.

[b]Calculated as the (mean of low access – mean of high access) / root mean square error.

[c]These values represent the percent of "yes" responses for both the supercenter utilization and shopping at nearest store outcomes.

FD, Food Desert; HFRT, Healthier Food Retail Tract; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval.

Table 4

Differences in spatial attributes of in food shopping behaviors and perceptions of food environment between residents of CDC non-HFRTs versus HFRTs (n=685)[a]

Outcomes	Model Parameters			Estimated Mean and Effect			
	β (SE)[a]	OR (95% CI)	*p*	CDC Non-HFRT (estimated mean)	CDC HFRT (estimated mean)	Adjusted Mean Difference	Cohen's *d*[b]
Shopping Behaviors							
Distance to Primarily Utilized Food Store (miles)	**3.01 * (0.62)**		**<0.001**	9.2	6.1	3.1	0.37
Shopping Frequency (per week)	−0.16 (0.18)		0.374	1.8	2.0	−0.2	0.07
Total Shopping Miles (per week)	**12.60 * (3.68)**		**<0.001**	28.0	15.4	12.6	0.27
Supercenter Utilization		1.22 (0.85, 1.77)	0.276	71.4[c]	72.8	−1.4	0.29
Shopping at Nearest Store		0.52 (0.17, 1.59)	0.248	97.8[c]	97.5	0.3	0.15
Perception Measures							
Healthy Food Availability in Neighborhood	**−1.39 * (0.28)**		**<0.001**	6.6	8.0	−1.4	0.39
Perception of Food Shopping Access	−0.16 (0.09)		0.071	2.2	2.4	−0.2	0.14

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

*Bonferroni adjusted alpha level is (0.05/7) = 0.007.

[a]Standardized regression coefficients (i.e., betas), standard errors, and the beta 95% confidence intervals from OLS regression models for continuous outcomes.

[b]Calculated as the (mean of low access – mean of high access) / root mean square error.

[c]These values represent the percent of "yes" responses for both the supercenter utilization and shopping at nearest store outcomes.

FD, Food Desert; HFRT, Healthier Food Retail Tract; SE, Standard Error; OR, Odds Ratio; CI, Confidence Interval.