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Do GIS-derived measures of fast food retailers convey perceived fast food opportunities? Implications for food environment assessment

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Abstract

Purpose—Geographic information systems (GISs) have been used to define fast food availability, with higher availability perhaps promoting poorer quality diets. Alternative measures involve perceptions; however, few studies have examined associations between GIS-derived and perceived measures of the food environment.

Methods—Telephone surveys of 705 participants within an eight-county region in South Carolina were analyzed using logistic regression to examine relationships between geographic presence of and distance to various types of food retailers and perceived fast food availability.

Results—The mean distance to the nearest fast food restaurant was 6.1 miles, with 16% of participants having a fast food restaurant within 1 mile of home. The geographic presence of and distance to all food retailer types were significantly associated with perceived availability of fast food in unadjusted models. After adjustment, only the presence of a fast food restaurant or pharmacy was significantly associated with greater odds of higher perceived availability of fast food. Greater odds of lower perceived availability of fast food were observed with the presence of a dollar store and increasing distance to the nearest supermarket or pharmacy.

Conclusions—Measures of fast food availability, whether objective or perceived, may not be interchangeable. Researchers should carefully decide on the appropriate measurement tool—GIS-derived or perceived—in food environment studies.

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Keywords

Fast food; Food retailers; Perception; Survey; Geographic; GIS

Introduction

The relationship between fast food opportunities and diet has become an area of interest in food environment research [1]. Foods purchased at fast food restaurants account for nearly 15% of both children's and adults' diets in the United States [2,3]. Coinciding with growing obesity rates, the number of fast food retailers in the United States has increased dramatically in recent years [4–6]. Researchers have hypothesized that greater availability and access to fast food outlets have contributed to the obesity epidemic by promoting unhealthy eating behaviors characterized by higher calorie meals [4]. However, studies examining the influence of fast food retailers have found mixed results in regards to diet quality and weight status [4,5,7]. A key issue with the existing literature could be with the way fast food exposure is measured. A few studies have used geographic information systems (GIS) to measure fast food exposure; however, many have not found a significant relationship between GIS-based fast food availability and fast food consumption [8–10]. In contrast, studies using subjective or perceived measures of fast food availability to examine this relationship have reported significant associations [9,11].

A growing body of evidence supports the notion that the food environment cannot be represented by just objective or subjective measures alone [7].

As mentioned, varying methods of measuring fast food opportunity could be responsible for inconsistencies between studies. To date, most studies have used objective measures of fast food exposure via GIS [4,12–14]. Typically, GIS or geographic measures have been defined according to the presence or number of food outlets in a given geographical area [12,13] or the ease of access (e.g., travel distance) to available food outlets [12,13,15]. However, because they typically rely on secondary data sources, GIS-based measures are subject to inaccuracies in the number of food outlets accounted for, the outlet-type designation, and the geospatial location of the outlets [4,16,17].

An individual's perception of fast food availability has emerged as alternative method to characterize fast food exposure; however, few studies have used such perception (e.g., subjective) measures of fast food availability in relation to fast food consumption and diet quality [9,11,18,19]. Specifically, Moore et al. (2009) reported that participants who lived in areas with higher self-reported exposure to fast food had 27% higher odds of consuming fast food near their home compared to those living in areas with lower reported exposure [9]. Ho et al. (2010) found that perceived availability of fast food is significantly associated with higher fast food consumption in a sample of adolescent boys [18]. Recently, Oxele et al. (2015) found no significant association of either perceived or GIS-based fast food availability with weekly fast food consumption in a sample of middle-aged adults [19]. However, the relationship between perceived and GIS-based fast food availability has not been examined in depth.

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Some researchers have pointed out that identifying fast food restaurants as the sole source of fast food in a neighborhood underestimates exposure [20]. As such, studies should consider nontraditional sources, such as supermarkets and convenience stores, as potential fast food and takeaway sources [20,21]. In addition to the different types of venues, researchers have also shown that fast food outlets and supermarkets tend to cluster geographically [22]. Thus, it is possible that a single food environment contains supermarkets, fast food chains, and convenience stores in close proximity. No previous studies have looked at the association between GIS-based measures of nontraditional fast food retailers and the perception of fast food availability.

Thus, the purpose of this study was twofold. First, using data collected from telephone surveys, the relationship between participants' perceived availability of fast food restaurants in their neighborhoods (defined as a 1-mile distance from home) and GIS-based (geographic) measures of fast food restaurants using a validated database (defined as GIS-based presence of and distance to the nearest food outlet) were examined. Additionally, the relationship between perceived availability of fast food restaurants and GIS-based measures of other types of food retailers, including supermarkets and/or supercenters, convenience stores, dollar and variety stores, and drug and pharmacy venues, and their impact on the association between perceived and GIS-based fast food availability were evaluated. Implications of this research contribute to ongoing efforts to redefine "food access" [7], especially as it relates to fast food exposure. Studies have shown that both perceived and objective measures of fast food opportunities can be useful tools to characterize a person's food environment; however, the relationship between the two types of measures are still underdeveloped. Evidence is needed to determine if GIS-based and perception measures are either complementary, interchangeable, or both.

Material and methods

This was a cross-sectional study using responses from a telephone survey of 968 primary household food shoppers, including geographic measures of their food environment. The study area (Fig. 1) was a contiguous geographical area encompassing eight counties in the Midlands region of South Carolina including one urban county (Richland) and seven rural counties (Calhoun, Chester, Clarendon, Fairfield, Kershaw, Lancaster, and Orangeburg). The one urban county contains the state capital, Columbia. The study area covered 5575 square miles (8920 km^2) and a population of more than 620,000. This article reports supplemental analyses related to a larger research effort aimed at developing measures of the built nutritional environment [16,17] and examining perceptions, shopping behaviors and diet in residents of the eight-county study region [23,24]. This study was approved by the University of South Carolina Institutional Review Board.

Study participants

Recruitment of study participants was geographically based to achieve good spatial coverage of the study area. Selection was done through a random selection of landline telephone numbers with listed addresses and was restricted to the 64 eligible ZIP codes within the study area, with a goal of 15 respondents per ZIP code. Recruitment calls were made by the

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interviewing staff of the University of South Carolina Survey Research Laboratory, during which respondents were screened with respect to the eligibility criteria, including being (1) at least 18 years of age, (2) the primary food shopper for the household, (3) capable of speaking English, and (4) living in the eight-county study area. Of the 2477 household telephone numbers screened, a total of 968 residents were eligible and completed the interview. However, there were 553 respondents that refused to participate; 377 that were ineligible; and 579 of noncontact, unknown, or other status. Applying the American Association for Public Opinion Research Response Rate Formula 4 [25], a response rate of 47% was estimated, which is comparable to the 49% found among landline households in a recent evaluation of the Behavioral Risk Factor Surveillance System landline response rates conducted in 18 U.S. states [26]. For analyses, participants were removed if they were missing any demographic or geographic data ($n = 263$), resulting in a final sample within nonmissing data of 705 participants.

Perceived availability of fast food

Perceived fast food availability was ascertained using a previously validated question during the telephone survey [27]; this question has also been used previously by other researchers [9]. Survey participants were asked to indicate the extent to which they agree with the following statement: “there are many opportunities to purchase fast foods in my neighborhood such as McDonald’s, Taco Bell, KFC, and takeout pizza places, and so forth.” Neighborhood was defined as a 1-mile buffer or 20-minute walk from home. Survey responses were “strongly agree” (1), “agree” (2), “neither agree nor disagree (neutral)” (3), “disagree” (4), and “strongly disagree” (5). For analysis purposes and ease of interpretation, responses were reverse coded and scaled to range from 0 to 4, with a score of 0 indicating the lowest perceived availability of fast food opportunities and a score of 4 indicating the highest perceived availability of fast food. The test-retest reliability has been previously examined, with an intraclass correlation of 0.66 (0.54–0.76) [23]. The fast food variable was then collapsed into a two categories: lower (0 or 1 score) versus higher (3 or 4) perceived availability of fast food. Those participants with a neutral score of 2 were removed from analyses ($n = 7$).

Geographic measures of the food environment

All geospatial analyses were conducted using ArcGIS 10.0 (ESRI Redlands, CA 2010). Geographic measures were calculated using the geocoded residents’ home addresses as the point of reference, with a 1-mile street and road network buffer representing the neighborhood boundaries. A 1-mile network buffer was selected to reflect the survey question and reasonable driving path participants may have to travel to the nearest retailer versus a Euclidean distance. All street network data were provided by StreetMap Premium within ArcGIS [28]. Addresses of study participants were then linked with an existing, validated geospatial database on retail food outlets [16,17]. Briefly, this database consisted of food retailers that were initially identified using three different data sources, then validated via direct field observation and verification (presence and geospatial location), and then classified using a name-based algorithm. Details of this database have been previously described [16,17]. Presence of food outlets within the buffer and the distance to the nearest food outlet of each type were then calculated using the shortest street distance based on

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StreetMap Premium data. For each outlet type, the presence of at least one outlet was determined within the corresponding 1-mile network buffer constructed for that study participant. The food retailer types were fast food restaurants, supermarkets, supercenters, warehouse clubs, convenience stores, drug and pharmacy stores, and dollar and variety stores. Supermarkets, supercenters, and warehouse clubs (of which there was only one within entire study region) were aggregated and classified as supermarkets and/or supercenters. Distances to the nearest measures were calculated independent of the whether a food retailer was present within the 1 mile network buffer. Thus, it is possible for a participant to not have a supermarket present within one mile of their home, yet have their nearest supermarket be close to 1 mile away. Examples of a 1-mile network buffer and distance to the nearest measure are shown in Figure 2.

Demographic covariates

The telephone survey included questions on demographic and socioeconomic characteristics that were based on Behavioral Risk Factor Surveillance System [29]. Age (in years) and the number of individuals living in the participant's household were continuous variables. Race and/or ethnicity were categorized as non-Hispanic white or minority (non-Hispanic black or African American, Hispanic and/or other). Annual household income was categorized as less than $20,000 or at least $20,000 to approximate a poverty threshold for a family of three living in the U.S. education was divided into three groups: (1) not a high school graduate, (2) high school graduate or equivalency only, and (3) some college or higher. Utilization of the Supplemental Nutrition Assistance Program and partner status were both dichotomous, coded as "yes" or "no." Employment status was a categorical variable grouped as employed, not employed, or retired.

Each participant was also classified individually on level of urbanicity, either urban or nonurban, using the 2010 U.S. Census–defined urban classification via a point-in-polygon operation within ArcGIS [30]. Specifically, an urban area was defined as any census tract classified as an "urbanized area of 50,000 or more people or urban cluster consisting of at least 2500 and less than 50,000 people." All census tracts not designated urban were considered nonurban.

Statistical analyses

Logistic regression models were used to assess the relationship between GIS-based retail food outlet measures and the perceived availability of fast food. Perceived availability was modeled as a dichotomous outcome (higher vs. lower) based on potential issues of normality given the original response variable for perceived availability of fast food was ordinal with only five levels (0 through 4). In addition, the use of logistic regression does not make the same assumptions of linear regression, for example, linearity, normality, and homoscedasticity. However, in separate analyses, we found that the relationships observed between GIS-based measures and perceived availability of fast food were the same either using logistic or linear modeling options. GIS-based presence of and distance to the nearest outlet were used as independent variables, and perceived availability of fast food (higher vs. lower) was the outcome variable in all models. Covariates included age, gender, race and/or ethnicity, education, employment, household income, Supplemental Nutrition Assistance

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Program utilization, partner status, household size and urbanicity. First, the independent influence of GIS-based presence of or distance to a specific type of food retail outlet was examined without controlling for other outlet types by conducting separate outlet type–specific models. Next, models examining the presence of or distance to all types of food outlets simultaneously were considered. In addition, the relationship between GIS-based measures of food retailers and perceived availability of fast food was examined by controlling for demographic covariates. All statistical analyses were performed in SAS version 9.3 (SAS Institute, Inc., Cary, NC).

Results

The majority of all participants in the study were female (77.7%), non-Hispanic white (65.5%), and lived in nonurban neighborhoods (79.1%) (Table 1). On average, participants were 57 years old, and more than half had some college education or higher (53.1%). Only 11% of participants did not have a high school diploma or equivalency. Nearly 23% of participants were unemployed, 32% were retired, and 29% had a household income less than $20,000 per year. Sixty-four percent of participants had a spouse or partner, and on average, each household included 2.5 residents. Overall, many participants did not have any food retailers near their home (i.e., within 1 mile), and only 16% of participants had a fast food restaurant in their neighborhood (Table 1). The mean distance to the nearest fast food restaurant for all participants was 6.1 miles, and the average distances to other food outlets ranged from 2.9 miles for convenience stores to 7.8 miles for a drug and pharmacy stores.

Table 2 summarizes the unadjusted relationships between each separate GIS-based food retail measure and perceived availability of fast food. Both the presence of fast food restaurants and the distance to the nearest fast food restaurant were significantly associated with perceived availability of fast food (odds ratio [OR] = 4.84, 95% confidence interval [CI]: 3.04–7.69 and OR = 0.85, 95% CI: 0.82–0.89, respectively). Thus, a higher proportion of participants with at least one fast food restaurant within 1 mile of their home reported a higher perceived availability of fast food compared to participants with no fast food restaurant within 1 mile of their home. Participants who lived further away from the nearest fast food restaurant were more likely to report lower perceived availability of fast food. Similarly, participants with a supermarket, convenience store, drug and pharmacy store, or dollar and variety store present each had greater odds of reporting higher perceived fast food availability, whereas those living at increased distance to these other types of food retailers had significant lower odds of reporting high perceived fast food availability.

The results of adjusted logistic models accounting for GIS-based measures for all food retail types and covariates are displayed in Tables 3 and 4. When accounting for all types of food retailers, the presence of a fast food restaurant (OR = 2.76, 95% CI: 1.37–5.54) and the presence of a drug and pharmacy store (OR = 5.02, 95% CI: 2.34–10.78) were both significantly associated with perceived availability of fast food opportunities. Participants with a dollar and variety store (OR = 0.39, 95% CI: 0.19–0.83) present in their neighborhood had much lower odds of reporting a high perception of fast food availability. However, only two of these GIS-based measures remained significantly associated after

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controlling for demographic covariates, the presence of fast food restaurants, and the presence of a drug and pharmacy store.

When modeling the adjusted relationships between GIS-based accessibility of food outlets and perceived availability of fast food, distance to the nearest fast food restaurant did not have a significant relationship with perceived availability of fast food when accounting for distance to all other types of food retailers. Significant relationships were found between distance to the nearest supermarket and to the nearest drug and pharmacy store (OR = 0.85, 95% CI: 0.78–0.93 and OR = 0.91, 95% CI: 0.86–0.95, respectively) and perception of fast food availability. In addition, the odds of reporting higher fast food availability increased as the distance to the nearest dollar store increased. All of these relationships remained after controlling for demographic covariates.

Discussion

This study examined the relationship between exposure to fast food retailers, as measured by GIS exclusively and perceived fast food opportunities. In this study, the presence of fast food restaurants in a person's neighborhood, but not the distance to these restaurants, was significantly independently associated with perceived fast food after controlling for other food retailer types and covariates. Surprisingly, other food retailers such as drug and pharmacy stores, dollar and variety stores, and supermarkets also exhibited some significant associations with perceived fast food availability.

Visits to fast food restaurants and fast food consumption have increased dramatically over the past 40 years [6,31–33]. Over 37% of sales of meals and snacks away from home are at food venues such as fast food restaurants [2]. Researchers have linked frequent fast food consumption with a less-healthful, high-calorie diet and increased body mass index [34–42]. However, findings have been varied on the relationship between fast food restaurant availability, diet quality, and weight status [4,5,7,8,34,43–48]. Such inconsistencies could be due to factors such as the availability of specific food items within food outlets, the cost of those food items, and individuals' actual food preferences, attitudes, and perceptions, beyond the scope of neighborhood availability and proximity. Thus, how people interact and make decisions within their food environment through their food purchasing and shopping choices could influence the rise in fast food consumption. However, studies have also pointed out that valid and reliable measures of the food environment are also essential to understanding potential discrepancies in studies and to improve future analyses [7]. Thus, understanding which measure is appropriate for characterizing the food environment in relationship to how people interact within their environment is just as important to move the field forward.

In a recent study, the association between participants' self-reported presence of a fast food restaurant and the GIS-based presence of fast food alone was examined [49]. Furthermore, researchers asked participants a factual-sounding question regarding whether they had a fast food restaurant within 1 mile of their home, finding participants had a very accurate recollection when reporting the presence or absence of a fast food restaurant within 1 mile of their home [49]. Thus, the findings suggest that individuals have a good idea of what is

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physically present in their neighborhood environment. However, when participants were asked a more opinion-oriented question rating their opportunities to purchase fast food in the present study, GIS-based measures were not found to be good predictors. Thus, it may be concluded that a person's perception of opportunities to purchase fast food is a different concept than a person's perceived presence of a fast food outlet: an individual's personal preferences, lifestyle, and behaviors may better predict his or her perceived availability of fast food. Based on our findings, future studies using perception measures should carefully consider the questions used and not assume a correlation or substitution between perception and GIS-based measures or vice versa.

Limitations exist in this study. First, the survey sample was limited to the primary food shoppers of the household and consisted mainly of older adults who may or may not eat out as much as younger adults or other individuals living in the household. Thus, the current findings may not be generalizable to all populations either by age, telephone usage and service, and/or region of the United States. In addition, our current sample had a slightly higher proportion of high school educated and non-Hispanic white participants than the general population in the study area which could bias some results. Second, the perceived fast food opportunity measure was determined using self-report and could be open to biases. Thus, individuals' perceptions of what constitutes a fast food restaurant may differ from the examples provided in the survey and personal perspectives and attributes. For example, individuals may consider food retailers such as sit-down restaurants or supermarket delis to be fast food.

Despite the disadvantages, our study has several strengths. A novel aspect of this study was that it also considered the association between perceived fast food availability and other types of food outlets such as supermarkets, convenience stores, and dollar and variety stores. It has been suggested that venues such as supermarkets and convenience stores, which can contain delis and takeaway food items, could be considered nontraditional fast food venues [20]. In addition, dollar and variety and drug and pharmacy stores have shelf space and freezer coolers available in which takeaway food items can be displayed. It may be that in the present study population, individuals living in closer proximity to supermarkets and drug and pharmacy stores rated the perceived availability of fast food higher by considering such amenities. Other strengths of this study include the use of a validated questionnaire examining perceived fast food opportunities [23] and the use of validated, GIS-based data on food outlets [16,17]. The study also included two GIS-based measures, including the presence of food retailers and distance to the nearest food source. In addition, the study area also contained both urban and nonurban communities. Most studies that have examined urban and nonurban differences in GIS-based measures of fast food have pointed out that fast food exposure is much higher in urban compared to rural or nonurban areas [5]. This same trend was also observed in this sample (not shown); however, to best of our knowledge, no other study has examined the association between perception and geographic-based measures of fast food availability while considering these designations.

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Conclusions

In this study, the relationship between perceived fast food availability and geographic measures of fast food restaurants and other retailers was examined, finding that the GIS-based presence of a fast food restaurant, but not distance to that restaurant, was significantly associated with perceived fast food opportunity when controlling for all other food outlet types and demographic covariates. Thus, objective and perceived measures of fast food availability may not be interchangeable. Results of this study could be helpful in providing a direction for future studies that aim to capture the factors—whether personal, environmental or both—that influence dietary behavior and obesity. Moreover, results emphasize that future studies should carefully consider the appropriate method to characterize the food environment, as the relationship between perceived and GIS-based measures of fast food is not straightforward.

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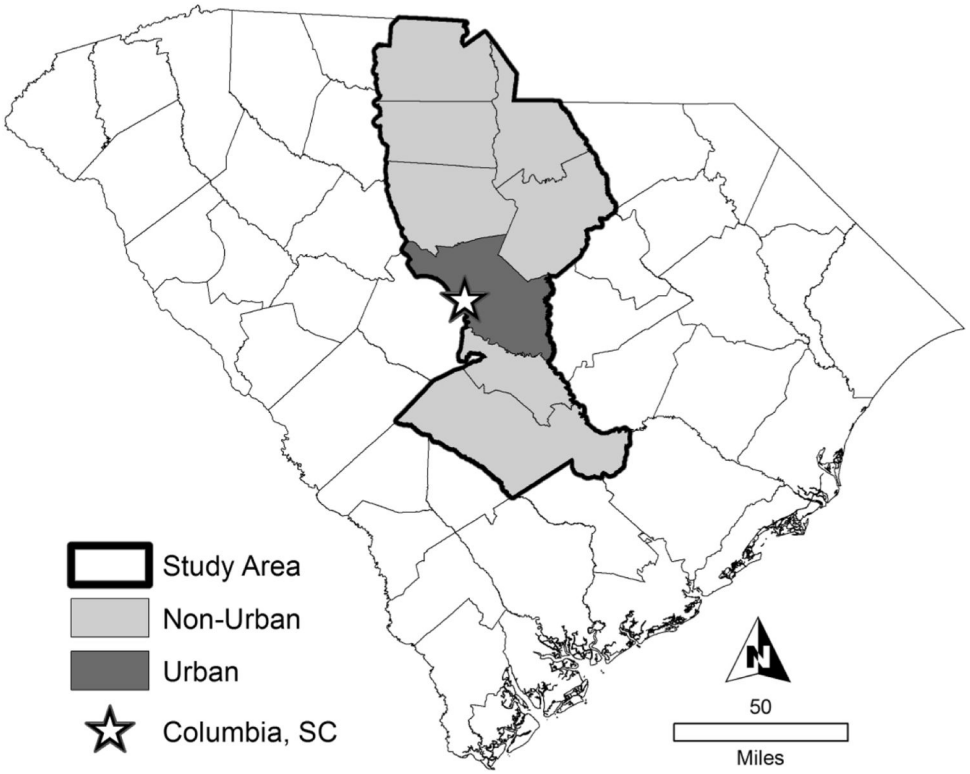

Fig. 1.
Eight-county study area in the Midlands of South Carolina.

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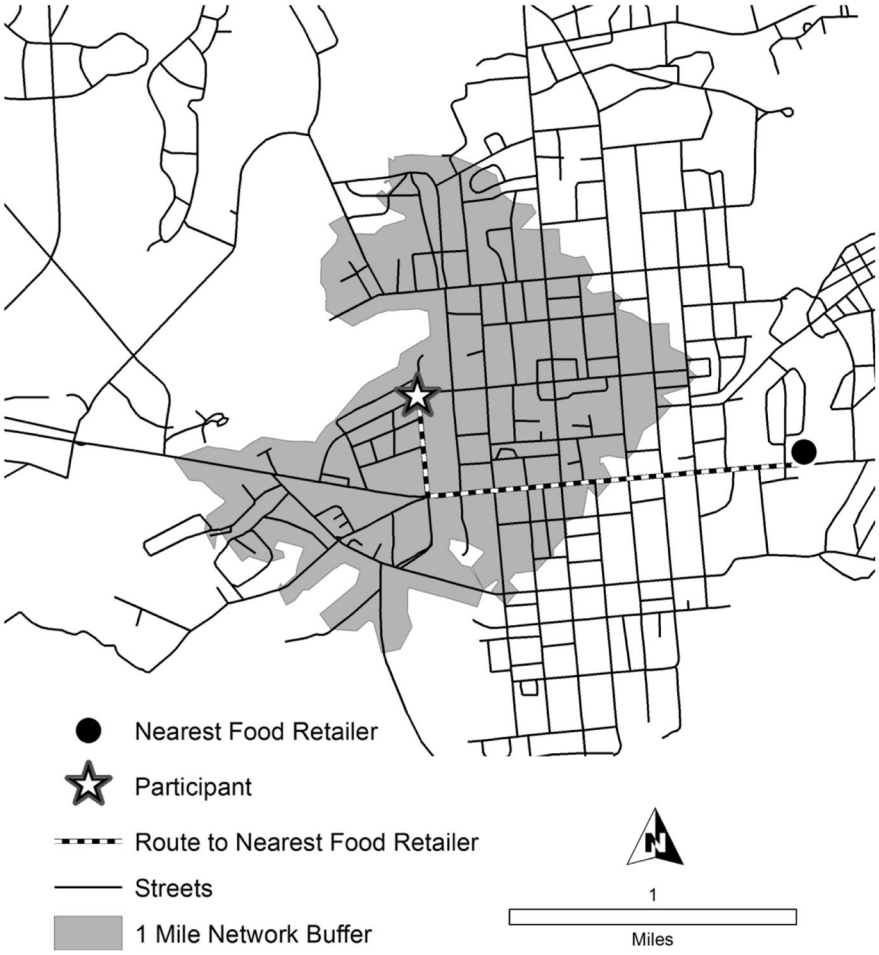

Fig. 2.
Example of 1-mile network buffer and distance to nearest retailer measure.

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Table 1

Demographic characteristics of participants living in the Midlands of South Carolina (n = 696)

Age in years, mean (SD)	56.6 (14.7)
Gender, %	
Male	22.3
Female	77.7
Race/ethnicity, %	
Minority (non-Hispanic black or African American, Hispanic and/or other)	34.5
Non-Hispanic white	65.5
Education, %	
Not a high school graduate	11.4
High school graduate	35.6
Some college or higher	53.0
Employment, %	
Not employed	22.6
Retired	31.6
Employed	45.8
Household income per year, %	
<$20,000	29.2
≥$20,000 to <$40,000	27.2
≥$40,000 to <$60,000	17.1
≥$60,000	26.6
SNAP recipient, %	
Yes	9.9
No	90.1
Spouse or partner, %	
Yes	64.1
No	35.9
# of household members, mean (SD)	2.5 (1.4)
Urbanicity	
Urban	20.8
Nonurban	79.2
Perceived availability of fast food	
Availability of fast food (within 1 mile), scoring range 0–4, mean (SD)	1.9 (1.5)
Lower availability of fast food (score of 0 or 1), %	55.0
Higher availability of fast food (score of 3 or 4), %	45.0
GIS-based food retailer measures	
Presence of fast food (within 1 mile)	
Presence of a fast food restaurant, %	16.0
Presence of other food retailers (within 1 mile)	
Presence of a supermarket, %	11.2
Presence of a convenience store, %	28.5

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Presence of a drug and pharmacy store, %	13.8
Presence of a dollar and variety store, %	14.8
Distance to fast food (miles)	
Distance to nearest fast food restaurant, mean (SD)	6.1 (5.1)
Distance to other food retailers (miles)	
Distance to nearest supermarket, mean (SD)	5.9 (4.5)
Distance to nearest convenience store, mean (SD)	2.9 (2.6)
Distance to nearest drug and pharmacy store, mean (SD)	7.8 (5.9)
Distance to nearest dollar and variety store, mean (SD)	5.1 (4.1)

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Table 2

Unadjusted associations between GIS-based food retailer measures and perceived availability of fast food in survey participants living in the Midlands of South Carolina (n = 696)

	Perceived availability of fast food; higher versus lower
	OR 95% CI
Independent variables	
GIS-based food retailer measures	
Presence of fast food (within 1 mile)	
Presence of a fast food restaurant	4.84 (3.04–7.69)
Presence of other food retailers (within 1 mile)	
Presence of a supermarket	2.41 (1.59–3.63)
Presence of a convenience store	2.43 (1.74–3.41)
Presence of a drug and pharmacy store	6.73 (3.93–11.53)
Presence of a dollar and variety store	2.06 (1.35–3.16)
Distance to fast food (miles)	
Distance to nearest fast food restaurant	0.85 (0.82–0.89)
Distance to other food retailers (miles)	
Distance to nearest supermarket	0.83 (0.80–0.87)
Distance to nearest convenience store	0.82 (0.77–0.88)
Distance to nearest drug and pharmacy store	0.87 (0.84–0.90)
Distance to nearest dollar and variety store	0.88 (0.84–0.91)

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Table 3

Adjusted associations between GIS-based presence of food retailers and perceived availability of fast food of survey participants living in the Midlands of South Carolina (n = 696)

	Perceived availability of fast food; higher versus lower	
	Model 1	Model 2
	Adjusted for all food retailers only	Adjusted for all food retailers and demographic covariates*
	OR 95% CI	OR 95% CI
Independent variables		
GIS-based food retailer measures		
Presence of fast food (within 1 mile)		
Presence of a fast food restaurant	2.76 (1.37–5.54)	2.40 (1.12–5.15)
Presence of other food retailers (within 1 mile)		
Presence of a supermarket	0.97 (0.52–1.83)	0.83 (0.43–1.63)
Presence of a convenience store	1.34 (0.83–2.16)	1.14 (0.68–1.91)
Presence of a drug and pharmacy store	5.02 (2.34–10.78)	3.29 (1.45–7.49)
Presence of a dollar and variety store	0.39 (0.19–0.83)	0.53 (0.23–1.21)

*Adjusted for age, gender, race/ethnicity, education, employment status, household income, SNAP status, spouse or partner, number of household members, and urbanicity.

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Table 4

Adjusted associations between GIS-based distance to nearest food retailers and perceived availability of fast food of survey participants living in the Midlands of South Carolina (n = 696)

	Perceived availability of fast food; higher versus lower	
	Model 1	Model 2
	Adjusted for all food retailers only	Adjusted for all food retailers and demographic covariates*
	OR 95% CI	OR 95% CI
Independent variables		
GIS-based food retailer measures		
Distance to fast food (miles)		
Distance to nearest fast food restaurant	0.99 (0.92–1.06)	0.98 (0.91–1.05)
Distance to other food retailers (miles)		
Distance to nearest supermarket	0.85 (0.78–0.93)	0.86 (0.79–0.94)
Distance to nearest convenience store	0.96 (0.87–1.05)	0.99 (0.90–1.08)
Distance to nearest drug and pharmacy store	0.91 (0.86–0.95)	0.94 (0.89–0.98)
Distance to nearest dollar and variety store	1.12 (1.03–1.22)	1.12 (1.03–1.23)

*Adjusted for age, gender, race/ethnicity, education, employment status, household income, SNAP status, spouse or partner, number of household members, and urbanicity.