

Food Deserts and the Sociology of Space: Distance to Food Retailers and Food Insecurity in an Urban American Neighborhood

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Abstract—Recent changes in food retailing structure have led to the development of large supercenters in suburban areas of the United States. These changes have led some authors to suggest that there are food deserts in some urban areas, where food is difficult to access, especially for disadvantaged consumers. This study tests the food desert hypothesis by comparing the distance from food retailers to food secure and food insecure households in one urban, Midwest neighborhood. This study utilizes GIS to compare household survey respondent locations against the location of various types of area food retailers. Results of this study indicate no apparent difference between food secure and insecure households in the reported importance of distance on the decision to shop at various retailers. However, there were differences in the spatial relationship between households and retailers. Food insecure households tended to be located slightly farther from large food retailers and slightly closer to convenience stores. Furthermore, food insecure households reported traveling slightly farther to their primary food retailer. The differences between the two groups was, however, relatively small.

Keywords—Food desert, food retailer, food security, sociology

I. INTRODUCTION

THE evolution of food retailers has followed much the same expansion and concentration as other retail segments in the United States. By the middle of the 20th century, supermarkets had risen to prominence, replacing the smaller, service oriented grocers with a retail format that allowed consumer to browse and select items themselves. Writing during this period, Zimmerman estimates that from the 1930s to 1940s 50% of consumers had switched from a “the long established habit of service, credit and delivery to that of self-service, cash and carry” [1]. Not only did supermarkets provide a wide selection of items, Zimmerman explains, but they also had a significant impact on the space of the cities and towns in which they located. In contrast to small grocers, which were typically located in downtown or city center areas, he states, “The character of the supermarket makes central location not important. In fact, many of the flourishing supermarkets are on the fringe of towns, where rentals are low, but where they can attract the motor trade.” Zimmerman concluded that these stores would expand in size to

approximately 930 square meters (10,000 square feet) in the Midwest region of the United States and begin to incorporate more and more product lines such as lunchrooms, soda fountains, drug departments, notions, novelties, and magazines.

Zimmerman was correct that food retailers would get bigger and diversify, only to a much greater extent than he anticipated. In the 1980s, food retailing went through another significant shift from large supermarkets to superstores and hypermarkets. No longer focusing only on food, these stores offer an even wider variety of food and nonfood items in stores even larger than seen before. Kaufman describes the shift through the 1980s and early 1990s [2]. He notes that floor space in supermarkets grew during this period from 2,140 square meters (23,000 square feet) to 3,250 square meters (35,000 square feet.) At the same time, the variety of items available also expanded from an estimated 14,000 items in 1980 to 25,000 items in 1993. While conventional grocery stores continued to be influential in the 1990s capturing 50% of grocery sales this had fallen from 80% in 1980. This growth in superstores was influenced in no small part by the growth of Wal-Mart’s supercenters during this period and by 2003 one out of every five dollars spent on food in the United States was spent at Wal-Mart, with sales greater than the other top four supermarket chains [3].

Wrigley et al. traces many of these changes to a consolidation and acquisition wave that swept across the United States food retailing industry in the 1990s [4]. A decline in power of anti-trust legislation in the 1980s was a contributing factor while the development of information technologies that facilitated centralized control also helped the process. Wrigley also notes that the rapid expansion of Wal-Mart’s supercenters in the late 1980s and into the 1990s also put pressure on other food retailers to “get big” in order to compete. Wal-Mart’s supercenters led to more frequent shopper visits and, consequently, greater profits. The success of this model, which was actually pioneered by Meijer and Fred Meyer, put pressure on other food retailer to do something similar.

The expansion in floor space has had some clear implications for the location of stores. Much as Zimmerman noted the movement of food retailing to urban fringes in order to obtain land necessary for larger stores, so too have superstores been developed increasingly farther from city and

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town centers in order to find sufficient space to locate these stores. The issue is not only one of sufficient land, but also convenience. Even when sufficient land is available within a city's limits, obtaining that land often requires negotiating with 25 to 30 landowners, each with a different set of interests and willingness to sell. This can translate into taking two to three times longer to develop a store within city limits than in the suburbs [5].

II. FROM SUPERCENTERS TO FOOD DESERTS

Of course, the growth of large food retailers does not represent a critical element of the structure of the food system because of where they are located. They are also a critical element because of where they are not. Drawing from widespread concern with suburban sprawl, urban flight, and food retailer concentration, the concept of food deserts was developed in the 1990s by a working group for the Low Income Project Team of the Department of Health in the United Kingdom [6]. The concept was meant to address issues related to the closing of food retailers in inner cities and the associated growth of large supermarkets in suburban areas—often beyond convenient access of low-income, inner city residents. In the decade since its inception, the concept of a food desert has sparked off a series of related research [7]-[10]. Much of this research has involved the use of GIS to examine the relationship between food retailer distribution and low-income populations. In some cases, consumer surveys and price indexes have been incorporated into the research. Additionally the concept has been applied to rural areas [11]-[12]. Although the coining of the phrase marked a new recognition of the role of physical access in food security, the inequalities inherent in food retailers had been examined to a limited extent in previous decades [13]-[14].

Furey et al. define a food desert as “an area where people do not have easy access to healthy, fresh foods, particularly if they are poor and have limited mobility” [12]. In contrast to traditional conceptualizations of food security, the emphasis is not on the characteristics of households, but rather the physical distribution of food retailers. An important critique underlying much of the literature is that the food system is structured in such a fashion as to negatively impact vulnerable populations. While this structuring is deliberate as big-box retailers position themselves in suburbs where large tracts of land are available and populations have sufficient purchasing power to support these retailers, the consequence is that inner-city populations are at a greater distance from certain food retailers, making food purchasing difficult for some. The point is that the food deserts literature stresses deficiencies in the modern food system rather than deficiencies of food insecure individuals.

Studies have been conducted that support the hypothesis that physical access to food is unequal. Moreland et al. (2002) examined the location of food retailers in Mississippi, North Carolina, Maryland, and Minnesota as compared to US Census data. They found large numbers of supermarkets

located in wealthy, predominantly white areas and relatively few in poor, black neighborhoods. Interestingly, they also found higher concentrations of places that sold alcohol in the poor, black neighborhoods. A similar study was conducted in New York which found that consumers in neighborhoods with high concentrations of black and elderly people face higher prices, lower levels of quality and cleanliness, and less variety of prices, brands, and sizes [14]. More recently, Blanchard and Lyson found that poor rural residents, when compared with higher income residents, were often located disproportionately far from large supermarkets [11].

Alwitt and Donely found that poor zip code areas in Chicago have fewer and smaller retail outlets overall than nonpoor areas, including fewer supermarkets, banks, and large drug stores [15]. However, they note that “it may be misleading to claim that poor areas are underserved, relative to nonpoor areas, unless one controls for differential levels of purchasing power. Even though there may be fewer stores of various types in poor neighborhoods, there may be or may not be a reasonable number given the sales expected from those neighborhoods.” After controlling for purchasing power, they found no difference in number of supermarkets. This highlights the point that the actions of the retailers make economic sense while at the same time generating social problems related to food access. Furey et al. also found mixed results in their study [12]. Although prices for some products were higher in small grocers than in large supermarkets, the differences were often only minor. Furthermore, most of the people in their survey were satisfied with the availability of food. However, much in line with other studies, segments of the population that had special needs, such as elderly populations, were still very concerned with physical access.

The point that different populations have different needs is further elaborated on by Whelan et al. [10]. They used a qualitative approach based on focus groups to assess a potential food desert in the UK. They found that physical access was a concern for many of their subjects; however, the level of concern often depended on the type of household. They conclude that access is not uniform across household groups. For instance, mothers with younger children were more motivated by cost while elderly subjects were more concerned about physical access due to personal mobility issues. Donkin et al. sought to develop a culturally sensitive price index by drawing on lists of foods commonly purchased by four major ethnic groups in London [8]. Prices and availability of these foods was then collected from 210 food outlets in the area. They found that culturally appropriate and reasonably priced food did appear to be physically accessible to the groups examined. They note, however, that even when food is reasonable priced (that is, no more expensive than other places) and physically accessible, this does not mean that all people can afford it.

Fundamentally, the issues addressed by food desert research relate to the relationship between the physical retail environment and consumer behavior. One of the most interesting studies in this area was conducted by Wrigley et

al., which involved a “natural experiment” when a large food retailer opened after a study of consumption patterns in a food desert [4]. After the opening, the researchers found a significant upward shift in fruit and vegetable consumption amongst those with the poorest diets. Furthermore, many local residents shifted away from using limited range/budget stores as a source of fruits and vegetables.

Despite this evidence, it is important to note that food deserts do not exist in all low income areas. For instance, Cummins and Macintyre actually found a higher concentration of food retailers in the low-income areas of Glasgow [16]. In many cases, food prices were also lower in low-income areas. It may appear, therefore, that while low-income populations are particularly vulnerable to food deserts and some inner cities may represent areas of higher cost for food retailers, impoverished neighborhoods and food deserts do not inevitably go hand in hand. Cummins and Macintyre, for example, found that the types of food that drove down the average cost of food in the low-income areas was often high-fat and high-sugar foods. Thus, while the food desert concept might be a problematic metaphor, it still retains some utility as a lens to understand the spatial distribution of different types and prices of food.

Despite the popularity and rhetorical power of the concept of the food desert, its analytical utility has often been limited or reduced to factoids [7]. This, in part, has stemmed from the 500 meter (1,640 foot) radius that was set by the UK Department of Health as a “convenient” walking distance and which has been used in several studies [17]. This simplistic proximity indicator fails to take into account the situation of elderly or disabled individuals who may be unable to carry groceries 500 meters or people with cars who may think little of traveling ten or more miles to shop for food. Furthermore, other elements of the landscape such as a dangerous neighborhood or a highway or road without sidewalks may create barriers not apparent in typical food desert research methods. Regularly traveled routes, such as between work and home, may be perceived as close, regardless of actual distance.

Other problems also exist. Blanchard and Lyson’s study suffers from a high level of spatial aggregation [11]. While operating at the zip code level may be necessary given data availability (something the authors admit), this can lead to problematic assessments of the relationship between a population and retailers. Such analyses can lead to the promotion of solutions, such as recruiting a large supermarket, which may actually undermine existing food retailers and reduce total access [17].

There have been other problems with studies that fail to actually obtain a statistically significant measure of the consumption patterns of people at various proximities to food retailers. Rather, assessments are done either qualitatively or conclusions are drawn from census. Simply because there are few grocery stores in low-income neighborhoods does not lead to the conclusion that these populations must be either having difficulty accessing food or compromising the quality

of the food that they eat. It is important that assessments of food retailers be compared against actual surveys of consumer behavior. Otherwise, unreasonable generalizations regarding relationships between retailer distribution and consumer behavior may be drawn based on class-based generalizations and vacant data on actual consumer behavior. It also overlooks the strategies that people have developed to purchase food, even when it is not readily available in their neighborhood.

Despite these problems, the food desert concept represents an interesting turn in assessing consumer behavior. Rather than attributing behavior to either independent action or the dictates of capital, food desert literature recognizes that different consumers have various levels of ability to engage in independent action and different levels of accountability to the interests of capital. Unfortunately, these levels of agency vis-à-vis the food system have not been closely examined. Rather, consumers are lumped into two different categories: disadvantaged consumers and everyone else. The former category lacks agency, even to travel 500 meters, while the latter feels few structural constraints on purchasing decisions.

While the existence of food deserts in inner cities is not inevitable, a growing body of research demonstrates that the structure of the environment can have a real impact on the food that people select. French, Story, and Jeffery review a wide variety of social changes that they argue have contributed to nutrition problems in the US [18]. Among other changes, they note the increased convenience of food with poor nutritional quality which has led to additional health problems. Sobal and Wansink argue that the spatial relationships influence food consumption in unconscious ways [19]. They note how the distribution of food items on a plate, on a table, or in a kitchen, can influence the types and amounts of food that people consume. In part, the new interest in the relationship between the environment and nutrition stems from concern with obesity rates and related health problems in the US. In addition, the relationship has implications for food security. After all, environments increasing the intake of some foods are likely to reduce the consuming of others. Similarly, Moreland et al. used food surveys to assess risk of atherosclerosis on people in different communities [20]. They compared this risk against the number of food retailers in each neighborhood. They found that there was a relationship between the two with density of grocery stores being related to fruit and vegetable consumption. Interestingly, the authors found the influence of retailer density on African-American consumption to be greater than White American consumption.

Space therefore represents one area in which the structure of the food system overlaps with the social structures that dictate household food demands. At the same time, recent developments in food desert literature suggest that the extent of overlap varies, quite literally, by how far people live from a food retailer. It appears therefore that the agency of different groups in relation to the structure of the food system may be influenced by the physical location of food retailers.

III. STUDY SITE

The study site examined in this research is an urban neighborhood located in Lansing, Michigan, USA. Lansing is the capital of Michigan and has a total population in 2000 of around 120,000 (US Census). Downtown Lansing is dominated by state government buildings and other offices. This area is surrounded by several residential areas mixed with commercial activity. Lansing is home to a community college and a law school. Located adjacent to Lansing is East Lansing the home of Michigan State University, a large land-grant university with over 45,000 students. As with many Michigan cities, Lansing has struggled with the declining American automotive industry; the city had an unemployment rate of 7.6% in 2005 (US Census). Median household income for the city was around US\$34,000 in 2005, below the national median of US\$46,000 (US Census).

The neighborhood examined in this study is an urban area located on the east side of the city. The land area of this neighborhood is approximately 12.4 square kilometers (4.8 square miles.) While the neighborhood is primarily residential, there are some small businesses scattered throughout the area and significant commercial activity to the north and between two major roads on its eastern edge. The boundaries used in this study are the 48912 zip code. This area corresponds with the service area of the Allen Neighborhood Center (ANC), a non-governmental organization community group established in 1996 and evolving out of the Eastside Neighborhood Organization (ENO), a 30 year-old volunteer neighborhood advocacy organization. Many people in the area identify as being part of the same neighborhood, in part due to the activities of the ENO and ANC so it was felt these were reasonable boundaries to use. The 48912 zip code corresponds approximately to 17 census blocks on the east side of Lansing.

The 2000 U.S. Census provided a sociodemographic profile

of the neighborhood. The total population of the study area is 18,583 with 8,740 housing units. The average household has 2.27 people and the average family has 3.09 people. There is some racial and ethnic diversity in the neighborhood. Seventy-three percent of the population identifies as white while 13.3% identify as African American. Just over ten percent (10.7%) of the neighborhood is Hispanic or Latino/Latina. There is also a significant foreign born population (8.8%).

Even in this relatively small geographic area, a significant amount of economic differentiation is evident. In particular, populations in the northern part of the neighborhood tend to have significantly higher incomes than populations in the southern area. This is evident in the median income of individual census blocks which range from US\$14,069 to US\$57,768 in the richest. Largely in the southern part of the neighborhood, significant poverty exists and, in aggregate, 18.5% of the people in the neighborhood live below the United States poverty line.

There are nearly 100 food retailers located either within or in close proximity to the neighborhood (Fig. 1) and InfoUSA data provide a picture as to the relative influence of each of these retailers on the food system. The largest number of which consisted of convenience or party stores (37%), with sales volumes most often below 3 million dollars per year. Convenience or party stores are stores that are typically relatively small and specialize in packaged food and alcoholic beverages. The only grocery store located centrally within the neighborhood is Apple Market, a relatively small grocery store with just over 8 million dollars in annual sales volume. In contrast, the two nearby Kroger stores, where a large portion of the neighborhood shops, have sales ranging from 12 to 16 million dollars per year. While sales data for the closest Meijer was not available, other Meijer stores in the area typically have in excess of 100 million dollars per year in sales volume.

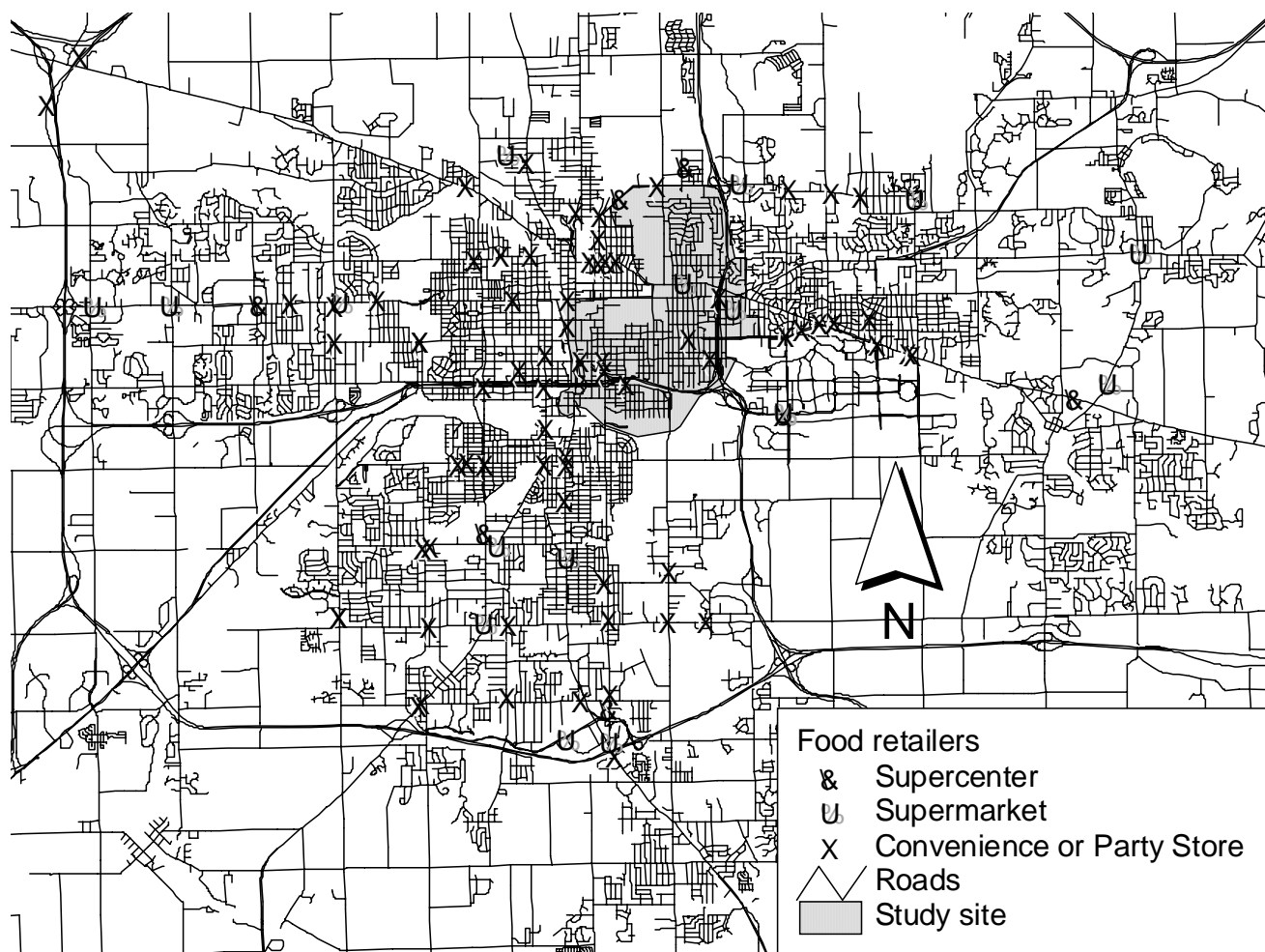


Fig. 1 Distribution Of Convenience And Party Stores, Supermarkets, And Supercenters Within And Around The Study Site

Focusing on a single urban area allows for greater depth of analysis than a study examining a larger geographic region. Understanding consumer perception and behavior of the retail food system requires both an assessment of consumers as well as an assessment of the structure of the food system. By focusing on a population in a single area, the amount of variation in the retail environment will be limited compared to examining a population across a wide geographic distribution. It will therefore be possible to use geographic information system (GIS) software to relate survey responses to the physical distribution of the retail environment. Such integration is greatly facilitated by limiting the geographic focus of the region and is a typical method used in food desert research. The retail environment is, essentially, held constant so that other household variables can be examined. While some researchers have examined larger geographic regions, this is only possible by using aggregated data, such as from counties or census blocks. Use of aggregated data can only indicate the types of areas where food retailers are located—it does not assess the actual behavior or perceptions of consumers which may or may not involve traveling to the closest store. This study goes a step farther by collecting data at the household level and relating that to the structure of the

food system in the neighborhood. In this way, we gain insight into the actual relationship between retailer choice and the retail environment.

IV. METHODS

In order to understand the relationship between food security and shopping behaviors, a survey of the Lansing eastside neighborhood was conducted using a self-administered mail survey. Use of a survey to examine food security and purchasing patterns is consistent with other research into food security and food deserts. The United States Department of Agriculture (USDA) uses telephone surveys in its national assessment of food security [21]. They have also provided methodologies for conducting food security assessments through other survey modes [22]. The Community Food Security Coalition also discusses the potential of using various survey modes to determine food security levels [23]. Wrigley et al. successfully used a combination of a self-administered survey and face-to-face interviews in order to assess food consumption patterns in an urban area in Britain [4].

The survey was four pages and included a six question assessment of household food security status based on USDA

measures and a series of questions regarding when, where, and why households purchased food at nearby locations. This study focused on food security status, the specific food retailers where households shopped, and the influence of distance on the decision of households to shop in those locations. Respondents were asked to identify the road where their primary food retailer was located in order to distinguish among chain stores with multiple locations.

The sampling frame for households was constructed based on a list of households purchased from Accudata Inc. for the zip code of 48912. Accudata Inc. is a marketing company that provides residential mailing lists, based on data obtained from the United States Postal Service. While on site enumeration is commonly regarded as one of the most comprehensive ways to obtain a complete sampling frame, the use of purchased, residential mailing lists was chosen to save time and resources. Assessments of the accuracy of residential mailing lists compared to on-site enumeration has found sampling frames from the two sources to largely coincide [24]. From the sampling frame a random sample was drawn of 1,100 addresses.

A total of 302 valid and usable surveys were returned for a response rate of 27%. Approximately 8% of the sample was returned due to vacancies, insufficient or incorrect addresses, or refusal to participate. Of these, the vast majority were returned because the residence was vacant with only a few returned because of an explicit refusal to participate. It is possible that the high percent of vacancies was an effect of conducting the survey in the summer. As noted below, many of those in the sample appeared to be college students, and it is likely that many of these residents were not living in rental housing during the summer.

While the response rate of the survey was slightly lower than the anticipated value of 35%, the response of 302 suggests that the sample is representative of the population at a confidence interval of +/-5.5% at the 95% confidence level. Furthermore, comparison of the sample against US Census data in terms of income, household size, children, age, disability status, and automobile ownership suggest that the characteristics of the sample are very close to that of the population. In terms of education level and home ownership, the sample appeared to be better educated and less likely to rent than the general population. In the case of the former, this may be due to the effect of education on the likelihood of respondents to appreciate, and consequently respond to, the survey. The survey came from Michigan State University so it may be that students of this university were more likely to respond. The relatively low instance of renters who were part of the sample is more difficult to explain; however, it may be an artifact caused by conducting the survey in the summer. While these concerns must be considered when generalizing the results of this study, the sample was felt to be reasonably representative of the population.

We compiled an initial list of all food retailers in an 8 kilometer (5 mile) radius by searching two internet business databases: www.yellowpages.com and www.mapsonus.com.

Additional retailers outside the five-mile radius were added to the list if they were mentioned either in previously conducted qualitative interviews or listed in surveys. The websites for large retailers such as Kroger, Meijer, L&L, and other supermarkets were also checked to insure all locations were included in the list. Businesses were categorized into supermarkets, grocery stores, convenience/party stores, specialty stores, and other. Supermarkets included all large chain food retailers such as Kroger and Meijer. Grocery stores included smaller, generally independent food retailers. Convenience and party stores consisted of stores such as Quality Dairy, liquor stores, and gas station based food retailers where food is available but selection is extremely limited. Specialty stores included both health food stores and stores specializing in particular ethnic foods. Only one store was not included in the above categories—Sam's Club, a membership based warehouse store. Later examination of retailer patterns led to a distinction being drawn between supermarkets, which primarily sold food, and supercenters, which sold a combination of food and other items. The location of all stores were geocoded using the same process as the surveys.

In order to assess distance from households to food retailers, we used GIS (ESRI ArcView 3.1a) to map the location of survey respondents in relation to neighborhood food retailers. Since addresses were listed on the survey form, it was possible to geocode nearly all of the respondents. In three cases, respondents removed the address label on the returned survey so coding was not possible. Geocoding was conducted using an automated service provided by Tele Atlas North America, Inc. This service was unable to match coordinates for 11 of the addresses, leaving a total of 289 responses which were spatially analyzed.

Two sets of spatial analyses were conducted. First, the distance between respondents and the closest food retailer were examined. This distance was assessed using an ArcView extension that automatically calculated the distance from each survey respondent to the nearest food retailer [25]. Subsequent comparisons were also made for the distance between survey respondents and the closest of each type of food retailer. Next, the distance between respondents and the food retailer most frequently used was assessed. In this case, a different ArcView extension was used which matched the most frequently shopped at store to the location of the survey respondent [26].

In both cases, straight line distances were measured, not actual driving distances. Therefore, distances do not represent actual distance one would have to travel to a food retailer. This straight line measurement is similar to the methods used to assess food deserts which involve the creation of buffers surrounding retailers to look for residential areas that are not close to any food retailers. In this case, however, I was able to quantify actual distances, rather than only identifying gaps.

V. RESULTS

Respondents were asked whether distance to home, work, other stores, and bus stops influenced their decisions to shop at a particular location. Distance to home was clearly the most important thing respondents considered (89% of the sample indicated that distance to home influenced their decision to shop at least one store in the past month). Distance to work was the second most important (30%), followed by distance to other stores (24%). Distance of stores to bus stops influenced store choice for less than 6% of the sample in the last 30 days.

The importance of distance to home was also evident in primary store choice (75% of respondents indicated that this was one of the factors behind their decision to obtain food from their primary retailer), while distance to work and other stores was only relevant for 17% and 16% of the sample respectively, and distance to bus stops was important to 5% of the sample. Interestingly, despite this apparent emphasis on selecting a primary retailer based on distance to home, less than 9% of the sample actually shopped at the food retailer that was closest to their home. This indicates that proximity is clearly being balanced against other factors and is not the only concern influencing primary store choice.

A t-test comparison between food insecure and food secure households revealed no statistically significant difference related to distance to home, work, other stores, or bus stops on their decision to shop at their primary food retailer. These results came as a surprise as it was anticipated that food insecure households, which suffer from some level of resource scarcity such as the time and gas that are required to travel greater distances. Given the number of respondents who indicated that they did not have an automobile, it came as even more of a surprise to find no difference between the two groups.

In general we found that survey respondents all live in very close proximity to food retailers. The average distance from a food retailer to respondents was less than a third of a mile. Some residents lived much closer and no respondents lived more than 1.2 kilometers (0.75 miles) from a food retailer. Many of the stores in close proximity to respondents were not large supermarkets. For 49% of the sample, the closest place was a convenience or party store, while for 32% the closest food retailer was a grocer (this can be accounted for by the presence of a single small grocer located in the center of the neighborhood), and 7.2% were closest to two small ethnic grocers. Notably, the distance that respondents did travel to shop for food was over twice the necessary distance with the average commute to the primary food retailer being about two miles.

One of the central arguments of the food desert literature is that distance from a food retailer increases the likelihood that a household will be food insecure, at least for disadvantaged consumers. A t-test revealed a statistically significant difference ($p < .05$) between the distance from food insecure and food secure households and the closest food retailer (Table I). The difference was very small with food insecure

households located only 0.05 miles farther from the closest retailer than food secure households.

Since the vast majority of food retailers in the neighborhood and surrounding area were convenience or party stores and the majority of respondents indicated that supermarkets were their primary food retailer, additional comparisons were made between the average distances to supermarkets and convenience stores (Table 1). Again, a t-test revealed a statistically significant difference in the distance to both supermarkets ($p < .01$) and convenience stores ($p < .01$). Food insecure households were located an average of 129 meters (0.08 miles) closer to convenience stores and 354 meters (0.22 miles) farther from the nearest supermarket. While these straight line distances appear rather small, they translate into much larger distances that people must travel following roads and sidewalks to reach the nearest food retailer.

TABLE I AVERAGE DISTANCE IN MILES FROM FOOD SECURE AND FOOD INSECURE HOUSEHOLDS TO DIFFERENT FOOD RETAILERS

	Food secure	Food insecure
Distance to the most frequently used food retailer*	2.04	2.25
Distance to the closest supermarket*	0.71	0.93
Distance to the closest convenience or party store*	0.38	0.30
Distance to the closest food retailer*	0.30	0.25

* Indicates a statistically significant difference between groups ($p < 0.05$)

Additional analysis was conducted using one-way ANOVA in order to assess whether distance was related to food security with hunger in addition to just food insecurity. In this case, relationships were found with proximity to convenience stores and supermarkets ($p < .01$), but not to the closest food retailer. Post-hoc testing was conducted using the Least Significant Difference (LSD) test. Post-hoc testing of the distances to supermarkets revealed significant differences between those who were food secure and those who were food secure with hunger, but not in other cases. This indicates that distance makes a particular difference for those suffering from very low food security. Post-hoc testing of distances to convenience and party stores revealed no difference between food insecure and food insecure with hunger respondents, but difference between both levels of food insecure and those that were food secure.

The influence of convenience stores was further apparent in the distances from households to convenience stores. A t-test revealed a statistically significant difference between the distance from food secure and food insecure households. In this case, food insecure households tend to be located, on average, closer to convenience stores than food secure households. This suggests that convenience stores are more likely to be located in areas of high food insecurity. Despite the high density of convenience stores in the area, relatively few respondents identified this type of store as being a primary retailer. It is reasonable to suggest that few consumers are able to rely solely on the selection available from these retailers. Therefore, additional spatial analysis was conducted

looking specifically at supermarkets.

Notably, only four different retailers were represented in a spatial analysis of nearby supermarkets. For 72% of the sample, Apple Market was the closest supermarket, followed by two different Kroger stores (16% -- eastern border; 7% northeast of the study site), and a Meijer (5%). Less than 1% of the sample was located in close proximity to a Shop Rite located in the southeast of the study site. There was no statistically significant difference between food security status and proximity to any of these retailers. This was somewhat unexpected due to census data that indicate higher income and education levels at the northern edge of the study site. However, due to the central location of the Apple Market, food security levels as related to proximity to different supermarkets might not be readily apparent since this single store may have obscured the influence of distance that might be apparent across a larger space.

The next set of analyses involved comparing the distances from respondents' homes to the food retailer where food was most frequently purchased. This revealed two trends. First of all, there was a statistically significant difference between the two groups in terms of distance to their primary food retailers with food insecure households being located, on average, farther than food secure households (the difference was 1.5 kilometers (0.93 miles) for food insecure respondents and 1.13 kilometers (0.7 miles) for secure respondents). More notably, food insecure individuals appeared to travel farther than those who were food secure to their primary retailer. In this case, food insecure households were located an average of 3.7 kilometers (2.3 miles) from their most frequently used food retailer while food secure households were located only 2.9 kilometers (1.8 miles) away.

This difference in behavior is particularly notable since analysis of survey data indicated no difference between the two groups' spatial perception as measured by how the groups thought about distance from home into their shopping decisions. This difference in behavior, while no doubt influenced in part by the fact that they lived on average slightly farther from available food retailers, is nonetheless interesting given that there was no apparent difference between the groups in terms of how distance from home influenced primary store choice. Again, this seems to reiterate the fact that perception of distance as a factor influencing store choice was the same for each group; however, how each group negotiated the distance to stores differed with food insecure households traveling farther.

This suggests that cultural preferences or perceptions related to class are not influencing the importance of distance on store choice. At the same time, food insecure households are driving farther in order to access their preferred stores and therefore suffering an additional cost due to the location of food retailers. If agency represents a measure of the extent to which a structure serves the preferences of a group, it appears that, at least in terms of physical distribution, food secure households are being better served. This is despite survey results that indicate a similar set of interests between the two

groups.

While a t-test revealed no statistically significant difference between the average distances from primary food retailer to home for both groups, there was a moderate negative correlation (-.212) between the proximity to the closest food retailer and the distance traveled to the primary food retailer. This suggests that the closer a consumer lived to a food retailer, the farther that they were likely to travel to a retailer. While these results contradict the trends suggested by the food desert literature, this can be explained in part by the confounding factor of the convenience and party stores. In fact, the closest food retailer to over half of the sample consisted of a convenience or party store. With 62 different convenience or party stores in the surrounding area and ten stores located within the neighborhood this comes as no surprise.

To control for the influence of convenience stores, correlations between distance to supermarkets and distance to primary retailer were also assessed. There is a moderate positive correlation (.186) between distance from a supermarket and the distance traveled to the primary food retailer. Interestingly, when the sample was divided into food secure and food insecure groups, the correlation continued to be statistically significant. However, the distance traveled by food secure households to the primary food retailer was influenced more by proximity to a supermarket (.146) than food insecure households (.298). This suggests a few things. First, there is a relationship between space and food security when looking only at supermarkets. Second, for food secure and food insecure households, distance influences store choice; however, for food insecure households, proximity has a much stronger influence.

Despite this apparent relationship between distance and supermarket selection, it is important to keep in mind that most residents do not shop at the supermarket that is closest to them. In fact, only 15% of the sample did most of their shopping at the closest supermarket. Furthermore, food insecure households were no more likely than food secure households to shop at the closest supermarket. This suggests that while distance does play a significant role in food retailer selection, it is not necessarily the force that is driving households, food insecure or otherwise, to the closest supermarket. In other words, distance to food retailers influences where people shop, but being the closest retailer may be insufficient to cause people to shop there.

VI. CONCLUSIONS

Changes in the structure of food retailers has led to growth in areas increasingly far from residential areas and food desert research suggests that this has led to problems among disadvantaged populations in accessing food. The spatial distribution of food retailers in this study site has similar patterns. Does this mean that distance limits the behavior of food insecure households? Both food secure and insecure households indicated similar perceptions of space.

Specifically, neither group was more likely to indicate that distance from home, work, nor bus stops influenced their store choice.

It is possible that while distance was equally important for both groups, the way in which distance was important may differ in a fashion not detected by the survey. For instance, for both food secure and insecure households, the time required to travel to a distance supermarket may be a limiting factor even if transportation is not a problem. Jabs and Devine cite time as a significant factor that influences food consumption practices [27]. These authors also note that time can be an even more significant constraint for low-income households who are unable to "buy time" by paying others to prepare food, clean, or engage in other activities in exchange. Therefore, while survey results indicated that the importance of distance on store choice was the same for each group, it seems possible that the reasons for, and consequences of, distance differed between groups, even if it was not apparent from the survey.

This is supported by results that suggest a relationship between food security status and proximity to food retailers. Food insecure households were located slightly farther from supermarkets while slightly closer to convenience stores. The farther one was located from a supermarket and the closer to a convenience store, the farther a respondent was likely to go to shop.

Perhaps it comes as no surprise that distance to a supermarket correlates with distance traveled to the most frequently used store. However, when we also consider that food insecure households tend to be located farther from supermarkets we see clear overlaps between the structure of the food system and the differing agency of consumers. Is distance the only factor that contributes to food security? Certainly not, and when distance to supermarkets and distance to nearest food retailer were added to logistic regression models (not reported here), they were not found to be statistically significant predictors of food security. However, the point of the food desert literature has never been to suggest that distance from food retailers is the only factor leading to food insecurity. Rather, as my results also suggest, the point is that distance can create an additional burden on segments of the population that are already struggling to obtain food.

Distance to a supermarket itself might not be enough to dictate whether a household is food secure or insecure. However, this does not mean that distance fails to influence food purchasing. Our results indicate that it might influence whether a household is able to manage that insecurity without going hungry. Research into the elements of the food system that weigh disproportionately on disadvantaged segments of the population provides an important insight into the structural constraints that many people face. Food desert research has certainly pointed to the negative impacts of a food system that is migrating farther and farther from city centers. It will be important that this research not limit itself solely to issues of distance, however, and begin also to look for other factors that may be constraining choice or creating a burden on those

struggling to obtain food for themselves and their families.

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