

EXAMINING THE BEHAVIORAL INTERACTIONS BETWEEN URBAN RESIDENTS
AND THEIR FOOD ENVIRONMENT:
A CASE STUDY OF GREATER LANSING, MICHIGAN

By

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ABSTRACT

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Access to nutritious food is essential to human survival and the consumption of fresh produce is an important part of a healthy diet. Previous research has found that residents of urban neighborhoods who lack access to fresh produce have greater difficulty maintaining a healthy diet. This thesis considers the interaction between residents of Greater Lansing, Michigan and their food environment. An in-person survey of 185 Greater Lansing residents was conducted during the summer of 2010 at twelve retail stores that sold fresh produce items. Participants were asked questions about their access to transportation, shopping habits, diet, and primary location of residence. Statistical analyses were conducted to examine the relationships between the collected data and calculated models of spatial accessibility. Findings suggest that (1) the perception of Greater Lansing residents is that food shopping is not done in close proximity to the primary residence; (2) there is not a straightforward association between calculated access to and the consumption of fresh produce; (3) supermarkets are the dominant food source for residents; and (4) individuals who receive nutritional assistance are significantly more likely to shop at neighborhood stores and consume a less healthy diet. Understanding how Greater Lansing residents interact with their food environment is essential in finding solutions to the growing obesity and overweight epidemic.

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CHAPTER 1: INTRODUCTION

1.1 Background

The United States is currently faced with a rapidly expanding epidemic of obesity and overweight¹, which has been associated with a number of different health problems including type 2 diabetes, heart disease, stroke, hypertension, and certain types of cancer (Sherry et al. 2010). In 2008 more than 72 million adults in the United States were classified as obese and research has estimated that more than 65% of the United States population are either obese or overweight (Hedley et al. 2004; Flegal et al. 2010; Sherry et al. 2010). As a result, the health risks that have been associated with obesity and overweight have had a tremendous impact on the cost of medical care in the United States. Obesity related illnesses alone accounted for more than one-quarter of the increase in United States healthcare costs between 1987 and 2001 (Thorpe et al. 2004). Obesity and overweight related health issues and healthcare costs continue to be a major challenge facing the United States.

An integral part of helping to decrease obesity and overweight in the United States will be ensuring that Americans consume a healthy and balanced diet. The United States Government established the Dietary Guidelines for Americans in 1980 to provide advice and recommendations on achieving a healthy diet in order to reduce incidents of major chronic diseases and ensure that Americans receive the proper nutrition they require (U.S. Department of

¹ According to the Centers for Disease Control and Prevention an adult who has a BMI between 25 and 29.9 is considered overweight and adult who has a BMI of 30 or higher is considered obese (CDC 2010).

Health and Human Services and U.S. Department of Agriculture 2010). Americans are recommended to consume a diverse diet, including a variety of different fruits and vegetables, in order to obtain their required daily nutrients. Unfortunately, research has indicated that Americans are not consuming the amount of fruit and vegetables each day necessary to achieve a healthy and balanced diet (Kantor 1998; Casagrande et al. 2007; Usual Dietary Intakes 2010). The inability of many Americans to consume a healthy and balanced diet, rich in fruits and vegetables and low in calorie-dense foods, has contributed greatly to the obesity epidemic and the health risks that are associated with obesity (Usual Dietary Intakes 2010). Improving the nutritional intake of Americans is an important step towards combating obesity and related illnesses in the United States. In order to improve the dietary behavior of Americans an understanding of why Americans are not consuming a healthy and balanced diet must be achieved.

1.2 Statement of problem

Previous research has revealed that adequate access to healthy and nutritional food items is a barrier to consuming a balanced diet (Clarke 2002; Campbell 2004; Pothukuchi 2004). Unfortunately, drastic changes that have taken place in the food-retail environment in the United States since 1970 have influenced and changed urban areas substantially. Major supermarket chains have moved out of the urban core and have located in the periphery of urban areas (Morland et al. 2002b). Small scale neighborhood grocery stores have been replaced by significantly larger scale supermarkets that are meant to serve substantial geographic areas (Lavin 2005). As a result, place and space have been recognized in recent years as being increasingly important in influencing health and health related behaviors (Ball et al. 2006). The term ‘food desert’ was first used by the Nutrition Task Force of the Department of Public Health

in 1995 in recognition of this developing problem and to help describe urban areas that did not have access to cheap, nutritious food items (Lavin 2005). The suburbanization of supermarkets has disproportionately affected urban residents with low incomes and decreased mobility, who reside in areas where cheap and nutritious food is unavailable and are disproportionately impacted by the limited food choice available in their neighborhood (Piachaud and Webb 1996; Whelan et al. 2002). Recent research has begun to suggest that the level of access an individual has to supermarkets and large scale grocery stores does in fact have an impact on their dietary behavior (Rose and Richards 2004; Henderickson et al. 2006). However, very few research studies have focused on how consumers actually interact with their food retail environment and have made assumptions based on large aggregated datasets (Morland et al. 2002b). As a result, it remains unclear about how the food environment actually impacts the behavior of local residents.

1.3 Research objectives

The overall objective of this thesis is to provide understanding of the interaction that Greater Lansing residents have with their food environment. In order to establish better models of the food environment and its impact on dietary behavior more information is needed on the behavioral patterns of Greater Lansing residents. This thesis will build off previous research conducted on the food environment in Greater Lansing, Michigan (Duvall et al. 2010; Goldsberry et al. 2010) in order to come to a greater understanding of how local residents interact with their food environment. Specifically, this thesis seeks associations between previous models of the Greater Lansing food environment (Goldsberry et al. 2010) and the level of consumption of fresh fruit and vegetable items by local residents. This information is essential in order to help understand complex interactions between urban food environments and dietary choices of Greater Lansing residents. Additional information on how Greater Lansing

residents travel, shop, and behave within the food environment was also obtained in order to further understand the interaction between Greater Lansing residents and their food environment. Residents who receive nutritional assistance were examined in depth to understand if they interact with the food environment differently than residents who do not receive nutritional assistance. The results of this research will help to achieve a greater understanding of how Greater Lansing residents interact with their food environment and help gain new insight into how the built environment influences dietary behavior.

1.4 Research questions

The primary focus of this thesis is to examine the associations between the food environment and the behavior of Greater Lansing residents; specifically this thesis attempts to answer four research questions:

- 1) Is there an association between calculated access to fresh produce products and the use of fruits and vegetables in the diets of Greater Lansing residents?;
- 2) Are there variables other than the retail food environment that influence the dietary behavior of Greater Lansing residents?;
- 3) Do Greater Lansing residents believe that the food retail environment in the Greater Lansing area is adequate?;
- 4) Do Greater Lansing residents who receive nutritional assistance interact with the food environment differently than Greater Lansing residents who do not receive nutritional assistance?

In order to answer the four primary research questions, interviews with Greater Lansing residents were conducted to understand their behavioral decisions and how they interact with their local food environment. The information obtained from this research will be compared to previous

models of the food environment that were created by Goldsberry et al. (2010) to understand how well models of the food environment predict dietary behavior. This thesis will provide new insight into the actual interaction between Greater Lansing residents and their food environment that can be used to inform future representations of the Greater Lansing food environment.

1.5 Hypotheses

The expected results of this research are that: 1) calculated access to fresh produce does impact the dietary choices of Greater Lansing residents and that previously calculated models of access to fresh fruit and vegetable items (Goldsberry et al. 2010) will be able to predict the quantity of fresh produce products an individual consumes (Rose and Richards 2004; Henderickson et al. 2006); 2) variables other than the retail food environment will influence the dietary behavior of Greater Lansing residents and the main variables that will predict the amount of fresh produce products an individual consumes will be location of primary residence, income, ethnicity and whether or not an individual receives nutritional assistance (Morland et al. 2002b; Rose and Richards 2004; Lavin 2005); 3) Greater Lansing residents will not believe that their food environment is adequate and recognize that not everyone has equal access to fresh produce products and will feel that improvements need to be made to achieve adequate shopping near their primary place of residence; 4) one of the main contributors to why Greater Lansing residents will not believe their food environment is adequate is that most Greater Lansing residents will have to travel farther than a 10 minute drive or walk to purchase food items and will have to travel by vehicle to get there; 5) Greater Lansing residents who live in areas that have low calculated levels of access to fresh produce products will shop more frequently at neighborhood type convenience and liquor stores; 6) Greater Lansing residents who receive nutritional assistance will consume less fresh produce items and be more impacted by their food

environment than Greater Lansing residents who do not receive nutritional assistance. The results of this analysis are meant to inform public policy and enable planners to better understand the actual interaction between people and their food environment. Hopefully this research will assist in the development of built environments that will enable Americans to achieve a healthy and balanced diet.

CHAPTER 2: LITERATURE REVIEW

2.1 Obesity and overweight in the United States

The United States is faced with an epidemic of obesity, which has had major consequences for the overall health of the United States population. More than 30% of Americans in most sex and age groups are currently classified as obese and 65% of Americans are either obese or overweight (Hedley et al. 2004; Flegal et al. 2010). While there have been no statistically significant changes in the United States obesity rate since 1999 there is also no evidence that the obesity rate has been decreasing (Hedley et al. 2004; Flegal et al. 2010). Obesity is associated with a number of different health problems including heart disease, stroke, type II diabetes, and certain types of cancer (Sherry et al. 2010). As a result of the extraordinarily large rate of obese and overweight Americans the average yearly healthcare costs associated with obesity have been estimated to be \$147 billion dollars, with an obese individual being estimated to pay \$1,429 more yearly on medical costs than a non-obese person (Sherry et al. 2010). Obesity and overweight will continue to be major obstacles to the overall health of the American population as the United States moves forward in the 21st century.

Research has indicated that a number of different factors contribute to obesity including diet, physical activity, and the environment (Papas et al. 2007). Specifically, a diet that includes a high intake of calorie-dense foods and low intake of calorie-poor items has been positively associated with obesity (Liese et al. 2009). An integral part of helping to decrease the rates of obesity and overweight in the United States will be ensuring that Americans are consuming a healthy and balanced diet. In response to the expanding rate of obesity and overweight the United States Government created the Dietary Guidelines for Americans in 1980 to provide

advice and recommendations on achieving a healthy diet with the purpose of helping to reduce incidents of major chronic diseases, which were beginning to strain the country's healthcare system (U.S. Department of Health and Human Services and U.S. Department of Agriculture 2010). The primary purpose of the Dietary Guidelines for Americans is to provide evidence based nutrition information for any American over the age of two, as well as to provide education on how to achieve a healthy and balanced diet (U.S. Department of Health and Human Services and U.S. Department of Agriculture 2010). Unfortunately even with national dietary guidelines Americans have been unable to meet the recommendations for achieving a healthy diet for many years, which has caused concern for public health officials (Morland et al. 2002b).

2.2 The consumption of fruits and vegetables by Americans

The 2010 Dietary Guidelines for Americans stress the importance of consuming fruits and vegetables in a healthy and balanced diet. Research has indicated that the consumption of fruits and vegetables helps to protect against cardiovascular disease, coronary heart disease, and ischemic stroke (Joshipura et al. 1999; Joshipura et al. 2001; John et al. 2002; Adebawo et al. 2006) and provide nutrients that are essential to a healthy diet (U.S. Department of Health and Human Services and U.S. Department of Agriculture 2010). However, fruit and vegetable intake by Americans is still well below the recommended dietary guidelines (Kantor 1998; Casagrande et al. 2007; Usual Dietary Intakes 2010). While research has found that the overall consumption of fruits and vegetables in the United States has increased since 1970 much of this has been a result of the growth in potato consumption, which accounted for 17.5% of all vegetable servings consumed by Americans in 1996 (Kantor 1998). Americans are simply not consuming the amount and diversity of fruits and vegetables required to achieve a healthy and balanced diet.

Research has been divided about the current availability of fruits and vegetables in retail stores in the United States. Putnam and Allhouse (1997) found that there has been an increase of 19% in the amount of fruits and vegetables stocked in retail stores since the 1970s. However, Krebs-Smith et al. (2010) found that from 1970 to 2007 the amount of fresh fruits and vegetables supplied by retailers in the United States has in fact changed very little. More importantly, the supply of fresh fruits and vegetables in the United States continues to remain approximately half of what it would need to be to adequately satisfy the fruit and vegetable requirements in the Dietary Guidelines for Americans. The supply of vegetables in particular would have to increase by 70% in order to adequately satisfy the established guidelines. Currently the available supply of fruits and vegetables in retail stores is insufficient to enable Americans to achieve a healthy and balanced diet (Krebs-Smith et al. 2010).

2.3 Nutritional assistance programs

An additional United States Government response has had to the nutritional problems plaguing Americans was the creation of the Food Stamp Program (now Nutrition Assistance Program) in 1970 in order to ensure that low-income households were able to maintain nutritionally adequate diets (Butler and Raymond 1996). The federal government originally created nutritional assistance programs because research indicated low socioeconomic status households were more likely to have nutritional deficiencies than the general population (Rose and Richards 2004). According to the United States Department of Agriculture Food and Nutrition Service, nutritional assistance programs were established with the purpose of helping to provide children and individuals with a low socioeconomic status access to food, a healthy diet, and nutritional education. While Michigan and other states also offer state programs to aid nutrition assistance, by far the largest provider of nutrition assistance in the United States is the

federal government (Gunderson and Oliveira 2001; Rose and Richards 2004). Even today, individuals receiving nutritional assistance have higher food insufficiency rates than individuals not receiving nutritional assistance (Gunderson and Oliveira 2001). Understanding why the subpopulation who receives nutritional assistance continues to be at risk for nutritional deficiencies is essential to helping decrease the rates of obesity and overweight in the United States.

2.4 Food environments

While there is not one individual factor that influences food choice (Sobal and Bisogni 2009) research has begun to suggest that the built food environment may play a role in an individual's dietary decision making process (Baker et al. 2006b; Cummins and Macintyre 2006; Kamphuis et al. 2006; Morland et al. 2006; Jago et al. 2007). Research has documented that the size of supermarkets and the market area that they are meant to serve has increased in recent years, which has led to a decline in the total number of food stores available in urban areas (Whelan et al. 2002; Clifton 2004). Analyzing the impact that this change has had on the overall food environment is important because of the potential for long lasting behavioral changes in dietary habits (Swinburn et al. 1999). Therefore, it is important to examine how neighborhoods may have been impacted by changes in the built environment as a result of the movement of large scale supermarkets to the urban periphery.

Food environments are complicated and multi-dimensional and have therefore proven difficult to define. Although much research has been done in recent years on food environments and their influences on dietary behavior there still is not a strong conceptual model to help establish a firm definition (Laraia et al. 2004; Ball et al. 2006). Three primary terms have been used to describe the spatial distribution of food retailers and the corresponding access to food

items within a specified geographic area; food desert, nutrition environment, and food environment (Leviton 2010). Initially much geographic research utilized the term food desert as a way to define areas where inexpensive, nutritious food items are unavailable (Lavin 2005; Beaulac et al. 2009). However, research has begun to deviate from this term as the concept of a food desert tends to focus only on the places that have inadequate access to food items and does not really describe all of the different interactions taking place in the environment (Glanz et al. 2005).

Recently research has begun to use the terms nutrition environment and food environment to define the access to food items in a defined area. Glanz et al. (2005) used the term nutrition environment to define the location of food retailers and their accessibility, the availability and cost of healthy options, how healthy food items are displayed and promoted, and the different geographical locations an individual operates in a given day. While all of these components are certainly essential elements to the food environment Ohri-Vachaspati and Leviton (2010) dispute the use of the term nutritional environment because of the fact that the word nutrition is more commonly thought of as the interaction of food items with a person's body and not the physical environment. Instead, researchers have begun to gravitate towards the term food environment, which can be broadly defined as the physical availability and accessibility of food retailers within a distinct physical boundary (Morland et al. 2002b; Ohri-Vachaspati and Leviton 2010).

The definition of the food environment that was utilized by this research was adopted from previous research conducted by Duvall et al. (2010) and Goldsberry et al (2010). In terms of this thesis the Lansing food environment is defined as the physical availability of fresh produce items and the accessibility of food retailers who sell fresh produce items within the

Greater Lansing area. Fresh produce was used as an indicator of the overall food environment based on previous research that has used the availability of fruit and vegetable items as an indicator of the food environment because of the nutritional diversity that these items bring to a healthy diet (Morland et al. 2002a; Bertrand et al. 2008).

2.5 Accessibility

The word “access” is often used in the vocabulary of researchers who are studying food environments in reference to the ability of area residents to obtain access to food items within the food environment. However, coming up with a satisfactory understanding of what the ability to access the food environment means has proven to be extraordinarily difficult. Peter Gould once wrote that, “accessibility...is a slippery notion...one of those common terms that everyone uses until faced with the problem of defining and measuring it” (Gould 1969, 64). While defining the idea of access is extraordinarily difficult the concept is very important when considering how residents interact with their neighborhoods (Church and Marston 2003). Previous research has indicated that there are three essential components that characterize the idea of accessibility: (1) locations of destinations, (2) the characteristics of the potential destinations, and (3) the ability to reach potential destinations (Burns and Golob 1976; Handy and Niemeier 1997). Recent research on food environments has begun to examine how those three components interact with residents’ ability to access their local food environment.

2.5.1 The automobile and access

In 1970 Hagerstrand developed the space-time framework, which was incredibly influential in the measurement of access. The space-time framework states that there are both spatial and temporal dimensions to how an individual takes part in an activity and that the transportation system can be a limiting factor in terms of the time it takes an individual to reach a

final destination. In the case of access to the food environment the space-time framework is certainly influential in understanding people's ability to access food items. Today in many places in the United States one of the most important components necessary to access the food environment is the automobile. Since the 1970s automobile use in the United States has increased dramatically for commuting to work and small trips (French et al. 2001). As supermarkets have moved to the urban periphery adequate access to an automobile has become increasingly important in order to obtain access to food retail stores (Pearce et al. 2006). The automobile has therefore become an essential part of an individual's ability to access food items within their food environment.

In the US and North America research has found that healthy food items are often more available to individuals with access to automobiles (Bertrand et al. 2008). Unfortunately, there are often disparities in who has access to an automobile and as a result who has the ability to obtain healthy food items. Individuals who have a high socioeconomic status are more likely to own an automobile and are therefore not as likely to depend solely on the stores located in their neighborhood (Wang et al. 2007). On the other hand, African Americans and those with low socioeconomic status have been found to have less access to private transportation (Morland et al. 2002b). Research has indicated that urban residents that have a low socioeconomic status have different shopping habits as a result of the fact that they do not have reliable access to transportation (Hendrickson et al. 2006). Specifically, research has suggested that for the subpopulation who lacks regular access to an automobile has limited access to healthy food items as a result of their inability to obtain access to food stores that provide these products.

2.5.2 The food environment and access

In the context of food environments access is often defined as the ability to obtain healthy food items (Donkin et al. 2000; Morland et al. 2002b). However, surprisingly few different approaches have been utilized by researchers in order to model the accessibility of food environments. Many studies obtain information on food store locations from previously established databases such as local departments of health and agriculture and InfoUSA (Morland et al. 2002b; Algert et al. 2006; Bertrand et al. 2008; Franco et al. 2008). Some researchers did conduct on-site inspections on a limited number of stores and validated other locations using phone records, telephone conversations, store descriptions, and food license records (Algert et al. 2006; Franco et al. 2008). Few research studies actually checked the list of food stores that they obtained from databases, and much research on food environments is conducted without ensuring if the retail food stores identified are still in business.

There are two primary methodologies that are utilized by researchers to measure the food environment, density based approaches, and proximity based approaches. The density approach measures the number of available retail outlets in defined area using a buffering method, kernel density estimation or spatial clustering (Charreire et al. 2010). Overwhelmingly the dominate methodology in this research is to use the census tract or block in which an individual lives as a proxy for their local food environment. In other words, these models make the assumption that the only accessible food stores to an individual are those located in the census tract or block of residence (Diez-Roux et al. 1999; Morland et al. 2002a,b; Inagami et al. 2006; Howard and Fulfroost 2007; Wang et al. 2007; Franco et al. 2008). A major flaw with this methodological approach is that just because an individual lives in a census tract or block does not mean that they are limited to only shopping within that same census tract or block (Morland et al. 2002a).

Census tracts and blocks are also not necessarily representative of a neighborhood or community. In a given day people function in a variety of different environments, including (but not limited to) where an individual shops, lives, and works (Ball et al. 2006). Research has also identified that there are often barriers that impact whether or not individuals shop within their own community. Hendrickson et al. (2006) found that cost, quality of food and food choice limited whether or not study participants shopped locally in their community or chose to shop in a location outside their community where food items were less expensive.

Even researchers who utilize this type of methodology recognize that in an ideal situation the smallest possible unit of analysis should be used to examine food environments (Howard and Fulfroost 2007). A methodology that utilizes zonal objects introduces the modifiable areal unit problem (MAUP) and edge effect problems to the research as the borders of the regions used are arbitrary and potentially modifiable introducing bias into the results (Openshaw 1983). A methodology based solely on zonal objects is also at odds with the space-time framework as it fails to take into account the temporal dimension of access. Just because a food retail store is located in a census tract that an individual resides in does not mean that individual can reasonably access that store through the transportation network available. There may be a store located in a neighboring census tract that is easier to access and this factor is left out when an individual's food environment is limited to the census tract or block in which they reside.

As a result of the flaws associated with a methodology utilizing zonal objects researchers have introduced several different methods to characterize and model the local food environment. One of these methodologies uses the distance from available food retail outlets through the established travel network to measure the local food environment (Charreire et al. 2010). This type of approach uses network distance as a method of analyzing access to the food environment

(Algert et al. 2006; Goldsberry et al. 2010) and measure the actual distance that it would take a person to travel to a food store along the available transportation network. For example Donkin et al. (2000) established indices that measured the cost and availability of items within a geographical area in London. Other research has suggested that the benefit of using multiple models of the food environment to identify areas that are underserved by food retailers (Clarke et al. 2002; Charreire et al. 2010). Overall, the concept of modeling the food environment is still in its preliminary stages and there is much research that must be done in order to establish more accurate models of urban food environments.

2.6 Research on spatial variation within food environments

There are two main ways that the food environment can impact an individual's behavior: how a person perceives the environment and the actual physical characteristics of the environment (Ohri-Vachaspati and Leviton 2010). Much previous research on food environments has focused on the physical characteristics of the environment and more specifically the presence (or lack thereof) of different retail store types within a food environment. The implication of this research is that the spatial variation present within the food environment impacts how individuals behave. Research has indicated that the presence of supermarkets in a food environment can lower the price of groceries and residents of neighborhoods that do not have access to a grocery store have been found to pay more for groceries (Lavin 2005). The introduction of farmers markets has also been found to increase the availability of healthy food and decrease the cost of food items within the neighborhood (Larson and Gilliland 2009). Much research has focused on the disproportionate lack of access to supermarkets and large scale grocery stores that some sub-populations have. The primary assumption of this research is that the level of access an individual has to a food item is directly

related to how likely they are to purchase and consume that item. However, most of the research that has been conducted on this particular topic has employed indirect and intermediate methods, which do not involve an interaction between the researcher and the environment (Booth et al. 2005). As a result this research relied on assumptions that were not based on actual information obtained from people who interact with the environment.

2.6.1 Socio-economic status

As food retail stores that are meant to serve large geographic areas are built many food stores located in or near neighborhoods with low socioeconomic status have been closed. Unfortunately new stores have not located in these areas, which has created a massive deficit of available food options in neighborhoods with low socioeconomic status (Clifton 2004). More importantly, neighborhoods with a low socioeconomic status have been found to have less calculated access to food items (Larson and Gilliland 2008; Beaulac et al. 2009) and less available healthy food items (Campbell et al. 2004; Andreyeva et al. 2008; Baker et al. 2006a; Hendrickson et al. 2006; Franco et al. 2008). Neighborhoods with low socioeconomic status are also more likely to have fresh produce available that is of a poorer microbial quality, which could potentially impact the appeal of these fresh fruit and vegetable items (Koro et al. 2010).

Research has found that there is a difference in the types of stores available in neighborhoods with different socioeconomic status. Supermarkets have been found to be more likely to be located in neighborhoods with a high socioeconomic status (Moore and Diez Roux 2006; Franco et al. 2008). Supermarket chain stores, which have the lowest prices on food items, tend also not to be located in neighborhoods with low socioeconomic status (Chung and Myers 1999). In contrast, corner stores tend to be much more common in neighborhoods with low socioeconomic status (Moore and Diez Roux 2006; Bertrand et al. 2008; Larsen et al. 2009).

Unfortunately the cheap food items which are available in these types of stores are often high in fat and sugar (Cummins and Macintyre 2002). There appears to be an overwhelming disparity in the level of access to healthy food items between high- and low socioeconomic status.

Little research focuses exclusively on the accessible food environment for individuals who receive nutritional assistance. Algert et al. (2006) found that those who receive nutritional assistance through food pantries in Los Angeles have less access to food stores that carry a variety of fresh produce products, with 41% of food pantry clients lacking pedestrian access to fresh produce products. However, this appears to be an area of research with significant room for exploration.

2.6.2 Ethnicity

Research has indicated that predominantly minority urban areas have less access to supermarkets and significantly more access to small scale grocery stores that have fewer fruit and vegetable options (Moore and Diez Roux 2006; Morland and Filomena 2007; Beaulac et al. 2009; Larsen et al. 2009). In general most research that examines ethnic differences in access to food retailers has focused on differences for African Americans and white (non-Hispanic) populations (Howard and Fulfroost 2007). Research has found that African American neighborhoods in urban areas have less access to healthy foods (Sloane et al. 2003; Baker et al. 2006a; Moore and Diez Roux 2006; Franco et al. 2008). African American communities are also less likely to have access to fruit and vegetable items (Sloane et al. 2003). Supermarkets are also more likely to be located in white neighborhoods than in African American neighborhoods (Morland et al. 2002b; Zenk et al. 2005b; Morland and Filomena 2007; Franco et al. 2008). Neighborhoods in which the majority of residents are Latino have been found to have less density of retail food outlets (Howard and Fulfroost 2007). Research has clearly indicated that

there is a disparity in the availability of healthy food items between neighborhoods where white (non-Hispanic) populations reside and neighborhoods where minorities reside.

2.7 Research on the impact of spatial variation in food access on dietary behaviors

Some research has also suggested that the spatial variation present in the local food environment has an impact on individuals' dietary choices (Baker et al. 2006b; Cummins and Macintyre 2006; Morland et al. 2006; Jago et al. 2007). There may be a relationship between the local food environment and obesity and overweight rates within that neighborhood (Morland et al. 2006) and a direct relationship has been established between the availability of fruits and vegetables and their consumption and changes in availability will result in changes in consumption practices (Jago et al. 2007). While there has been a plethora of research examining the association between environmental influences and dietary practices around the world, particularly in Europe, there only appears to be a relationship between access to food items and dietary behavior in North America (Cummins and Macintyre 2006). However, associations between the food environment and dietary behavior in the United States are still uncertain.

2.7.1 Food environments where healthy food is not available

One approach to understand the relationship between the food environment and dietary behavior is to examine neighborhoods where healthy food items are unavailable. Residents of neighborhoods that do not have access to healthy food items have been found to be at an increased risk for obesity and overweight (Wang et al. 2007). The presence of convenience stores in a neighborhood has also been associated with a higher amount of overweight and obese individuals (Morland et al. 2006). Finally, research has found that there is a positive correlation between the availability of healthy food products and the healthfulness of resident's diet at both a community and zip code level (Cheadle et al. 1991). The results of this research indicate that

there might be an association between the fact that there are higher rates of obesity in neighborhoods that have less access to healthy food items.

2.7.2 Importance of supermarkets

Much research on the food environment focuses on the supermarket because of its unique ability to provide a plethora of healthy food items at a low cost (Lavin 2005). Research has indicated that individuals who shop at supermarkets consume a significantly healthier diet than individuals who do not shop at supermarkets. African-American women who shop at supermarkets have been found to consume more fruits and vegetables than those who shop at independent grocers (Zenk et al. 2005a). Also, pregnant woman who live more than 4 miles from a supermarket were found to have a significantly worse diet quality than pregnant women who live near a supermarket (Laraia et al. 2004).

The presence of a supermarket in a local food environment has been found to be associated with lower rates of obesity and overweight individuals in the neighborhood (Morland et al. 2006; Larsen et al. 2009). A plethora of research studies have also found that the addition of a supermarket to a neighborhood increases the consumption of fresh fruits and vegetables by local residents (Morland et al. 2002a; Wrigley et al. 2002; Rose and Richards 2004). An analysis of the Atherosclerosis Risk Study sponsored by the National Heart, Lung, and Blood Institute (NHLBI) found that the addition of a supermarket to a census tract increased the consumption of fruits and vegetables for white Americans by 11% and African-Americans by 32% (Morland et al. 2002a).

2.7.3 Socioeconomic status

The socioeconomic status of a neighborhood has also been found to influence health related behaviors (Baker et al. 2006b). Research has previously indicated that environmental

factors have an influence on the dietary choices of participants in the nutritional assistance program (Rose and Richards 2004). Individuals with a low socioeconomic status have been found to have lower food expenditures, lower fruit and vegetable consumption, increased consumption of non-core foods including chips and sugar sweetened beverages, pay higher prices for food items, and have overall lower quality diets (Bell and Burlin 1993; Diez-Roux et al. 1999; Drewnowski and Specter 2004; Vinkeles Melchers et al. 2009). An association has also been identified between living in a socioeconomically advantaged neighborhood and the purchase of healthy food items (Turrell et al. 2003). Neighborhoods with a low socioeconomic status have been found to have an increased risk for obesity and a higher Body Mass Index (BMI) (Inagami et al. 2006; Wang et al. 2007). The lower quality diets that are found in neighborhoods of low socioeconomic status are associated with the inadequate access these neighborhoods have to healthy food items (Morland et al. 2002b; Rose and Richards 2004).

2.7.4 Mobility

Finally, research has indicated that the mobility of an individual impacts their ability to achieve a healthy diet. An association has been found between individuals who have to travel farther by automobile to obtain food items and a high BMI (Inagami et al. 2006). Elderly individuals who have restricted mobility consumed inadequate amounts of fruits and vegetables (Wylie et al. 1999). The level of mobility that an individual possesses is an important factor to consider when attempting to understand access to healthy food items.

2.7.5 Level of impact of spatial variation in food access on dietary behaviors

There are a number of reasons why the availability of healthy food items may impact dietary behavior. Most basically, increased availability of fresh produce items makes it more convenient to purchase fresh fruits and vegetables (Jago et al. 2007). Visual cues, long term

exposure to healthy food items, and culture may also impact an individual's purchasing preferences leading to an increased consumption of fresh fruits and vegetables (Jago et al. 2007). However, research has indicated that it is often a number of different factors that contribute to an increased risk of obesity and that consumption of healthy food items is not only influenced by the food environment (Ford and Dzewaltowski 2008). Therefore it is often a combination of access to healthy food items and the population residing in the neighborhood that influences dietary behavior.

2.7.6 Food environment does not influence dietary behavior

Some research, however, indicates there is not enough evidence to suggest that there is an association between access to food retailers and dietary habits (White 2007). Other research has concluded that there is no association between the socio-economic status of a neighborhood and a healthy food environment (Bertrand et al. 2008). Living near to a supermarket is not necessarily associated with a lower risk of obesity (Wang et al. 2007). Research on the interaction between the food environment and dietary behavior is incomplete. There is some indication that there are neighborhoods with limited access to healthy food items and that in many cases those same neighborhoods have poor dietary practices, however, there has not been enough evidence to indicate that there is a clear correlation between the two phenomena. Often the assumption is made that the limited access to healthy food items is the cause of the poor dietary habits and obesity in those same neighborhoods. Correlation, however, does not imply causation and few studies have examined the actual impact that the food environment has on dietary behavior and how residents of neighborhoods actually interact with their local food environment.

2.8 Behavioral geography

Human Geography is a science that draws upon theories from many different disciplines in the social sciences. In the case of this research many of the concepts and principals of behavioral research can also be utilized to help understand the interactions between the residents of Greater Lansing and their food environment. Traditional human geographic analysis is very cause and effect oriented and fails to take into account the larger reasoning the goes into how people make decisions in their day to day lives (Norton 1997). One of the major downsides of the introduction of theory to geographic research by the quantitative revolution of the 1950s and 1960s was that theory is based on rigid constraints that are not entirely in line with how the real world operates (Golledge 2008). This left researchers seeking to better understand how an individual's decision making eventually influenced their behavioral choices (Golledge 2008). Behavioral geography is based on inferences that are made from the observed actions of individuals (Gale 1972). When a person makes their decision of where to shop for food items the problem is very complex, causing the person to weigh a number of different options, with individual reasons for each part of their decision. Behavioral geography recognizes this phenomena and attempts to provide an explanation for how these chains of decisions are made in order to understand behavioral actions (Gale 1972). As opposed to the methods employed by those involved in the quantitative revolution, behavioral geography examines individual disaggregate behavior based on primary data (Golledge 2008). This research draws upon behavioral geography in an attempt to understand how residents of Greater Lansing come to their decision of what food items to consume utilizing primary data in order to help develop better models of how to conceptualize the food environment.

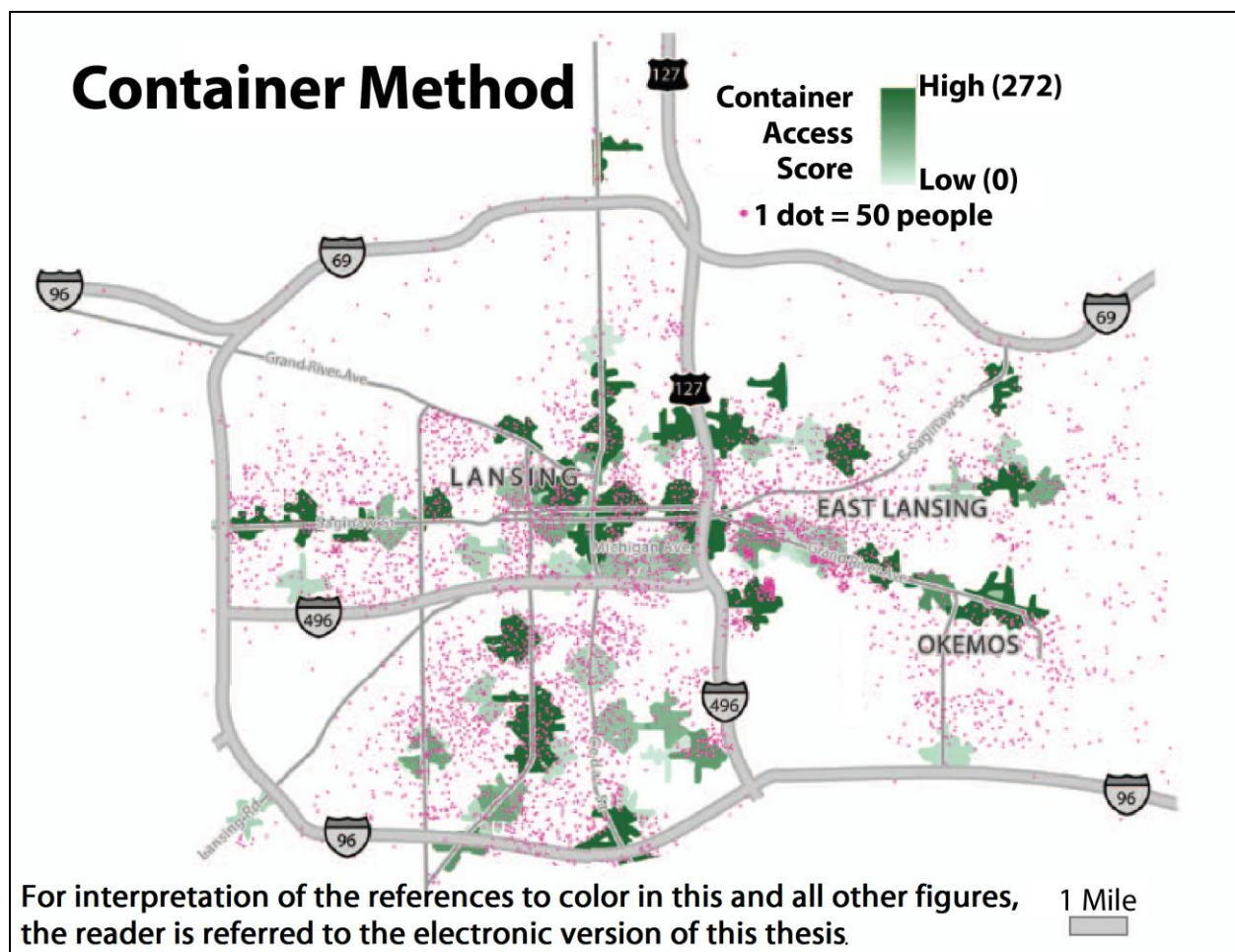
2.9 Previous food environment research in Greater Lansing, MI

Previous models of access to fresh produce in Lansing created by Duvall et al. (2010) and Goldsberry et al. (2010) provided the background measure of the food environment that was used for this research. In order to identify the retail stores to be used in the models of the Lansing food environment Duvall et al. (2010) and Goldsberry et al. (2010) established a list of all potential food retail businesses (not including restaurants) that were located in Lansing. The list was compiled based on phone book listings, Internet searches, on-the-ground surveys and commercial data from ESRI based on the InfoUSA database (Duvall et al. 2010). After the list of potential retail stores that sold fresh produce was established each store was checked through visits and telephone calls to make sure that they were operating and that they sold fresh produce. A total of 94 retail stores were identified that sold fresh produce in Lansing. Between February and April 2008 data were recorded from each of these stores and a list of available produce items was established for each store (Duvall et al. 2010). From this data Goldsberry et al. (2010) established three different models of access to fresh produce in Lansing: a container method, a weighted method, and a cumulative distance method. Each of these different models created drastically different visualizations of the food environment in Lansing. The container and weighted method models of access were also established for both pedestrian and automotive access. A total of five models of access to fresh produce items in the Lansing food environment were available to be used as measures of accessibility in the food environment for this research.

The container method of accessibility (Figure 2.1) in the Lansing food environment that was used by Goldsberry et al. (2010) is a measure of the number of opportunities to purchase fresh produce items within a 10 minute walk (.5 miles) for pedestrian access and a 10 minute drive for automobile access. This type of accessibility measure was first developed by Wachs

and Kumagai (1973). One of the main flaws with this type of model of access is that not all individuals have the same opportunity to purchase fresh produce items (Church and Marston 2003) and the container method weights an item that is a 10 minute drive away from an individual the same as an item that is right next door.

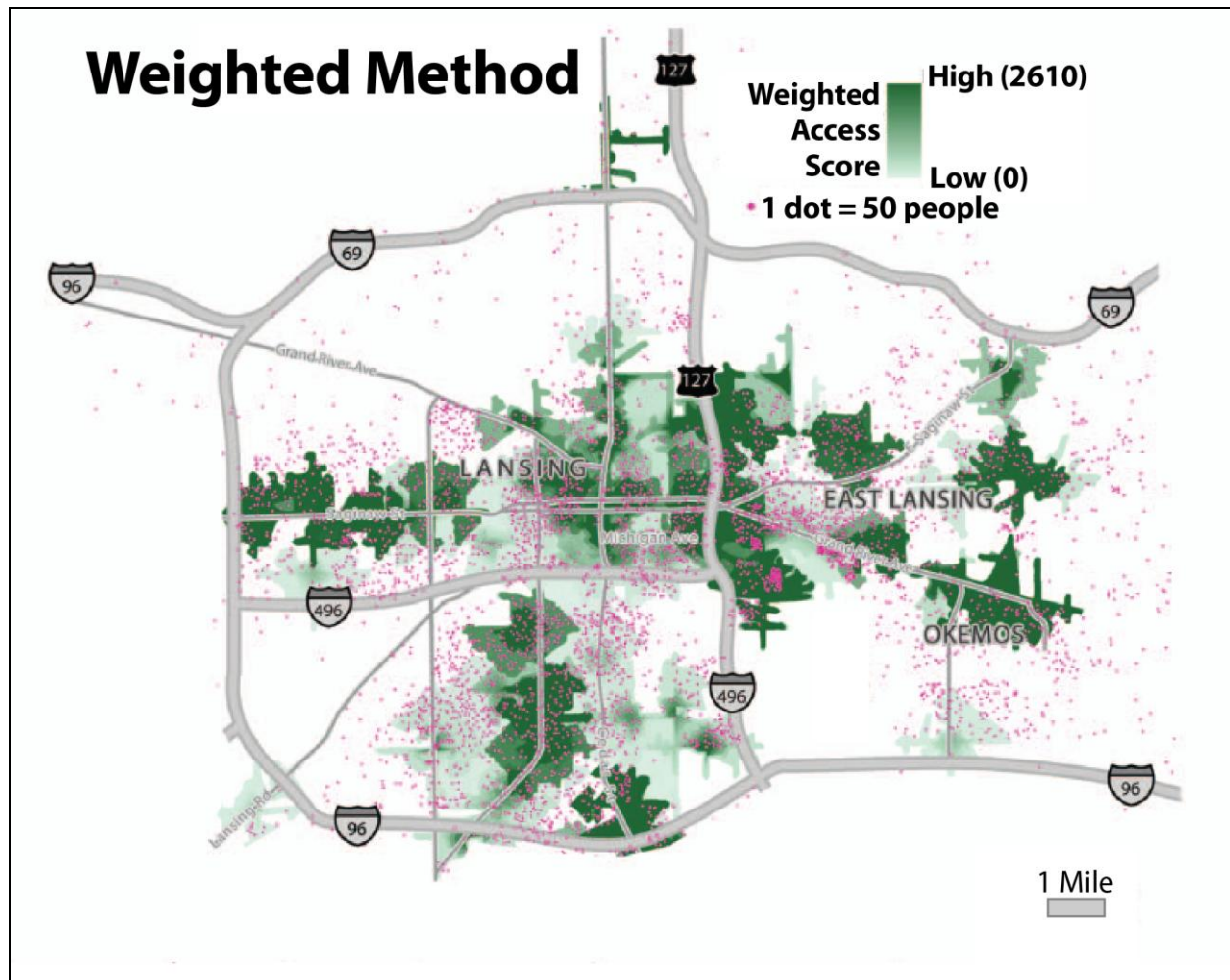
Figure 2.1: Container method accessibility model of Lansing food environment (pedestrian) (Goldsberry et al. 2010)



The weighted method of accessibility (Figure 2.2) established by Goldsberry et al (2010) follows the same basic model as the container method but instead of using a blanket number of opportunities this model gives higher accessibility scores to fresh produce items that are located closer to an individual location than to fresh produce items that are located farther away. This

type of accessibility model was first applied to the social sciences by Hodgard (1978) and is a slightly more complex measurement than the container method as it accounts for the distance to obtain fresh produce items (Church and Marston 2003).

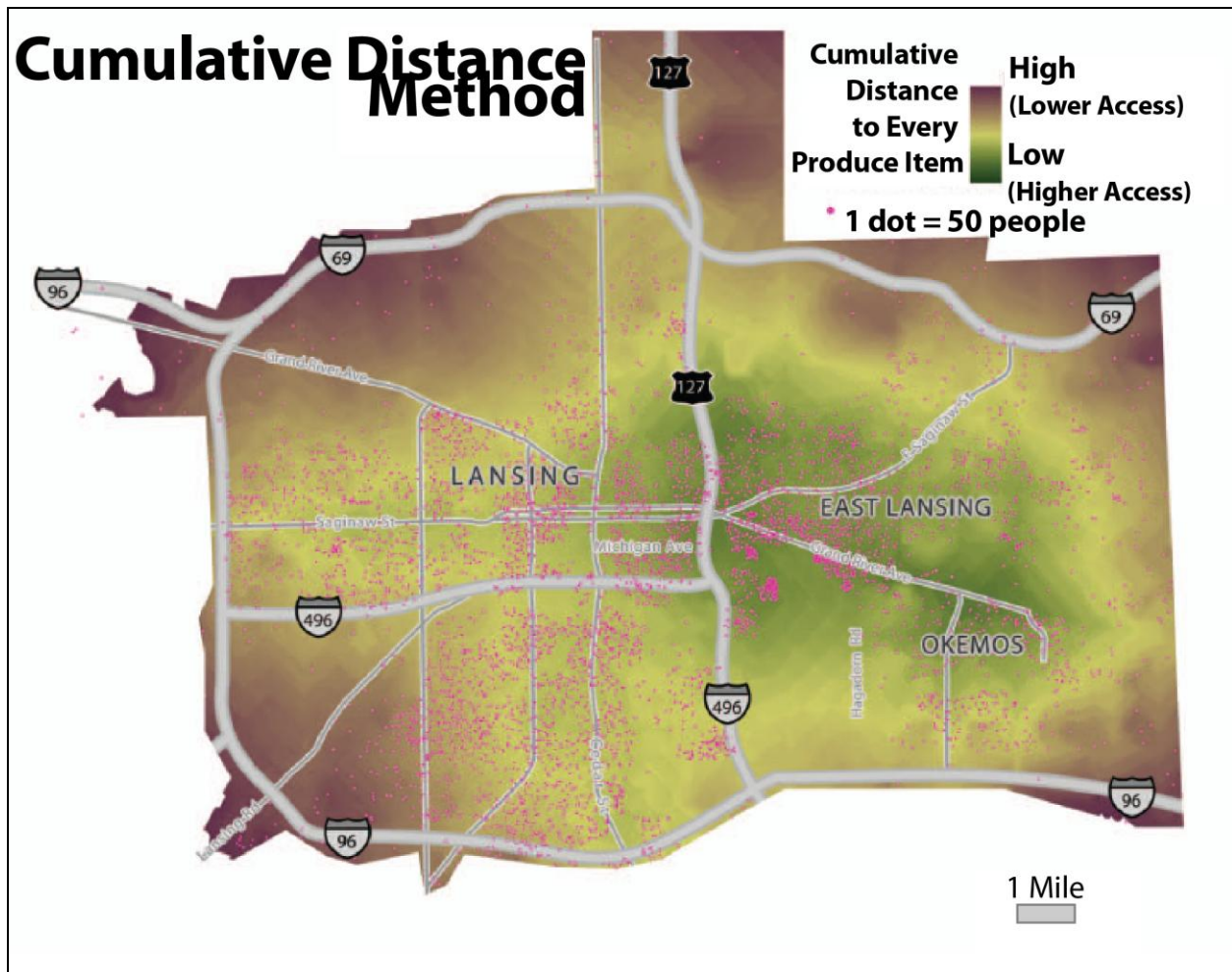
Figure 2.2: Weighted method accessibility model of Lansing food environment (pedestrian)
(Goldsberry et al. 2010)



Finally, the cumulative distance method (Figure 2.3) establishes an access score based on the overall distance that a consumer would need to travel to obtain every produce item that was available in Lansing. This method is another version of a weighted measure with a different set of criteria. Instead of measuring the amount of items available within a certain distance this

model measures the total distance that an individual would have to travel from an initial starting point to obtain all produce items that are available in the Lansing food environment (Goldsberry et al. 2010). This model was only established for automobile access.

Figure 2.3: Container method accessibility model of Lansing food environment (Goldsberry et al. 2010)



All five of these separate models of access are used as measures of the food environment in Greater Lansing for this thesis. This decision was made because each different model established a drastically different picture of the Greater Lansing food environment. Previous research has found that there are many benefits associated with conceptualizing the food environment through multiple models of access (Clarke et al. 2002; Charreire et al. 2010). At

this point in time there is no straightforward methodology for modeling the food environment and as a result it is important to understand how all of the different models that have been established interact with data that has been collected on the ground. Comparing how these models interact with survey data will help to achieve a greater understanding of the Lansing food environment as a whole and enable better models of access to be established in the future.

CHAPTER 3: METHODS

3.1 Overview

The methods that were employed in this thesis were designed to help understand the behavioral interactions between Greater Lansing residents and their food environment. Although there has been much qualitative and observational assessment of food environments in urban areas, there has been very little quantitative analysis attempting to understand how residents actually interact with their food environment (Morland et al. 2002b). The primary objective of this thesis is to understand the behavioral interactions between Greater Lansing residents and their food environment using quantitative methods. Specifically, this thesis seeks to answer the following research questions:

- 1) Is there an association between calculated access to fresh produce products and the use of fruits and vegetables in the diets of Greater Lansing residents?;
- 2) Are there variables other than the retail food environment that influence the dietary behavior of Greater Lansing residents?;
- 3) Do Greater Lansing residents believe that the food retail environment in Lansing is adequate?;
- 4) Do Greater Lansing residents who receive nutritional assistance interact with the food environment differently than Lansing residents who do not receive nutritional assistance?

In order to achieve the primary objective and answer the research questions proposed by this thesis, customers of food retail stores in Lansing were surveyed to obtain information on the shopping and dietary behavior of area residents. Statistical, geographic, and spatial analyses

were performed as a means to understand and explore the interaction between Greater Lansing residents and their food environment.

3.2 Study area

The Greater Lansing, Michigan area is considered to be a mid-sized metropolitan area with an overall population of around 450,000 (ACS 2009). The specific study area that was used for this research was approximately 1,200 square miles with an estimated population of 291,000 residents (Goldsberry et al. 2010). The city of Lansing is comprised of three counties Ingham, Eaton, and Clinton and portions of all three counties were included in the study area for this research. Based on 2009 American Community Survey data, the majority of Greater Lansing residents are White (81%), with the rest of the population reporting that they were African American (8%), Hispanic (5 %), Asian (3%), and Other (3%).

As a result of its situation as a mid-sized city with a heavy reliance on the automobile Lansing provides an excellent case study to examine how area residents interact with their food environment. Much of Lansing is difficult to access by walking or biking, which forces residents to rely on automobiles or public transportation options to move around the city. As a result, the built environment creates a number of obstacles for many of the residents of Lansing who lack access to an automobile. In fact, many such residents also receive nutritional assistance and are at risk for not achieving their required daily nutritional intake. In Ingham County 28% of those that receive emergency food assistance have no access to an automobile for transportation (*Food Systems Project Annual Report* 2010). Due to the lack of supermarkets in northwest Lansing, almost one-third of this area's residents shop for their groceries at places other than the major supermarket chains: Kroger, Meijer, and L&L (*Food Systems Project Annual Report* 2010).

3.3 Questionnaire development

The decision to use a street-intercept methodology, randomly sampling patrons of food retailers located in the Greater Lansing area, to understand how Greater Lansing residents interact with their food environment was made based on previous research indicating that this was the best way to obtain responses from segments of the population that have traditionally been more difficult to reach with random-digit dialing telephone methodologies (Bush and Hair 1985; Miller et al. 1997). Previous literature identified that low-income groups, minority groups, and those receiving nutritional assistance are often the most impacted by their surrounding food environment (Morland et al. 2002a; Rose and Richards 2004; Baker et al. 2006b). Therefore, it was essential to obtain sufficient responses from these more difficult to reach subpopulations to understand how they interact with the Lansing food environment.

The benefits associated with a street intercept methodology including: increased response rates from hard to reach segments of the population, higher response rates to sensitive questions, and the ability to see firsthand the interaction that consumers have with their shopping environment, made this method a clear choice to administer the questionnaire for this thesis. Bush and Hair (1985) found that there was a consistent pattern of fewer refused questions and more accurate responses when administering their survey in person. In-person surveys also had the added benefit of allowing the researcher to obtain both more in-depth responses and additional information that are potentially lost when conducting research over the phone (Bush and Hair 1985). Survey participants are also more likely to divulge sensitive information, like their income level, with an in-person surveying technique in comparison to a survey that was conducted over the telephone (Miller et al. 1997). Previous research on food environments has also utilized a street-intercept methodology. Baranowski et al. (2006) used this method to recruit

participants for their research in front of grocery stores, however, the actual interview for their research took place over the telephone.

Once a street-intercept methodology was selected as the method to interact with research participants a questionnaire was developed that was suitable for this particular methodology. The questionnaire was designed in an effort to gain as much information as possible from Greater Lansing residents within a short interview period of five minutes. The questionnaire was divided into six sections: interviewer notes, transportation, consumer behavior and shopping habits, diet and use of produce, location of residence and demographics. A copy of the final survey instrument used in this research can be found in Appendix A.

3.3.1 Interviewer notes

The questionnaire instructed the researcher to take notes and record the location of the survey, date and time the survey was conducted, as well as the weather at the time of the interview. The notes from the interviewer were collected in order to ensure that an adequate sample of the Lansing retail customers had been obtained and that there was no bias within the sample towards individuals who shop at a particular time of day or day of the week.

3.3.2 Transportation

Questions related to access to transportation were asked in an attempt to understand the various transportation options available to Greater Lansing residents. These questions were designed to determine the level of access Greater Lansing residents had to automobiles, the mode of transportation that the respondent used to get to the retail location and whether or not the shopping trip was exclusively to go to the retail location or if the trip had multiple destinations. This information was used to help determine how Greater Lansing residents access their food environment.

3.3.3 Consumer behavior

The next section in the questionnaire was designed to help understand consumer behavior and shopping habits. Greater Lansing residents were asked if they were the primary food preparer in their household and the types of retail locations where they typically purchase food items. This information was obtained in an effort to understand how involved the respondent was with the food purchasing in their household. Questions that were related to shopping behavior were used to determine the type of retail stores that Greater Lansing residents shop for their food products at.

3.3.4 Diet and use of produce

The use of fresh produce in the diet of Greater Lansing residents was measured by questions that focused on the number and type of fresh produce items purchased, the use of frozen and canned produce items, and gardening activities. The information provided in this section of the survey was used to help gauge the use of fresh produce items in the Greater Lansing residents' diets.

3.3.5 Location of residence

Location of residence for Greater Lansing residents was determined by asking participants to provide the address of their primary residence. If survey participants were not comfortable providing their physical address then they were presented with the option of providing the intersection that is located nearest to their primary place of residence.

3.3.6 Demographic information

Questions regarding demographic information were asked at the end of the survey. Since survey participants can feel uncomfortable disclosing demographic information, the questionnaire was designed in order to ensure that respondents completed the bulk of the survey

before they were asked to divulge personal information. The demographic information participants were asked to disclose included: gender, year of birth, number of people residing in their household, ethnicity, participation in food assistance programs and annual household income.

3.3.7 Pretesting and IRB approval

Pretesting of the questionnaire was performed on graduate students in the geography department in order to ensure that questions were easy to understand and answer. Once questionnaire design was completed the questionnaire was submitted to Michigan State University's Institutional Review Board (IRB) for review. IRB approval was granted on May 28, 2010 (IRB #10-491) with Dr. Kirk Goldsberry as the primary investigator. When IRB approval was granted the process of selecting study sites began.

3.4 Selection of study sites

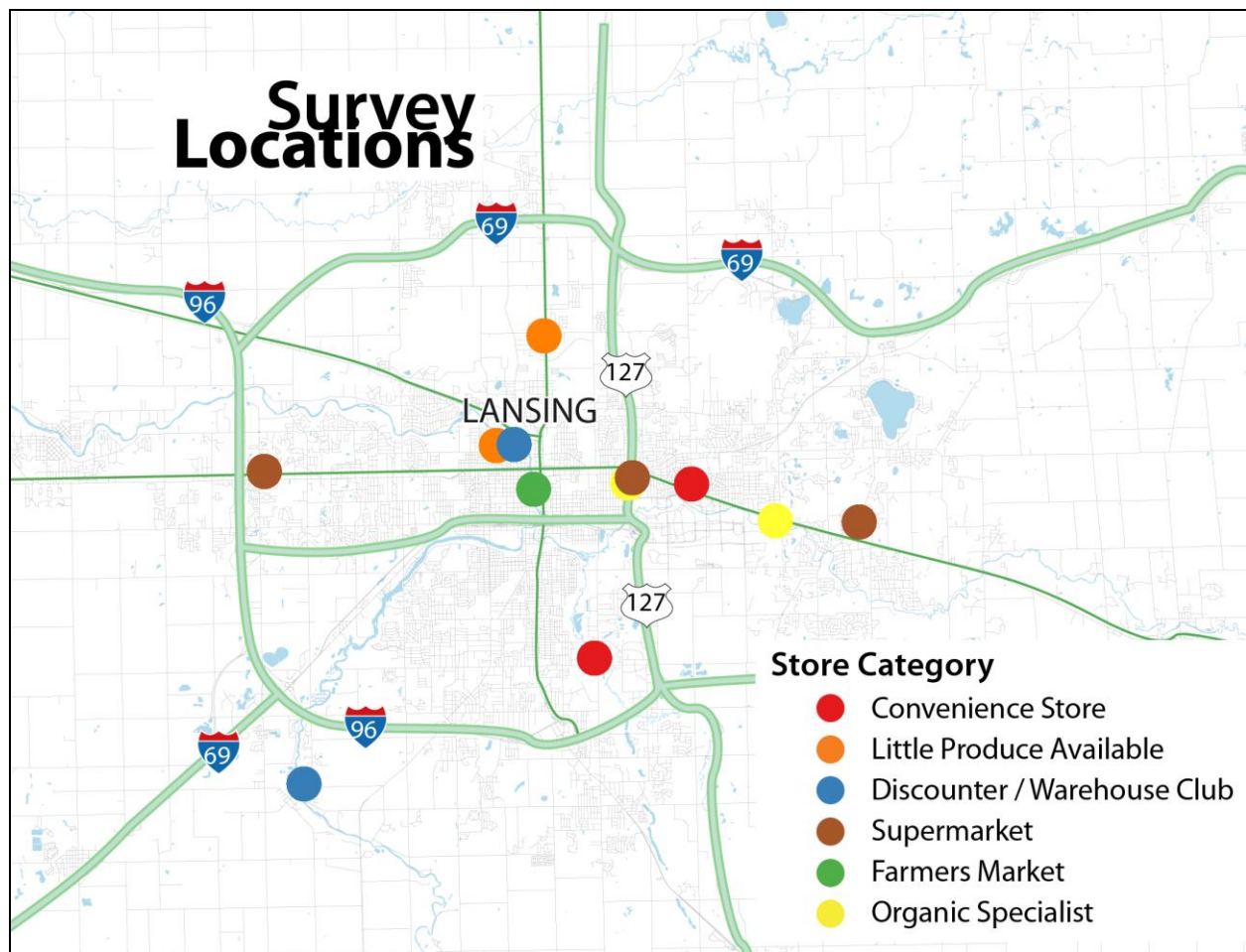
The research previously conducted by Duvall et al. (2010) and Goldsberry et al. (2010) was used to help inform methodological decisions and the survey instrument implementation. Study site selection was based on the classification of 94 food retail establishments performed by Duvall et al. (2010). Duvall et al. (2010) found that the majority of retail stores in Lansing that sold fresh produce items were supermarkets, generalist grocers and convenience stores. Previous research, however, has also suggested that there is significant variability in products stocked at food retail stores depending on where the store was located and whether or not there were other retail stores located nearby (Guptill and Wilkins 2002; Duvall et al. 2010). Therefore, a variety of different categories of food retail store types were selected based not only on the category of store but on the relative importance of that store within the food environment.

Stratified random sampling was used to select the 30 initial stores to contact based on the list of food retailers that provided fresh produce compiled by Duvall et al. (2010). Two additional farmers markets that were not included in the list compiled by Duvall et al. (2010) were added to the list in order to gain greater perspective on how Greater Lansing residents interact with their food environment. Research has indicated that stratified random sampling is on the average just as accurate as random sampling (Cochran 1946), while still ensuring the inclusion of places deemed important by the researcher. A stratified random sampling methodology was selected for store survey locations in order to ensure certain food retail stores were included in the analysis, while still maintaining a level randomness in the sample population. Certain stores were specifically selected to survey based on their footprint in the Lansing food environment. The list of preselected stores included the East Lansing Meijer, the Okemos Meijer, and the Kroger located in the Frandor mall. The remaining stores to contact were selected by generating random numbers. Initially, two farmers markets, four convenience stores, two discounters, two ethnic food stores, four grocers, two liquor stores, two organic specialists, and six supermarkets were selected to contact.

Initial contact of the selected study sites began on June 3, 2010. Soon after contact of the selected study sites began it became apparent that getting permission from retailers, especially supermarkets and grocers, would be very difficult and many more stores would need to be contacted in order to ensure an adequate sample. Meijer corporate offices very quickly responded that no solicitation was allowed on any of their property, which meant that Meijer store property could not be used for this research. Quality Dairy, which is an important provider of fresh produce products in the Lansing area as well as the major grocery chain in the region, also declined to participate in the project. Unfortunately, the lack of willingness from many of

the major retailers in the area forced the selection of study sites in some cases to be based more on retailers that were willing to participate in the project than on a complete stratified random sampling of area food retailers. A strong effort was made, however, to ensure that there was diversity in both the geographic location and the type of retailers that were surveyed. Ultimately 40 retail stores were contacted to participate in the research and twelve study sites were eventually selected to survey. The list of study sites included two 7-Eleven convenience stores, Vallarta Supermarket, Carl's Supermarket, the Lansing City Market, Sav-On Market, Rainbow Party Store, Better Health, Foods for Living, Horrocks Farm Market, and two Kroger Supermarkets (Figure 3.1).

Figure 3.1: Location of study sites



The list of selected study sites covers a wide variety of types of retail stores from party stores to full-scale supermarkets. In terms of categories of produce retailers that were established by Duvall et al. (2010) the list of study sites included, three supermarkets (Frando Kroger, Okemos Kroger, and Horrocks Farm Market), two discount grocery stores (Vallarta Supermarket and Carl's Supermarket), one farmers market (Lansing City Market), two organic specialists (Better Health and Foods for Living), two liquor stores (Sav-On Market and Rainbow Party Store) and two convenience stores (East Mt Hope Ave 7-Eleven and East Grand River Avenue 7-Eleven).

3.5 Sampling method

Once permission was granted by the manager of a selected retail store, times when the store would be able to be surveyed were established. Numerous stores offered to allow the research to be conducted inside and some stores even offered to allow the research to be conducted in the produce department to watch customer shopping behavior. However, as a result of the fact that not all stores offered this level of access the research always took place outside by the store entrance in order to maintain a level of control in the results. During the designated periods of time when I was allowed at the stores, generally between one to two hours, participants were selected as they entered or left the retail store. Potential participants were asked if they wanted to participate, informed of the \$100 gift card drawing, and were given the information necessary for them to make informed consent. If potential participants gave informed consent an interview was then conducted. Conducting the survey took between four and seven minutes depending on how long it took participants to respond to the questions. At least fourteen interviews were conducted at each of the different food retail stores and each retail establishment was surveyed for a total of at least three hours. Some stores were surveyed over a

longer period of time if they had less foot traffic because it took longer to get the desired number of interviews.

The actual process of administering the survey took place from June 5, 2010 until July 8, 2010. Greater Lansing residents who were shopping at study locations were surveyed from 10am until 6:30pm on all seven days of the week. The time in which Greater Lansing residents were surveyed was often dictated by the store managers and when they would allow the research to take place although an effort was made to ensure that there was a diversity of different times at each store surveyed. Most of surveying for this project took place during sunny weather conditions (67%), although Greater Lansing residents were surveyed on cloudy (28%), rainy (1%), and overcast days (4%). Unfortunately, it was difficult to administer surveys on rainy days as all of the interviews took place outside and potential survey participants were not interested in standing in the rain. A total of 185 interviews were conducted for this research project. Once sampling was completed the responses were coded and entered into Microsoft Excel.

3.6 Statistical analysis

Data analyses were conducted in order to obtain general information about the dataset, establish associations between the amount of calculated access Greater Lansing residents had to fresh produce and the use of fresh fruits and vegetables in their diet, determine variables that influenced Greater Lansing residents' dietary choices to inform future models of accessibility, and analyze the impact that access had on those who receive nutritional assistance. In order to answer the primary research objective of this thesis a variety of different statistical methods were employed including basic statistics, correlation analysis, backwards stepwise regression, geographically weighted regression (GWR), and two-sample t-tests.

A review of the data using basic statistics was conducted in order to ensure that the data were an accurate representation of the greater Lansing population. The information obtained from this review was also used to help answer the research question; do Greater Lansing residents believe that their food environment is adequate? Responses from participants were analyzed in order to understand how Greater Lansing residents perceived their current food environment.

To conduct the data analysis for this research a number of different inferential statistical models were used. Inferential statistical models were originally designed to handle experiments that took place under controlled conditions (Wrigley 1983) and were based on a very specific set of assumptions. Controlled geographic experiments are often the exception rather than the rule and that it is important to take into account the nature of the data when using inferential statistical models (Gould 1970; Goodchild 2009). Goodchild (2009, p.441) argues that quantitative analysis in the social sciences should move in a new direction, "...that treats natural experiments, spatial dependence, and spatial heterogeneity as the norm". Since there was no way to overcome the fact that the data obtained in this research did not perfectly meet the assumptions of inferential statistical models diagnostic tools were utilized before each model was employed in order to understand how the data fit with the assumptions of the model. These tools were also essential in understanding the potential problems and limitations of the models that were created (Wrigley 1983).

3.6.1 Calculation of access scores

A method was established in order to determine the level of access each survey participant had to fresh produce items. Research subjects were asked to disclose either their primary residence or an intersection that was located close to their home and from that

information geographic coordinates were obtained using Google Maps. Once the geographic coordinates were obtained for the primary residence of each survey participant, the data were uploaded into ArcMap along with the raster files that contained the accessibility scores of the five models of the food environment in Lansing established by Goldsberry et al. (2010). Each individual primary residence was given an access score based on the raster file for each of the five models that were calculated by Goldsberry et al. (2010). Out of the 185 individuals who were surveyed a total of 183 addresses were obtained. Each address was given five access scores that could be used as a variable in further statistical analysis.

3.6.2 Correlation

Correlation analysis was used to measure the association between calculated access to fresh produce and the use of fresh fruits and vegetables in the diets of Greater Lansing residents. The information obtained from this data analysis was used to help answer the research question; is there an association between calculated access to fresh produce products and the use of fresh produce in the diets of Greater Lansing residents? All of the correlation analysis for this research was performed using the MYSTAT statistical software package. In order to understand the association between calculated access to fresh produce and the use of fresh fruits and vegetables in the diets of Greater Lansing residents correlation analysis was performed between the three variables that measured the consumption of fresh produce products and the five access variables that were obtained from the research conducted by Goldsberry et al. (2010). The results of this analysis were used to determine whether or not the level of access that was calculated by the models created by Goldsberry et al. (2010) actually predicted the dietary choices of Greater Lansing residents.

3.6.3 Backwards stepwise regression

Backwards stepwise regression was used in order to determine the variables that had the most influence on the consumption of fresh produce items by all Greater Lansing residents and those residents that receive nutritional assistance. The results obtained from this data analysis were used to help answer the research question; are there variables other than the retail food environment that influence the dietary behavior of Greater Lansing residents? Regression analysis was one of the first statistical techniques that was used in geographic research (Hartman and Hook 1956). In terms of geographic analysis, regression is often used to help describe relationships between variables, interpolate between observations, test hypotheses, and extrapolate information (Mather and Openshaw 1974). For this thesis bivariate backwards stepwise regression analysis was used to help establish models that predicted the consumption of fresh produce by Greater Lansing residents. All bivariate regression analysis that was conducted for this research was performed using the MYSTAT statistical software package. Three models were created to predict the three variables that measured the consumption of fresh produce items by all Greater Lansing residents.

All of the models that were established for this research were examined to ensure that they met the assumptions of a linear regression model. The assumptions of linear regression models were outlined by Poole and O'Farrell (1970) and include (1) the values are obtained without measurement error, (2) the relationship between the variables is linear, (3) all conditional distributions have a mean of 0, (4) there is no hetero-scedasticity present in the residuals, (5) the residuals are independent of each other, (6) there is no multicollinearity present between the independent variables, and (7) the distribution of all the variables are normal. In the context of geographic research, however, it is often difficult to ensure that all of these assumptions are

completely met. Gould (1970, p.446) wrote that “given the fact that the assumptions seldom hold individually, and that the chances of them holding severally is virtually zero, it is difficult not to think of traditional, non-spatial inferential statistics as totally irrelevant as correspondence rules in geographic enquiry”. Gould felt that in geographic inquiry satisfying the assumptions of a linear model is nearly impossible and therefore it is important to take that information into account and make decisions based on your individual data. When establishing the models for this thesis an effort was made to ensure that all of the assumptions of a linear regression model were met, however, when the assumptions could not be met an effort was made to explain why that particular model was still an accurate representation of the data presented and how the results of these models might be limited based on the fact that they violated the assumptions of the model.

Stepwise regression models are incredibly useful because the conditions of the model are established before the model is created, enabling the researcher to ensure that their data meets the assumptions of a linear regression model to the best of their ability. The backwards stepwise regression process results in a traditional ordinary least squares (OLS) regression equation:

Equation 3.1: OLS regression

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_n X_n + \varepsilon$$

An ordinary least squares regression equation seeks to predict the value of a variable (Y) based on the value of other independent variables (X). Independent variables (n) are selected for entry into the model based on their statistical fit with the dependent variable and not previously defined hypotheses. In the case of backwards stepwise regression modeling all of the initial candidate variables are entered into the model and then eliminated based on whether or not they meet the criteria that were established by the researcher. Coefficients (β) measure the strength and type of relationship that each independent variable has with the dependent variable and the

residuals (ϵ) are a measure of the random error present in the model. In the case of this research backwards stepwise regression was useful because it was important to determine what the variables that predicted the consumption of fresh produce were, as previous research was not entirely clear on what those variables might be.

3.6.4 Geographically weighted regression

Geographically weighted regression (GWR) analysis was used mainly as an exploratory technique to measure the variation of regression coefficients over space and to help further answer the research question; are there variables other than the retail food environment that influence the dietary behavior of Greater Lansing residents? The information obtained from this analysis was used to further understand how the physical location of Greater Lansing residents' home residence influenced their dietary behavior and to better understand the models that were created from the backwards stepwise regression process. The analysis for this research was performed using both ArcMap and R statistical software programs. In traditional regression analysis geographic relationships between coefficients are often lost and smoothed over. GWR allows researchers to further explore their data and identify possible variables that may be missing from the model, as well as spatial variations that may be difficult to introduce into the model but are worth recognizing (Brunsdon et al. 1998).

A traditional regression model makes the assumption that the parameters of the model are the same across the entire (Equation 3.2).

Equation 3.2: Traditional regression

$$Y = \beta_0 + \beta_1 X_1 + \epsilon$$

For a traditional regression equation each independent variable has the same coefficient across all observations, which in the process can potentially smooth out some of the spatial variation

from the model. In the case of GWR an estimation of the model takes place at each observation with other data points that are located near the observation achieving a higher weight.

Equation 3.3: Geographically Weighted Regression

$$Y(u,v) = \beta_0(u,v) + \beta_1 X_1(u,v) \dots + \beta_n X_n(u,v) + \varepsilon(u,v)$$

The result of a GWR model is that each individual observation has its own parameters and coefficients measuring the strength and type of relationship that the independent variables in the model have with the dependent variable, with (u,v) referring to the geographic coordinates of the individual data points. This provides additional information about spatial variation within the dataset. For this research the three regression equations that were established using backwards stepwise regression were reexamined using geographically weighted regression. This additional analysis was performed to obtain additional information on the validity of the backwards stepwise regression models and to better understand the spatial variation in dietary behavior among Greater Lansing residents.

3.6.5 Two-sample t-test

Finally, two-sample t-tests were employed in order to understand how the population of those who receive nutritional assistance differed from the population who did not receive nutritional assistance. The information that was obtained from this analysis was used to answer the research question; do Greater Lansing residents who receive nutritional assistance interact with the food environment differently than Greater Lansing residents who do not receive nutritional assistance? Two sample t-tests are used to assess if the means of two different populations vary significantly, in the case of this research the population of residents who receive nutritional assistance and the population of residents who do not. The two sample t-test was used to determine if the mean travel time to the retail store Greater Lansing residents were

surveyed at, the frequency Greater Lansing residents visited different types of retail stores, and the consumption of fresh produce items differed between Greater Lansing residents who received nutritional assistance and Greater Lansing residents who did not. The primary hypotheses for these tests are that the mean travel time to store surveyed at is greater for those who receive nutritional assistance than those who do not, that those who receive nutritional assistance shop at convenience and liquor stores for food items then those who do not, and that those who receive nutritional assistance consume less fresh produce items then those who do not.

The primary assumptions of this statistical model are that the data were collected using random sampling, the samples are independent of each other and the data that is being examined are interval/ratio data. There are two different models of two-sampled t-tests that can be employed, separate variance and pooled variance. In the case of this research pooled variance was used when the variance for those that receive nutritional assistance and those that did not was approximately equal. If the variance for those that receive nutritional assistance and those who did not receive nutritional assistance was not equal separate variance was used. The null hypothesis for the two-sample t-tests that were employed was that there is not a significant difference in the means for the variable selected for the population who received nutritional assistance and the population who did not receive nutritional assistance. The alternative hypothesis is that the observed mean for those that receive nutritional assistance is significantly different than for those who did not receive nutritional assistance. The information obtained from this analysis will be useful to help inform future models of access to food items in the Lansing area and to understand how certain subpopulations may interact differently with their local food environment.

CHAPTER 4: RESULTS AND ANALYSIS

4.1 Introduction

The results of the survey revealed important new information about the Lansing food environment and helped to achieve the primary objective of this thesis to understand the behavioral interactions between Greater Lansing residents and their food environment. Most other research of food environments examines the food environment as purely a geographic entity with assumptions that fail to take into account how local residents actually interact with the food environment. The results and analyses in this chapter shed light on how Greater Lansing residents actually interact with their food environment.

4.2 General survey results

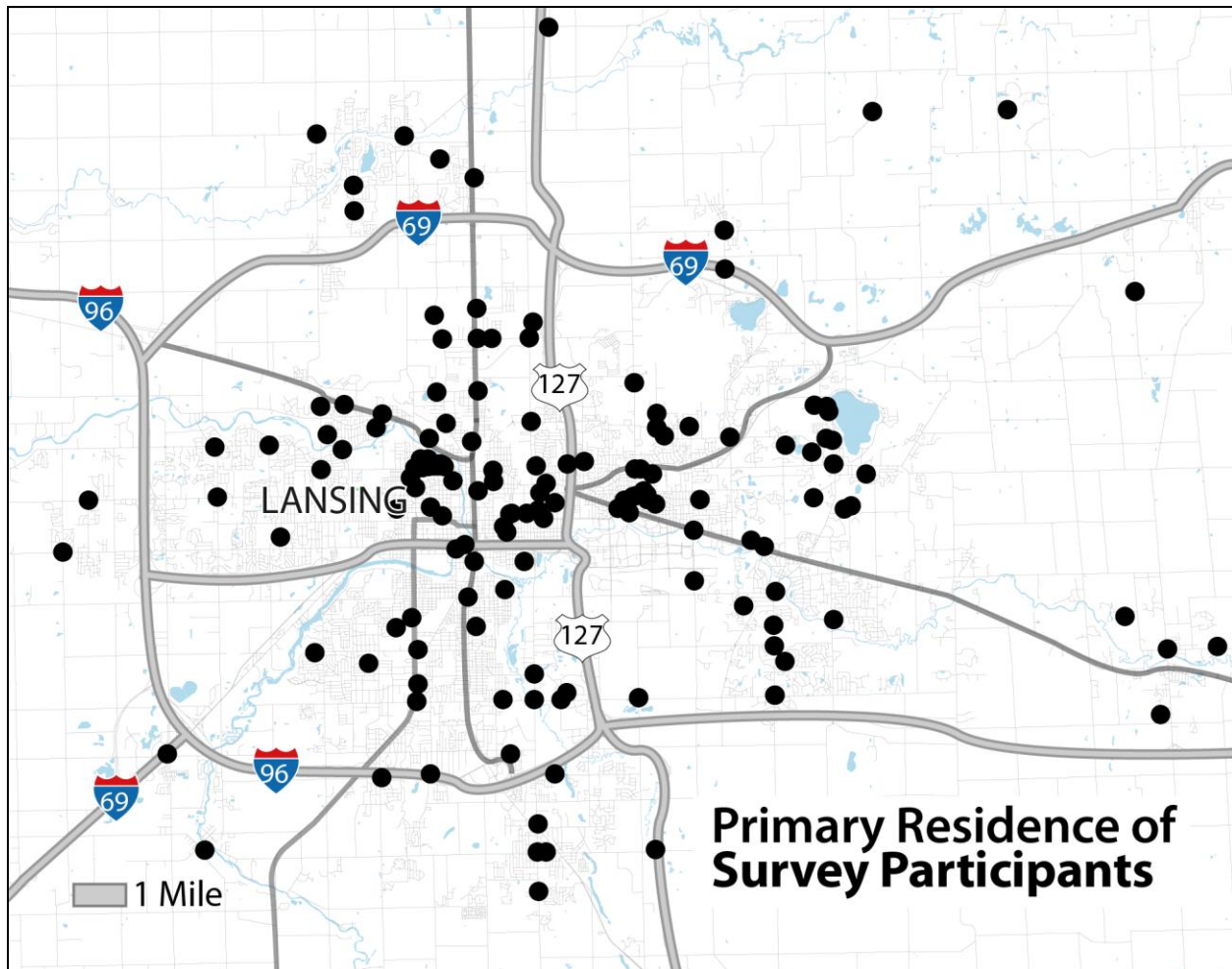
Overall the survey sample of Greater Lansing residents appeared to be a good representation of the Lansing population when compared to 2009 American Community Survey (ACS) data (Table 4.1). For the most part the demographic information obtained from the survey population was in line with the Lansing demographic information available from the ACS. The mean age for survey participants was 44 years old, which is slightly higher than the mean age of Greater Lansing residents reported by the 2009 ACS (34 years), however, part of this discrepancy is a result of the fact that children under the age of 18 were not allowed to participate in this research but were included in the 2009 ACS data.

Table 4.1: Demographic results

		Survey Participants	2009 American Community Survey
Gender	Male	49.2%	48.3%
	Female	50.8%	51.7%
Age (median)		44	34
Ethnicity	White (non-Hispanic)	70%	81%
	African-American	10%	8%
	Hispanic	7%	5%
	Asian	2%	3%
	Other	10%	3%
	Refused	2%	N/A
Household size (median)		2.7	2.4
Children younger than 18		27%	28%

There did appear to be a slight skew in the data as a high proportion of survey participants (14%) reported that they earned less than \$10,000 per year, which is not surprising as one-fifth of the surveyed population reported some form of receiving nutritional assistance. One-fifth of survey participants also did not know their annual household income or refused to disclose that information. A diverse array of locations were reported as their primary residences (Figure 4.1).

Figure 4.1: Primary residence of participants



4.2.1 Travel behavior

A private automobile was the primary mode of transportation that survey participants used to gain access to all different categories of stores surveyed, although eight out of the twelve stores surveyed were accessible by public transportation. A substantial majority of those surveyed had regular access to an automobile (88%), with the average household having access to two automobiles. A higher percentage of pedestrians were surveyed shopping at liquor (35%) and convenience stores (22%) than other categories of food stores, which indicates that stores that sell few produce items and convenience stores may serve a more local pedestrian based

community (Table 4.2). Health food stores (93%) had the highest percentage of customers that accessed the store by automotive transportation, which indicates that these types of stores may serve a much wider geographic area.

Table 4.2: Travel time based on retail store type

Store category	Avg. Travel Time (minutes reported)	Auto	Public	Pedestrian
Convenience	7.8	72%	3%	22%
Discounter	4.6	81%	--	13%
Farmers market	12.5	81%	--	13%
Health food store	13.5	93%	3%	3%
Liquor	5.8	59%	3%	35%
Supermarket	10.3	83%	13%	4%

On average participants indicated that it would take approximately 10.4 minutes to travel from the store at which they were surveyed shopping to their primary residence. However these travel times varied depending on the type of food retail store where they were surveyed (Table 4.2). Participants were willing to travel the longest to health food stores (13.2 minutes), supermarkets (12.4 minutes), and farmers markets (12.3 minutes). The shortest reported travel time was to discount grocery stores (6.1 minutes) and to liquor stores (7.2 minutes).

Respondents (71%) indicated that they would visit multiple other destinations on the shopping trip they were on when surveyed before returning to their primary residence. Most survey participants (58%) reported that the food retail store they were surveyed at was closer to their primary residence than other locations that they frequented. This finding indicates that food retail stores in close proximity to a respondent's primary residence may have more importance in their overall food environment. However, a significant number of participants (32%) did

indicate that the store they were shopping at when surveyed was nearer to location that they frequented other than their primary residence including their work (21%), child's school or daycare (2%), church (1%), gym (1%), or other location that they regularly travel to (7%). Interestingly, 11% of participants reported that the store was not near any place associated with their daily activities, which demonstrates that some individuals are willing to travel outside of their regular routine to shop for food items.

4.2.2 Shopping behavior

Most participants did not seem to feel that access to adequate shopping was a problem in the neighborhood surrounding their primary residence with a strong majority (82%) indicating that it was only a “minor problem” or “not a problem”. Only a small percentage (7%) of participants felt that access to adequate shopping was a “very serious problem” in their residential neighborhood. Despite the fact that most participants did not feel that access to adequate shopping was a problem participants did not seem to indicate that the majority of their food shopping was done in their immediate neighborhood. A majority of participants (57%) indicated that only “some” or “none” of their shopping was done within a 20 minute walk or about a mile away from their home and only 22% of participants indicated that “all” or “almost all” of their shopping was done near their primary residence. This finding suggests that while Greater Lansing residents are generally satisfied with their food environment most residents are not doing their food shopping in close proximity to their homes. More than four-fifths of those surveyed indicated that they were the primary shopper in their household.

The supermarket was the most commonly visited food retail location and had the highest frequency of visits (Table 4.3). Almost all participants indicated that they regularly shopped for food items at supermarkets, with 94% indicating that they shopped for food items at a

supermarket at least once a month and 63% at least once a week. The average number of trips to a supermarket per month reported by participants was 4.7, which indicates that participants frequent supermarkets on a regular basis. Based on the survey results the supermarket is clearly an essential component of the Lansing food environment.

Table 4.3: Consumer behavior based on retail store category

Store category:	Mean number of times shopped at for food items per month:	Percent who never shop at this category:	Percent who shop at this category at least once a week:	Percent who shop at this category 3 or more times per week:
Supermarket	4.7	6%	63%	10%
Restaurant	4.4	16%	27%	12%
Convenience store	4.2	52%	28%	10%
Fast-food restaurant	3.7	27%	39%	10%
Grocery store	3.6	30%	39%	8%
Health food store	1.8	64%	15%	3%
Farmers market	1.5	52%	22%	3%
Liquor store	1.5	82%	12%	5%
Department store	0.8	66%	5%	1%
Discounter / warehouse club	0.7	76%	5%	1%

Most participants indicated that they ate out frequently, consuming fast-food (73%) and eating at restaurants (84%) at least once per month. A small percentage of respondents indicated that they consumed food from fast-food restaurants (10%) and restaurants (12%) more than 3 times per week. Unfortunately, restaurants and fast-food retailers were not included in the models of the food environment that were established by Duvall et al. (2010) and Goldsberry et al. (2010).

Alternative food stores did not appear to be a major component of the Lansing area food environment with less than half of participants indicating that they shopped at farmers markets (48%) and health food stores (36%) for food items. The subpopulation of participants that do shop at these types of stores does so relatively frequently with 45% of that group shopping at farmers markets and health food stores at least once a week. Less than a quarter of respondents reported gardening at home (22%) or in a community garden plot (2%).

4.1.3 Dietary behavior

Overall respondents “strongly agreed” or “agreed” that they are careful about what they eat (73%) and have a healthy (78%) and nutritious (73%) diet (Table 4.4). Almost all participants (96%) reported that they consumed fresh produce products. Those who did not consume fresh produce items cited the ease of preparing other items, taste preferences, and availability as reasons that they did not consume fresh fruits and vegetables. Respondents indicated that they prepared meals with fresh fruits and vegetables on average 23 times per month, which is less than daily. Fresh produce items were the most commonly purchased fruit and vegetable items with the average participant purchasing 7.5 fresh, 1.9 canned, and 1.7 frozen fruit and vegetable items in a typical week. Most respondents preferred to prepare meals with fresh fruits and vegetables (86%) in comparison to frozen (8%) and canned (6%) fruit and vegetable items. Less than half of survey participants indicated that they purchased organic fruit and vegetable items (46%).

Table 4.4: Participant diet perceptions

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
“I am a healthy eater”	22%	56%	9%	12%	2%
“I am someone who eats in a nutritious manner”	22%	51%	10%	15%	2%
“I am someone who is careful about what I eat”	24%	49%	14%	12%	2%

4.3 Correlation analysis

Correlation analysis was used mainly as an exploratory technique to understand the association between calculated access to fresh produce items and the use of fresh fruits and vegetables in the diets of Greater Lansing residents. Three variables were used to measure the use of fresh produce in the diets of Greater Lansing residents; the number of meals prepared with fresh produce items each week, the estimated number of fresh produce items purchased each week, and the listed number of fresh produce items purchased each week. These three variables were then compared to the five access scores that were obtained from the analysis performed by Goldsberry et al. (2010). The Pearson correlation values between access to fresh produce products and the reported use of fresh fruits and vegetables by respondents indicate that there is no relationship present between modeled access to fresh produce items and the reported use of fresh fruits and vegetables in the diets of Greater Lansing residents (Table 4.5). The consumption of fresh produce items by participants was not influenced by their calculated access to fresh fruit and vegetable items. The strongest relationship based on Pearson correlation values was between the cumulative distance method of access and the consumption of fresh produce; however this relationship was still weak, with the highest Pearson correlation value being only

0.196. These results indicate that the models of the food environment established by Goldsberry et al. (2010) do not predict how many fresh fruit and vegetable items a resident of Greater Lansing will reportedly consume in a month.

Table 4.5: Pearson correlation values between modeled access to fresh produce and dietary behavior

	Number of Meals Prepared with Fresh Produce each Week	Number of Fresh Produce Items (estimated) Purchased each Week	Number of Fresh Produce Items (listed) Purchased each Week
Automobile (weighted)	-0.005	-0.043	-0.076
Automobile (count)	-0.009	-0.006	-0.048
Pedestrian (weighted)	-0.027	-0.083	-0.066
Pedestrian (count)	0.007	-0.039	-0.034
Cumulative Distance Method	0.196	0.169	0.115

4.4 General population backwards stepwise regression models

Since correlation analysis indicated that there was no association between calculated access to fresh produce products and the use of fresh fruits and vegetables in the diets of Greater Lansing residents the next step was to understand what other variables might influence the consumption of fresh produce products. Three separate backwards stepwise regression models were established for each of the variables in the dataset that measured the consumption of fresh produce in order to identify the variables that were particularly important in predicting the number of fresh fruit and vegetable items consumed by the population.

For each of the three backwards stepwise regression models, all eligible variables from the survey results were initially entered. A list of these variables can be found in Appendix B. All eligible variables were entered into to the model because there was no clear understanding as

to which variables might influence the use of fresh produce in the diets of Greater Lansing residents. The same criteria were established for all three backwards stepwise regression models. The tolerance criteria for entry into the final regression model was purposefully kept low ($1e-012$) because of the fact that there was likely to be high amount of correlation among the independent variables that were entered into the model and it was important to keep all possible variables eligible for entry. The probability for removal from the model was set to 0.15. An initial analysis of each variable's distribution was conducted to check for normality. All of the variables had normal distributions and no transformations were performed.

4.4.1 Model #1: Number of different produce items (listed) purchased each week

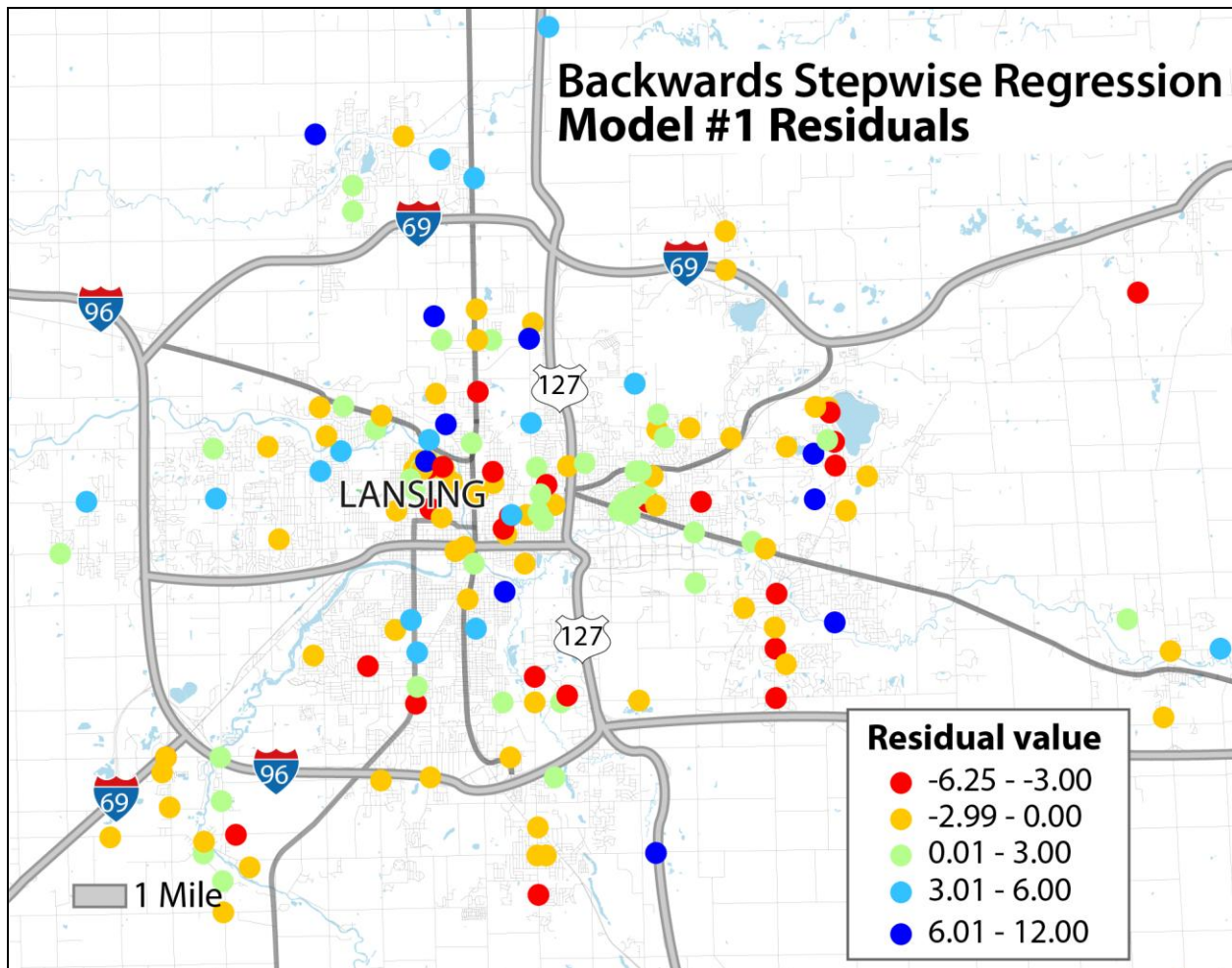
The first backwards stepwise regression model that was created used the listed number of different produce items purchased each week as the dependent variable. The final model employed four independent variables: how nutritious a respondent believed that their diet was, gender, number of household members, and whether or not a household received nutritional assistance. The final regression model did not have a large explanatory power ($R^2 = 0.181$), although the F-Ratio was significantly large (10.816) to reject the null hypothesis at a 99% confidence level ($p\text{-value} < 0.001$).

Table 4.6: Number of different fresh produce items (listed) purchased each week: Backward stepwise regression results

Effect (X_n)	Coefficient	Std. error	Std. coefficient	Tolerance	t	p-value
Constant (β_0)	1.539	1.750	0.000		.879	.380
How nutritious respondent believed their diet was	-0.959	0.260	-0.260	.933	-3.696	0.000
Gender	1.628	0.521	0.218	0.944	3.121	0.002
Number of household members	0.266	0.182	0.105	0.901	1.467	0.144
Whether or not a household receives nutritional assistance	1.922	0.666	0.209	0.882	2.886	0.004

The coefficients of variables (Table 4.6) behaved as would be expected within the final regression model. The more nutritious a respondent believed that their diet was the more likely they were to purchase a large variety of fresh produce products. The coefficients of the variables also indicated that women were more likely to list a larger number of fresh produce products that they purchased each week. The coefficient of the regression model indicated that the larger the household size the more different fresh produce items were purchased each week. Finally households who received nutritional assistance purchased a less diverse variety of produce products.

Figure 4.2: Number of different fresh produce items (listed) purchased each week: Model residuals



The regression model established some observations that were outliers or exhibited leverage; however, based on analysis of the individual observations there was no reason to remove these observations from the analysis. The residuals of the model appear to be homoscedastic and there is no serial correlation based on the scatter plot and histogram of residuals. There appears to be a slight but not overly consequential left-skew to the residuals of the model. There did not appear to be any multicollinearity present between the independent variables. A map of the residuals (Figure 4.2) of the model indicated that there was no spatial bias and the model was not predicting some areas substantially better than other areas. The

residuals appeared to be evenly distributed. While there is evidence that the model violated some of the assumptions of a linear regression model there was not enough evidence to indicate that these results were not valid.

4.4.2 Model #2: Number of different produce items (estimated) purchased each week

The second backwards stepwise regression model used the estimated number of different fresh produce items purchased each week as the dependent variable. The final model resulted in the inclusion of five independent variables: whether or not participants viewed neighborhood access as a problem, how nutritious participants believed that their diet was, frequency of visits to farmers market, income, and whether or not participants received nutritional assistance. This final regression model that was established did not have a large explanatory power ($R^2 = 0.198$); however the F-Ratio was significantly large (9.870) to reject the null hypothesis at a 99% confidence level (p-value<0.001).

Table 4.7: Number of different fresh produce items (estimated) purchased each week: Backward stepwise regression results

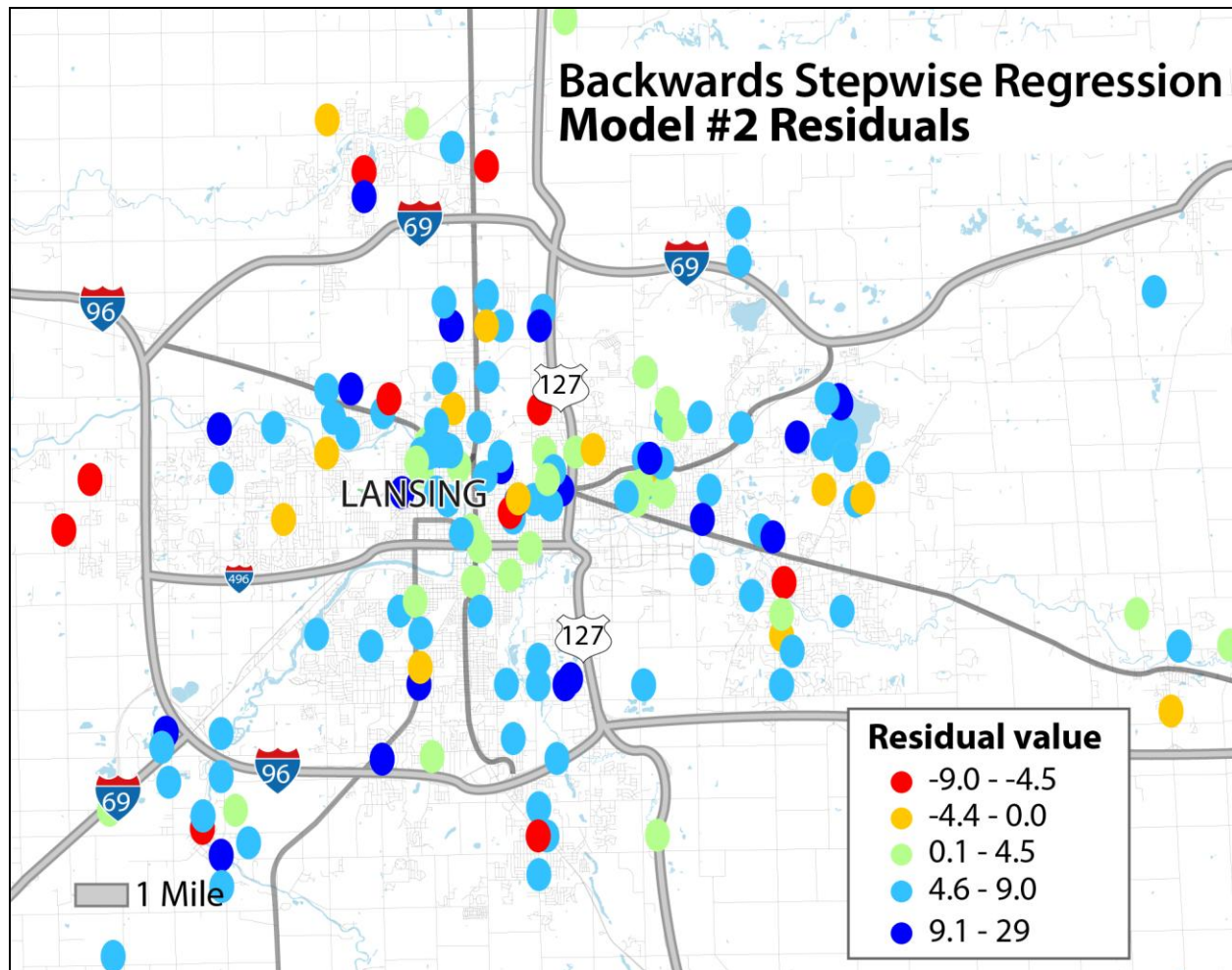
Effect (X_n)	Coefficient	Std. error	Std. coefficient	Tolerance	t	p-value
Constant (β_0)	7.891	2.712	0.000		2.909	0.004
Neighborhood access problem	-.0854	0.460	-0.126	0.969	-1.857	0.065
Nutritious diet	-1.846	0.436	-0.292	0.936	-4.237	0.000
Farmers market frequency	0.321	0.177	0.127	0.918	1.818	0.071
Income	0.375	0.164	0.160	0.913	2,289	0.023
Nutritional assistance	2.304	1.124	0.146	0.881	2.050	0.042

Again the coefficients of variables behaved as should be expected within the model (Table 4.7) despite the fact that only three of the five variables included in the final regression

model had a relationship that was significant. According to the coefficients in the final regression model those who felt their diet was nutritious were more likely to estimate that purchased a greater variety of fresh produce products. Those who reported a higher income and did not receive nutritional assistance were also more likely to estimate that they purchased a diverse variety of fresh produce products. Respondents who indicated that they lived in a neighborhood where access to adequate shopping was a problem and respondents who did not shop frequently at farmers markets purchased a less diverse variety of fresh produce items.

The results and residuals of the model were examined in order to ensure none of the assumptions of the model were violated. The distribution of the residuals had a slight left-skew, which indicates there may be some heteroskedasticity in the residuals and may cause some doubt about the reliability of using a ordinary least squares regression model to examine this relationship. A map of the residuals (Figure 4.3) of the model indicated that the model was not predicting some areas significantly better than others and the residuals appeared to be evenly distributed.

**Figure 4.3: Number of different fresh produce items (estimated) purchased each week:
Model residuals**



4.4.3 Model #3: Number of times meals are prepared with fresh produce items in a week

The third backwards stepwise regression model that was established for this research used the number of times that meals were prepared with fresh produce items in a week as the dependent variable. Overall this final model had the highest explanatory power of all of the models that were developed, most likely as a result of the number of independent variables that were able to gain entry into the model. The final model resulted in the entry of eight independent variables; whether or not respondents viewed their neighborhood access as a problem, how nutritious respondents believed that their diet was, frequency of visits to fast food

restaurants, frequency of visits to farmers market, frequency of visits to department stores, gender, age, and household size. This regression model had a larger explanatory power ($R^2 = 0.345$); however the overall explanatory power of the model was still not very large. The F-Ratio was significantly large (12.925) to reject the null hypothesis at a 99% confidence level (p-value=0.000).

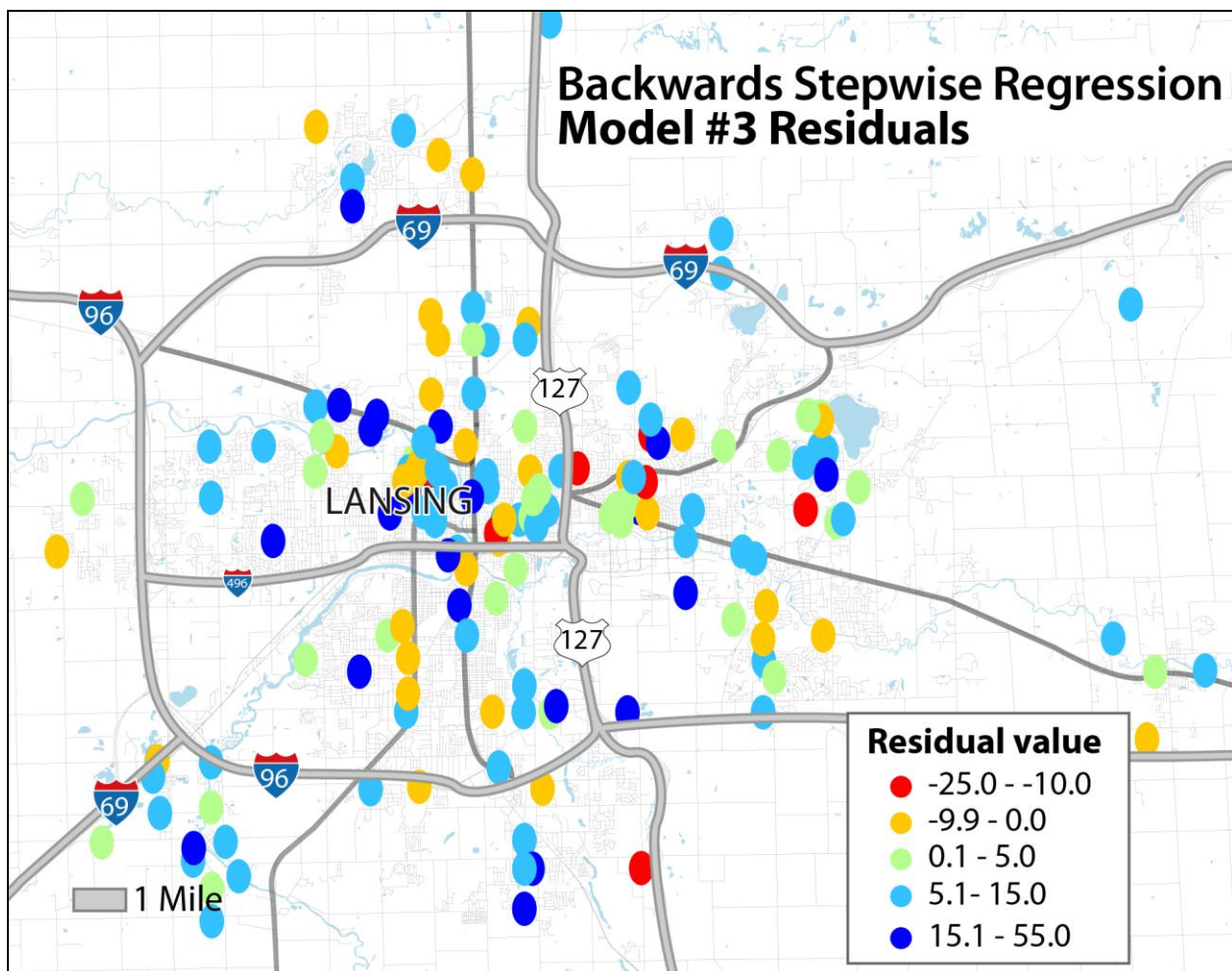
Table 4.8: Number of times meals are prepared with fresh produce items each week: Backward stepwise regression results

Effect (X_n)	Coefficient	Std. error	Std. coefficient	Tolerance	t	p-value
Constant (β_0)	24.610	4.015	0.000		6.130	0.000
Neighborhood access problem	-1.566	0.623	-0.153	0.981	-2.513	0.013
Nutritious diet	-3.911	0.641	-0.412	0.792	-6.098	0.000
Fast food frequency	-.0296	0.131	-0.154	0.780	-2.258	0.025
Farmers market frequency	0.472	0.237	0.123	0.945	1.989	0.048
Department store frequency	0.404	0.257	0.100	0.900	1.572	0.118
Gender	2.586	1.190	0.134	0.948	2.173	0.031
Age	0.091	0.038	0.150	0.904	2.372	0.019
Household size	1.004	0.411	0.153	0.921	2.440	0.016

The coefficients of variables (Table 4.8) behaved as anticipate within the final regression model. According to the model those who felt their diet was nutritious were more likely to consume fresh produce. Those respondents who lived in a neighborhood that they believed had adequate access to shopping, shopped infrequently at fast food restaurants, shopped frequently at farmers markets, were female, older and lived in a large household were also more likely to consume fresh produce items. More frequent shopping at department stores for food items was associated with more frequent meal preparation with fresh produce items.

The results and residuals of the model were examined in order to ensure none of the assumptions of the model were violated. Based on the analysis of a plot and histogram of the residuals there did not appear to be heteroskedasticity present in the residuals of the model. The tolerances of the variables also indicated that there was not significant multicollinearity in the model either. A map of the residuals of the model indicated that the model was not predicting some areas significantly better than others and the residuals appeared to be evenly distributed.

**Figure 4.4: Number of times meals are prepared with fresh produce items each week:
Model residuals**



4.4.4 Overall analysis of general population backwards stepwise regression models

Backwards stepwise regression analysis using the variables that were generated for this research was unable to create a regression model that explained a substantial amount of the variance in the consumption of fresh produce items by Greater Lansing residents. For this analysis none of the accessibility score variables were entered into any of the models, which is not surprising based on the Pearson correlation values that were generated. The independent variables that appeared in at least two of the backward stepwise regression models that were created included: how much of a problem respondents felt that access was in their neighborhood, how nutritious respondents felt that their diet was, how often respondents shopped at farmers markets, gender, the number of people in a household, and whether or not a resident received nutritional assistance. Unfortunately, many of the variables that had high explanatory power within the established regression models will not prove to be incredibly useful when creating improved models of the Lansing food environment. While it is certainly interesting that how nutritious a person believes their diet is, how much access people believe they have to shopping in their neighborhoods, and how frequently a person shops at farmers markets are statistically significant predictors of some of the variance in the consumption of fresh produce items, this information will not be very helpful for developing predictive models of the food environment because it is not available in large scale public datasets such as the Census and ACS.

Gender and the size of household could provide some important information for informing future models of the food environment. The most important variable identified by these regression models was that nutritional assistance, which would predict individual consumption of fresh produce items. Previous literature has identified that people who receive nutrition assistance are at risk for consuming an unhealthy diet (Gunderson and Oliveira 2001;

Rose and Richards 2004; Algert et al. 2006) and the results that were obtained from the backward stepwise regression models appear to support this finding. As a result a deeper analysis of how Greater Lansing residents who receive nutritional assistance interact with their food environment was conducted to fully understand the environmental factors that may influence the dietary behavior of this subpopulation. The results of this analysis will be displayed later in this chapter.

4.5 Geographically weighted regression

GWR enables the further examination of regression models to understand and identify other possible variables that might be missing from the model as well as to identify spatial variations that might be present but difficult to enter into the model as an independent variable (Brunsdon et al. 1998). As a result, GWR was employed using variables established using ordinary least squares backwards stepwise regression to help further explain and understand the geographic variation in the consumption of fresh produce by Greater Lansing residents, as well as test the validity of the regression models that were established. In order to perform GWR on the survey data obtained for this thesis, the data were spatially aggregated into census block groups, a necessary step in order to use GWR analysis on the data. The responses of all survey participants who lived in a census block group were averaged in order to create an overall mean response for the block. While aggregating the data introduces a plethora of different problems to the analysis including boundary issues and the modifiable areal unit problem, the aggregation of data at this stage was necessary in order to conduct GWR analysis and further explore the spatial variation that might be present in the consumption of fresh produce by Greater Lansing residents. An adaptive kernel with varying bandwidths was used to set the number of neighbors used in analysis as the study region was irregular and it was necessary for all observations to have near

neighbors to aid with the estimation of the model. The number of neighbors that were used for the GWR was set to six.

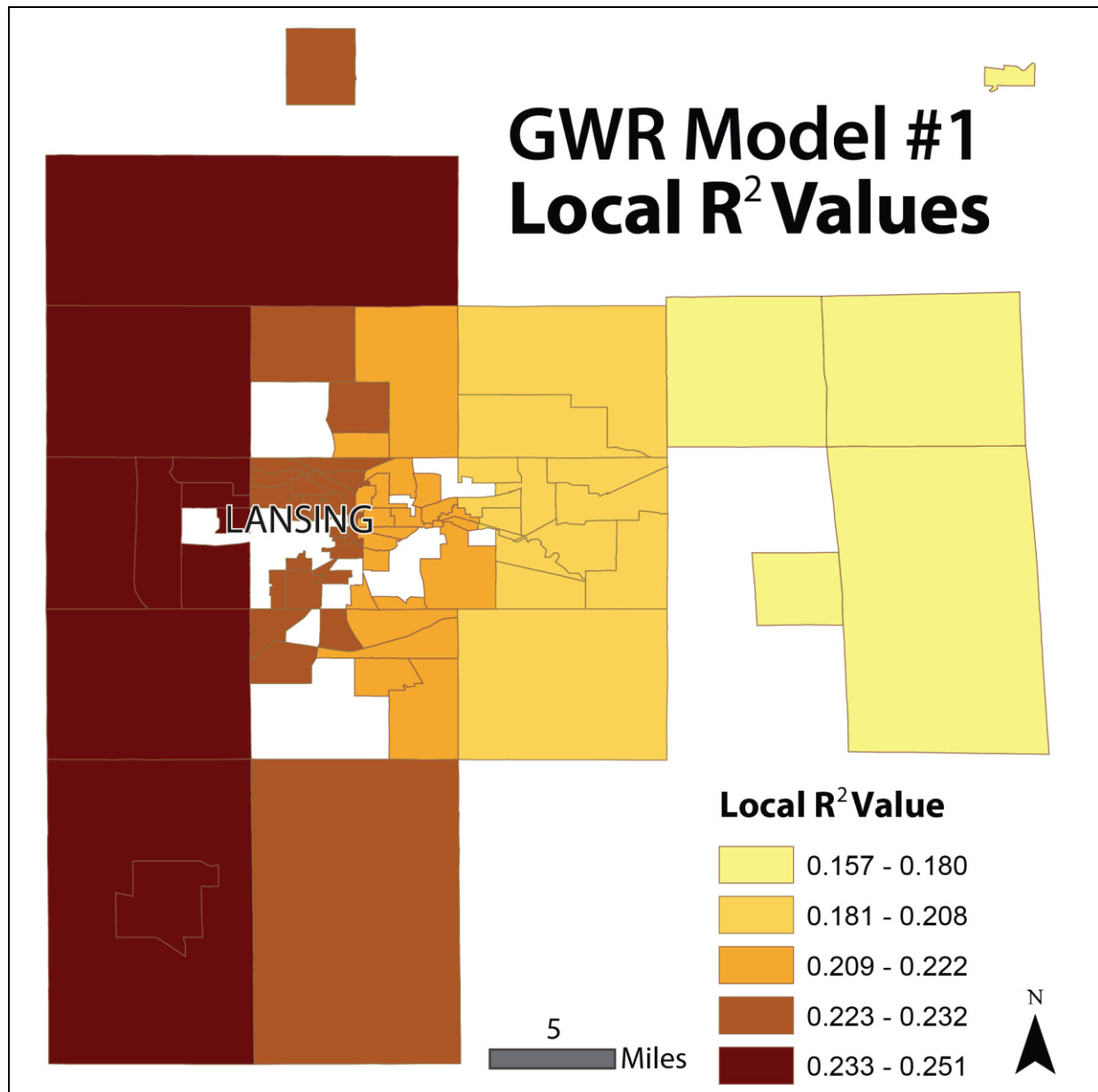
4.5.1 Model #1: Number of different produce items (listed) purchased each week

The regression model established using backwards stepwise regression analysis that used the number of different produce items (listed) purchased each week as the dependent variable had very little explanatory power ($R^2 = 0.181$) as an OLS regression model. The four independent variables that were used in this model were; how nutritious a respondent believed that their diet was, gender, number of household members, and whether or not a household received nutritional assistance. When that same regression model was employed using GWR, which enables a separate estimation of the parameters of the model at each observation, the overall explanatory power of the model remained the same ($R^2 = 0.181$). It is apparent that the data collected for this research does not have the ability to explain the variation in the listed number of different produce items purchased each week by respondents.

There is a clear indication based on the results of the GWR that the regression model that was originally established using backwards stepwise regression analysis for the listed number of produce items purchased each week has significant geographic bias in its explanatory power (Figure 4.5). There is a clear visible trend in the explanatory power of the model, which was able to predict up to 25% of the variance in the listed number of fresh produce items purchased each week in the western portions of the study area and was only able to predict 16% of the variance in the eastern part of the study area. This finding indicates that there might be some spatial variation that is taking place in the interaction between Greater Lansing residents and their food environment, which was not captured in the data for this research. An examination of the spatial variation in the regression

coefficients for the four independent variables further indicated that there clearly was a spatial dimension to the listed number of fresh produce items purchased each week.

Figure 4.5: Number of produce items purchased each week (listed) GWR R^2 values (predictive power of number of produce items purchased)



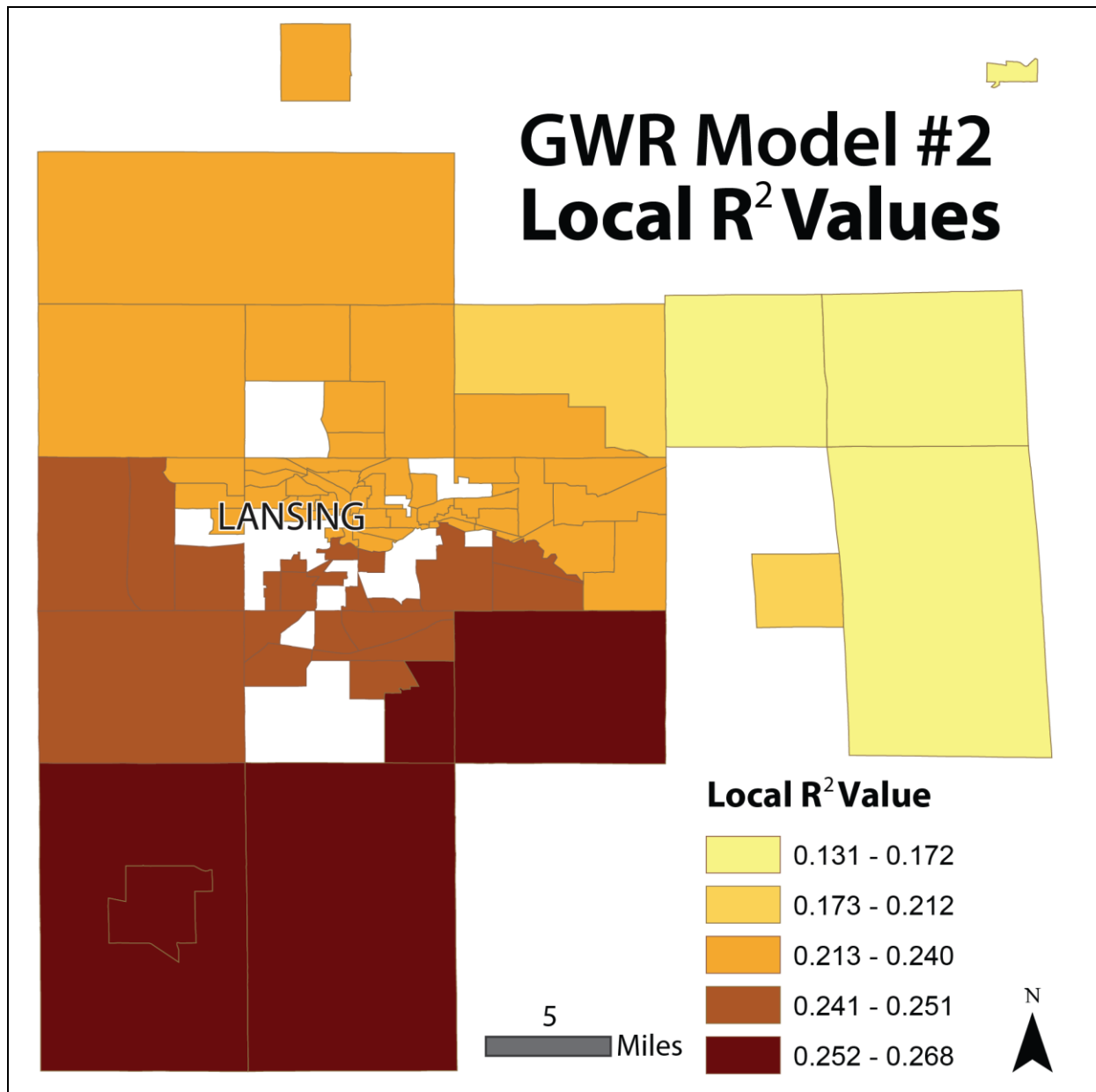
4.5.2 Model #2: Number of different produce items (estimated) purchased each week

The regression model established using backwards stepwise regression analysis with the estimated number of different produce items purchased each week as the dependent variable also

had very little explanatory power ($R^2 = 0.198$). The five independent variables that were used in this model were; whether or not respondents viewed neighborhood access as a problem, how nutritious respondents believed that their diet was, frequency of visits to farmers market, income, and whether or not respondents received nutritional assistance. When that same regression model was employed using GWR the overall explanatory power of the model increased only slightly ($R^2 = 0.223$).

Again, there is a clear indication that the regression model established to explain the estimated number of produce items purchased each week has significant geographic bias in its explanatory power (Figure 4.6). In comparison to the previous model analyzed with GWR the geographic bias in the predictive power of the model appears to be significantly stronger. While there does continue to be an east-west bias in the predictive power of the model there also appears to be significant variation between the southern and northern portions of the study area. The GWR model was able to predict up to almost 27% of the variation in the southwestern census blocks of Lansing, while the model was only able to predict 13% of the variation in eastern Lansing. The results obtained from this GWR analysis continue to indicate that there might be some spatial variation that is taking place in the interaction between Greater Lansing residents and their food environment and that there are explanatory variables that are missing from the data obtained for this research. An examination of the spatial variation in the regression coefficients continued to indicate that there was a spatial dimension to the estimated number of fresh produce items purchased each week, specifically between the southwestern and eastern Greater Lansing area. The strength of the regression coefficients also appeared to be associated with the trends that were visible in the geographic predictive power of the model.

Figure 4.6: Number of produce items purchased each week (estimated) GWR R^2 values (predictive power of number of produce items purchased)

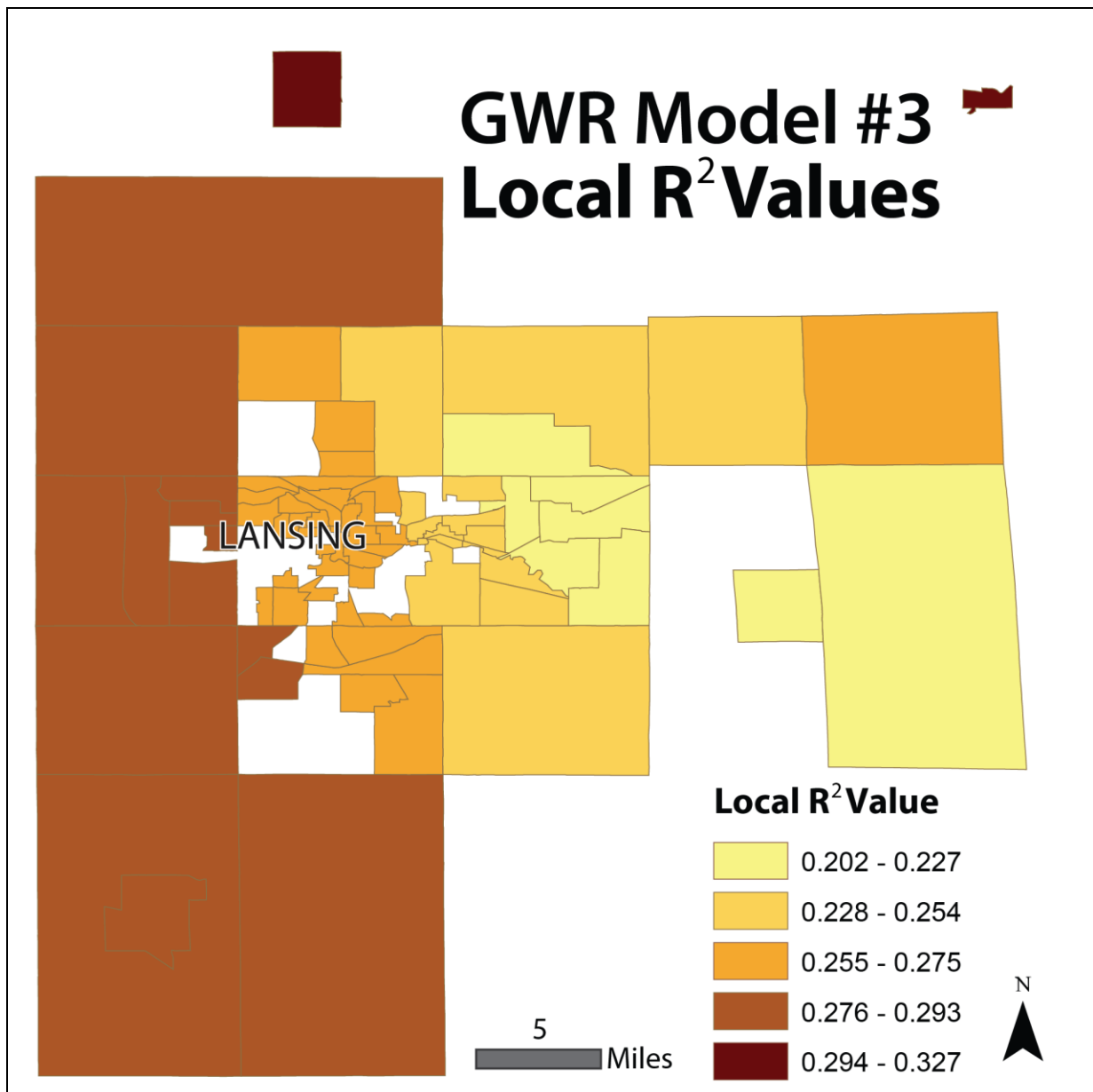


4.5.3 Model #3: Number of times meals are prepared with fresh produce items in a week

The regression model with the number times a week that meals are prepared with fresh produce items as the dependent variable had the most explanatory power ($R^2 = 0.345$) of all of

the regression models that were established for this research using backwards stepwise regression. The eight independent variables that were used in this model were; whether or not

Figure 4.7: Number of times meals are prepared with fresh produce items in a week
GWR R^2 values (predictive power of number of times meals are prepared with fresh produce items in a week)



respondents viewed their neighborhood access as a problem, how nutritious respondents believed that their diet was, frequency of visits to fast food restaurants, frequency of visits to farmers market, frequency of visits to department stores, gender, age, and household size. When that same regression model was employed using GWR the overall explanatory power of the model actually decreased ($R^2 = 0.234$), which indicates the OLS regression model may be over predicting the relationship potentially as a result of the modifiable areal unit problem. The trend of significant variation in the predictive power between western (33%) and eastern (20%) portions of the study area continued with this regression model (Figure 4.7).

4.5.4 GWR analysis

Based on the analysis of all three regression models using GWR there is a clear indication that there is some spatially related phenomenon occurring in the regression models. An analysis of the spatial distribution of the regression coefficients also continues to establish a clear difference in what influences the consumption of fresh produce products by residents of the western and eastern portions of the study area. One variable that could potentially be missing from the data obtained for this research and may be necessary in future analysis of how Greater Lansing residents interact with their food environment could potentially be educational attainment, which was not included in this research. This finding may also indicate that the relationship between the independent variables and the consumption and use of fresh produce items is not linear. As a result, regression modeling techniques may not be appropriate to examine the relationship between the behavioral choices of Greater Lansing residents and the use of fresh produce items in their diets.

4.6 Analysis of population who receive nutritional assistance

The results of this research have indicated that receiving nutritional assistance is associated with a decreased consumption of fresh produce products. Previous research has indicated that environmental factors have an amplified influence on the dietary choices of participants in nutritional assistance programs (Rose and Richards 2004) and that this subpopulation has been previously identified in the literature as being less likely to have sufficient access to fresh produce items (Algert et al. 2006). Since the initial review of the dataset indicated that those who receive nutritional assistance in Lansing may interact with the food environment differently than the general population in Lansing who do not receive nutritional assistance, an in-depth analysis of this subpopulation and their interaction with the food environment was performed.

Out of the entire sample for this research 37 (roughly one-fifth of) respondents indicated that they were currently receiving some form of nutritional assistance. The responses from this subgroup indicate that the behavior of those who receive nutritional assistance varies from those who do not receive nutritional assistance, specifically in a number of ways that may impact this subpopulations ability to achieve a healthy and balanced diet. Only 62% of those who received nutritional assistance had access to an automobile in comparison with 94% of those who did not receive nutritional assistance.

In terms of shopping behavior, the group of respondents that received nutritional assistance was more likely to visit a store as a unique trip (57%) in comparison to those who did not receive nutritional assistance (22%). This subgroup was also more likely to be surveyed shopping at a store that was located in their residential neighborhood (76%). The mean travel time from the store at which they were surveyed to their home for those who received nutritional

assistance was 7.3 minutes, which was shorter than the population who did not receive nutritional assistance whose average travel time to a store was 11.4 minutes. However, those who received nutritional assistance did not appear to believe that access to adequate shopping was a problem in their neighborhood, with 70% indicating that access to adequate shopping was only a “minor problem” or was “not really a problem”. Despite indicating that access was not a problem in their neighborhood, most of the respondents who receive nutritional assistance (59%) did not report shopping for the bulk of their food items within a mile of their home. While those who receive nutritional assistance tend to believe that their food environment is satisfactory they do not appear to do the majority of their food shopping in the neighborhood surrounding their primary residence.

The nutritional assistance subpopulation was also less confident than those who do not receive nutritional assistance that the diet they were consuming was healthy. While the population of respondents who received nutritional assistance felt that their diet was healthy (68%) less respondents reported that they were careful about what they ate (54%) and that they had a nutritious diet (51%) than the population who did not receive nutritional assistance (Table 4.9). Most respondents who received nutritional assistance would prefer to prepare meals with fresh fruits and vegetables (73%). However, more than a quarter of respondents indicated that they would rather prepare meals with frozen (16%) and canned (11%) fruit and vegetable items, which was greater than respondents who did not receive nutritional assistance (5% and 6% respectively). Less than one-third of respondents who receive nutritional assistance reported purchasing organic fruit and vegetable items.

Table 4.9: Dietary perceptions of those who receive nutritional assistance in comparison to those who do not

		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
“I am a healthy eater”	Nutritional assistance	14%	54%	11%	16%	5%
	No nutritional assistance	24%	56%	9%	11%	1%
“I am someone who eats in a nutritious manner”	Nutritional assistance	22%	30%	19%	27%	3%
	No nutritional assistance	22%	56%	8%	12%	1%
“I am someone who is careful about what I eat”	Nutritional assistance	24%	30%	19%	24%	3%
	No nutritional assistance	24%	53%	13%	9%	1%

4.6.1 Correlation analysis

Correlation analysis was performed in order to understand whether or not the relationship between the consumption of fresh produce items and previously established models of the Lansing food environment (Goldsberry et al. 2010) was stronger for those who receive nutritional assistance than those who do not receive nutritional assistance. However based on the results obtained from correlation analysis (Table 4.10) there also does not appear to be a substantial association between calculated access to fresh produce items and the use of fresh fruits and vegetables in the diets of those who receive nutritional assistance. While the relationship between calculated access and the use of fresh produce in the diets is stronger for those who receive nutritional assistance in comparison to those who do not receive nutritional assistance, there is still not a large amount of predictive power. There appears to be only a slight indication that the built environment as represented in the models established by Goldsberry et

al. (2010) has more of an influence on those who receive nutritional assistance than those who do not based on the analysis of the Pearson correlation results.

Table 4.10: Pearson correlation vales between calculated access and dietary behavior for those who receive nutritional assistance and those who do not

	Number of Meals Prepared with Fresh Produce each Week		Number of Fresh Produce Items (estimated) Purchased each Week		Number of Fresh Produce Items (listed) Purchased each Week	
	Nutritional assistance	No nutritional assistance	Nutritional assistance	No nutritional assistance	Nutritional assistance	No nutritional assistance
Drive (weighted)	0.251	-0.038	0.231	-0.023	0.261	-0.060
Drive (count)	0.105	-0.027	0.136	0.014	0.244	-0.049
Pedestrian (weighted)	0.142	0.000	0.107	-0.028	0.023	0.039
Pedestrian (count)	0.067	0.069	0.141	0.010	0.008	0.066
Cumulative Distance Method	-0.171	0.008	-0.121	0.007	-0.045	0.008

4.6.2 Difference in travel time

In order to understand if the observed differences between the population of those who received nutritional assistance and those who do not receive nutritional assistance were statistically significant analysis of the dataset using two-sample t-tests was performed. The first variable that was examined using a two-sample t-test was the amount of time that it took for the respondent to travel to the retail store where they were surveyed from their primary residence. The responses for this particular variable by survey participants were examined to ensure that the data did not violate the assumptions of the model. After it was determined that this variable could be analyzed using a two-sample t-test hypotheses were generated:

H₀: There is no significant difference in the mean travel time from retail store to home for the population who receive nutritional assistance and the population who do not.

H_A: There is a significant difference in the mean travel time from retail store to home for the population who receive nutritional assistance and the population who do not.

Based on the fact that the variance in this variable for those that received nutritional assistance and those that did not was not equal a separate variance model two-sample t-test was used.

Table 4.11: Mean and standard deviation for perceived travel time from home to retail location

	Mean	Standard deviation
Nutritional assistance	7.270	7.974
No nutritional assistance	11.399	9.204

The results of the two-sample t-test indicated that the difference in the mean perceived travel time from home to the retail store surveyed at for those who receive nutritional assistance and those who do not was significant. The t-value was large enough (-2.716) to reject the null hypothesis at a 99% confidence level (p-value=0.009). This finding indicates that the population of participants who receive nutritional assistance interact differently with their food environment than participants who do not receive nutritional assistance. Respondents who received nutritional assistance were significantly more likely to shop at food stores that were located closer to their home and only traveled 7.3 minutes to the store where they were surveyed in comparison to the rest of the population who traveled 11.4 minutes.

4.6.3 Difference in food retail store frequency

The ten variables (Table 4.12) which measured the frequency that Greater Lansing residents shopped at different categories of food retailers to purchase food items were examined to see if there were significant differences between the population of respondents that receive nutritional assistance and the population that does not. The responses for all ten variables were examined to ensure that the data did not violate the assumptions of the two sample t-test model. After it was determined that these variables could be analyzed using a two-sample t-test hypotheses were generated:

H_0 : There is no significant difference in retail store shopping frequency for the population who receive nutritional assistance and the population who do not.

H_A : There is a significant difference in retail store shopping frequency for the population who receive nutritional assistance and the population who do not.

Finally each variable was individually examined to determine whether or not pooled or separate variance models should be used.

The results of the two-sample t-tests indicated that there were some differences in shopping behavior between the population of respondents who receive nutritional assistance and the population that does not. Although for the majority of food retail store categories the null hypothesis was accepted and there were no statistically significant differences in shopping behavior, there were some significant differences in shopping behaviors between the two separate populations (Table 4.12). The surveyed population that received nutritional assistance were more likely to shop at convenience stores and liquor stores for food items at a 99% confidence level. The respondents that did not receive nutritional assistance were more likely to purchase food items at restaurants (95% confidence level) and farmers markets (99% confidence

level). Based on these findings it continues to appear that there are significant differences in how the population of Greater Lansing residents who receive nutritional assistance interact with their food environment in comparison to the population who does not receive nutritional assistance.

Table 4.12: Food retail store frequency two-sample t-test results

Variable	Nutritional assistance mean	No nutritional assistance mean	t-value	p-value	H ₀
Convenience store	9.703	2.764	2.833	.007	Rejected at a 99% confidence level
Farmers market	0.486	1.806	-4.028	.000	Rejected at a 99% confidence level
Liquor store	5.405	0.507	3.194	.003	Rejected at a 99% confidence level
Restaurant	2.757	4.875	-2.319	.021	Rejected at a 95% confidence level
Department store	1.108	0.708	1.170	.245	Failed to reject
Discounter	0.622	0.694	-0.231	.817	Failed to reject
Fast food	4.649	3.417	1.222	.227	Failed to reject
Grocery store	2.919	3.875	-1.404	.163	Failed to reject
Health store	1.405	1.896	-0.446	.657	Failed to reject
Supermarket	4.730	4.681	0.065	.948	Failed to reject

4.6.4 Difference in the consumption of fresh produce

Finally the three variables that measured consumption of fresh produce products were examined to determine if there were statistically significant differences in dietary behaviors between the respondents who received nutritional assistance and those that did not. The responses for these three variables were examined to ensure that the data did not violate the

assumptions of the two-sample t-test. After it was determined that these variables could be analyzed using a two-sample t-test hypotheses were generated:

H_0 : There is no significant difference in fresh produce consumption between the population who receive nutritional assistance and the population who do not.

H_A : There is a significant difference in fresh produce consumption between the population who receive nutritional assistance and the population who do not.

The variance of all three variables was examined to determine whether or not pooled or separate variance models should be used.

Based on the results of the two-sample t-test it is clear that there are differences in the use of fresh produce in diets between the respondents that receive nutritional assistance and the respondents that do not (Table 4.13). For two of the three fresh produce consumption variables the difference in means between the population of respondents who receive nutritional assistance and the population of respondents who do not was statistically significant. The two variables that were statistically significant were measuring the diversity of different fresh produce items purchased. For both the estimated and listed number of fresh produce items purchased in a week the population of respondents who received nutritional purchased fewer different items than the population who did not receive nutritional assistance. These results indicate that the population who are not receiving nutritional assistance are consuming a more diverse variety of fruits and vegetables than those who do receive nutritional assistance. According to the 2010 Dietary Guidelines for Americans one of the key elements of achieving a healthy and balanced diet is consuming a diet with a diverse variety of different fruit and vegetable items. Based on this result it is apparent that the population of respondents who are receiving nutritional assistance

are not consuming as diverse a diet as those who do not receive nutritional assistance, which may have an impact on their overall health.

Table 4.13: Consumption of fresh produce two-sample t-test results

Variable	Nutritional assistance mean	No nutritional assistance mean	t-value	p-value	H₀
Number of times a month respondent prepares meals with fresh produce	21.162	23.097	1.222	.227	Failed to reject
Number of fresh produce items purchased in a week (estimated)	4.514	8.347	-2.319	.021	Rejected at a 95% confidence level
Number of fresh produce items purchased in a week (listed)	4.108	6.507	2.833	.007	Rejected at a 99% confidence level

CHAPTER 5: DISCUSSION

5.1 Research question #1: Association between calculated access to and the use of fruits and vegetables in the diets of Greater Lansing residents

A person's decision on what to eat is incredibly personal and often unique to the individual. Research has indicated that there is not one variable that can completely explain how an individual makes dietary decisions and there are a plethora of different factors that can potentially influence an individual's dietary decisions (Lytle 2009; Sobal and Bisogni 2009). As a result, it may be incredibly difficult to isolate whether or not physical access to food retailers impacts the dietary choices of residents (White 2007). The results of this research indicate that there is not a straightforward relationship between calculated access to fresh produce and the use of fresh fruits and vegetables in the diets of Greater Lansing residents, as the survey data indicated that there was no correlation between calculated access to fresh produce and the dietary behavior of Greater Lansing residents.

There may be a number of different reasons why no association was found between calculated access to fresh produce and the use of fresh produce in the diets of Greater Lansing residents. First it is possible that the accessibility models established by Goldsberry et al. (2010), that were used as representations of the food environment for this research, do not capture the entire interaction taking place between Greater Lansing residents and their food environment. Results from this survey indicate that access through the available transportation network may only be a small part of how an individual interacts with the food environment and other important variables that influence dietary behaviors are not included in these models. The results of the GWR analysis also indicated that the relationship between the variables obtained from the

survey instrument and the consumption of fresh produce items by Greater Lansing residents is not linear and more complex models should be used to understand the relationship.

5.2 Research question #2: Variables that influence dietary behavior

This research found that it was very difficult to identify individual variables that had a large amount of explanatory power over the consumption of fresh fruits and vegetables, which is supported by previous research that has suggested that a variety of different factors may influence dietary behavior (Ford and Dzewaltowski 2008). The food environment as represented by Goldsberry et al. (2010) does not appear to have any explanatory power over the dietary related behavior of Greater Lansing residents. When all of the variables that were obtained from this research were entered into a backwards stepwise regression model there were only a few variables that had an association with dietary behavior; how much of a problem Greater Lansing residents felt that access was in their neighborhood, how nutritious Greater Lansing residents felt that their diet was, how often a respondent shopped at a farmers market, the gender of a respondent, the number of people in a household, and whether or not a respondent received nutritional assistance. Unfortunately, many of the variables that had high explanatory power within the established regression models are not incredibly helpful when establishing improved models of the food environment as they are not readily available in public large scale datasets, such as the Census and ACS. Further research must be done to better understand the dietary behaviors of Greater Lansing residents and how that influences their interaction with the food environment, as the variables from the survey instrument for this research were not able to predict the dietary behavior of Greater Lansing residents.

Another key finding from this thesis is that not all food retail stores have an equal impact on the Lansing food environment. While organic and health food stores often provide a diverse

variety of produce items to the surrounding community (Duvall et al. 2010) these stores are not frequently visited by the general population of Lansing, with only 15% of respondents reporting that they shop at this category of stores at least once a week. In comparison supermarkets, which also provide a diverse variety of fresh fruit and vegetable items, were visited at least once a week by 63% of the survey population. This finding is incredibly important as this information can be used to inform and create more representative models of the Lansing food environment. The results of this research clearly indicate that supermarkets are the primary location where Greater Lansing residents obtain food items. The information regarding the frequency of visits to certain retail food stores will enable researchers to give retail store weights based on their overall impact on the Lansing food environment. Updating models of the Lansing food environment with this type of information could potentially facilitate a more informed model of how Greater Lansing residents are actually impacted by their food environment.

While some research has suggested that the popularity of CSAs, farmers markets, and other direct-selling systems has increased in recent years resulting in an increased consumption of fresh fruits and vegetables among the general population (Guptill and Wilkins 2002), this research has found that may not necessarily be the case. There is some indication in the data that was obtained for this research that the frequency one shops at a farmers market may be associated with a greater consumption of fresh produce items. Currently, however, only 52% of the Lansing population report shopping at farmers markets and only 22% of the population does so at least once a week. Increasing the attractiveness of farmers markets with populations who are at risk for consuming an unhealthy diet may be an important step towards combating obesity in Lansing and more research must be performed to further understand this phenomenon. While alternative food environments are certainly an essential part of the Lansing food environment the

findings of this research indicate that at the moment they are only a small part of how Greater Lansing residents obtain food items on a large scale.

5.3 Research question #3: How Greater Lansing residents view their food environment

Greater Lansing residents do not appear to believe that the food environment in Lansing is a significant problem. A majority of Greater Lansing residents (82%) did not feel that access to shopping was a problem in their neighborhood, which may indicate that the food environment in Lansing may exist in part as a reflection of consumer demand in the area. This finding is supported by previous research which has suggested that food retail outlets do not sell items that will not be purchased (Baker et al. 2006a). In fact, despite indicating that access to adequate shopping was not a problem in their neighborhood most Greater Lansing residents (57%) did not report shopping for their food items at a food retail store within a mile of their home. The lack of demand for fresh produce products in these neighborhoods may be reflected in the lack of stores selling fresh fruits and vegetables in the area. Solutions to the nutritional problems plaguing Greater Lansing residents may need to include approaches to incentivize stores in neighborhoods at risk for obesity to sell fresh produce items, as well as to provide educational programs within those same neighborhoods to help increase knowledge of the necessity to consume fresh produce items to increase the demand for these items.

5.4 Research question #4: Difference between Lansing residents who receive nutritional assistance and those who do not

The population of Greater Lansing residents who receive nutritional assistance has statistically significant differences in food environment than the general population the observed interactions between residents and the environment are statistically significant. The association between calculated accessibility and dietary behavior becomes stronger and there does appear to

be some level of environmental influence on dietary behavior for this subpopulation. GWR analysis also indicated that there was a strong spatial dimension in the predictability of the consumption of fresh produce items by Greater Lansing residents. The results of this research indicate that not all groups of the population may use the food environment the same. The behavioral information from Greater Lansing residents that was obtained for this research may help provide insight into how Greater Lansing residents interact with their food environment in order to enable researchers to create more accurate models of the Lansing food environment in the future.

According to the 2010 Dietary Guidelines for Americans one of the essential parts of achieving a healthy diet is consuming a diverse variety of fresh fruits and vegetables. Greater Lansing residents reported that they purchased more than seven different fresh fruit and vegetable products in an average week and that fresh was by far the most common way that they purchased fruit and vegetable items. This research has found, however, that those who receive nutritional assistance are not purchasing as diverse of an array of fresh produce products, only four different items a week, which is statistically significantly different from the general population. Although, this finding is in no way is an absolute measure of dietary practices it does indicate that Greater Lansing residents who do receive nutritional assistance are consuming a less diverse diet than those who do not. Jago et al. (2007) found that long term exposure to fresh produce items may in fact influence dietary practices. If the Greater Lansing residents who receive nutritional assistance are not purchasing a diverse array of fresh produce products then it is possible that their children may grow up without the knowledge to purchase fresh produce products on their own. Therefore it is of the utmost importance to focus on this subpopulation when analyzing the food environment in Lansing.

Previous research has found that shopping behavior can be variable depending on the individual and every person interacts with their food environment differently (Whelan et al. 2002; Yoo et al. 2006). These findings by previous researchers are supported by this thesis, which found that the population of Greater Lansing residents who receive nutritional assistance interact with the food environment differently than those who do not receive nutritional assistance. The population of Greater Lansing residents who receive nutritional assistance are significantly more likely to shop for food items at convenience stores and at liquor stores. Convenience and liquor stores are more likely to sell products that are energy rich (i.e. carbohydrates, sugars, breads, pasta) and often less expensive than fresh produce items, which makes them potentially more desirable to individuals on a limited income (Cummins and Macintyre 2002; Morland et al. 2006). This particular research finding is worrisome as a diet that is high in energy rich food items has been associated with obesity (Liese 2009). When establishing representations to help understand the food environment in Lansing it is important to include behavioral information on how subpopulations interact with the food environment differently in order to fully understand how local residents are interacting with their food environment.

One of the primary assumptions of the Lansing food environment models developed by Goldsberry et al. (2010) is that Greater Lansing residents are willing to travel 10 minutes to reach a food retail destination within the Lansing food environment. This assumption was validated by the findings of this thesis. The average travel time that it took survey participants to reach the store location where they were surveyed was 10.4 minutes, which confirms the use of a 10 minute threshold. However, an additional important finding was that respondents who received nutritional assistance traveled on average only 7.3 minutes to the store at which they

were surveyed in comparison to those that do not receive nutritional assistance who traveled 11.4 minutes, which was a statistically significant difference. This difference in travel time between the two populations could be indicative of a larger issue with generating models of the food environment. Greater Lansing residents may interact with the food environment in very different ways. The findings of this research indicate that the population of Greater Lansing residents who receive nutritional assistance have a much smaller food environment accessible to them than those who do not. Therefore, the 10 minute threshold used by Goldsberry et al. (2010) might actually be overestimating the number of fresh produce items available to Greater Lansing residents who receive nutritional assistance.

The finding that the population of Greater Lansing residents who receive nutritional assistance interact with the food environment differently is additionally supported by the fact that the Greater Lansing residents who receive nutritional assistance were more likely to shop at retail locations in their residential neighborhoods (76%) than the general population (58%). This important difference in shopping behavior may be a result of the fact that those who receive nutritional assistance are less likely to own automobiles, with only 62% of those surveyed who received nutritional assistance having regular access to an automobile. While research has shown that local shopping options do not necessarily decrease the reliance of neighborhood residents on their automobile (Handy and Clifton 2001) the lack of transportation options available to Lansing resident who receive nutritional assistance may have an impact on the food environment available to them.

5.5 Importance of examining the food environment as a whole

The findings of this thesis highlight the importance of examining the food environment as a whole and not only focus on the food environment near where a person resides. Food choice

decisions are often situational and are made based on the environment in which a person is in at that particular point in time (Sobal and Bisogni 2009). The interaction between Greater Lansing residents and their food environment appears to support this finding. Not all Greater Lansing residents shop for food items in neighborhoods that are close to their primary residence, with 42% of survey participants indicating that the retail store where they were shopping at when surveyed was closest to a location other than their primary residence.

5.6 Limitations of research

While the findings of this thesis have established a new understanding of how Greater Lansing residents interact with their food environment this thesis does not suggest that the same data is directly comparable to regions outside of Lansing. Each urban area has its own unique set of characteristics and problems, and the analysis presented here is merely a discussion of the phenomena occurring within the food environment of Lansing. The data for this research was collected during two summer months, June and July and as a result the analysis provided in this thesis may be slightly biased as the data was collected during a season when produce items were readily available. The proportion of Greater Lansing residents that obtain fresh produce items from outside the food retail environment at places such as gardens or local farmers markets may be significantly higher during the summer months. In order to help mitigate the impact of the increased availability of fresh produce items an effort was made to only survey places that were available to Greater Lansing residents year round. However, there is no way to be certain that the findings that were obtained from survey results obtained during summer months would be the same as findings from a survey that took place over winter months.

The survey methodology used for this research may have also introduced some bias into the results. This study is based on a sample of 185 residents of Lansing, Michigan, which is only

a small portion of the 291,000 estimated people who reside in the study area. An effort was made to ensure that the sample of Greater Lansing residents obtained for this research was as representative of the overall population as possible by constantly reviewing the demographics of the sample population to ensure that they approximately matched the census distribution of the Lansing population. In addition, according to Goldsberry et al. (2010) there are 94 retailers of fresh produce products in the Lansing area, however, only 12 retailers were surveyed for the purpose of this research. The list of 12 retailers surveyed also does not include and Meijer or Quality Dairy stores, which are both significant parts of the Lansing food environment. As a result, the participants surveyed in this research are patrons of only a small portion of Lansing retail establishments. This may in turn bias my results as the entire Lansing food environment was not surveyed. Finally, while there are many positive benefits to conducting in-person research, the presence of the researcher during the interview can cause the respondent to give answers that they believe to be more socially acceptable (Tyebjee 1979). This could cause some potential problems for this research as there may be a social stigma associated with eating poorly and obesity. This may cause participants to answer questions how they believe that they should answer and not provide responses that are representative of their actual behaviors.

There are a number of different factors which may influence an individual's dietary choices including culture, social capital, and price that were not included in the survey and data analysis for this research (Ball et al. 2006; Ford and Dzewaltowski 2008; Sobal and Bisogni 2009). While information such as education, more in depth daily dietary choices, the actual items purchased during the shopping trip, and year round shopping habits may have been useful in this analysis these variables were not included in the research because of the scope of the project and time limitations on the survey questionnaire. Previous research has also found that

social support is significantly correlated with the purchase of fruits and vegetables (Baranowski et al. 2006) and there was no measure of this factor at all in my data analysis. In retrospect the questions related to the consumption of fresh produce items could have been improved upon dramatically. There were also many different ways that a person can consume fruits and vegetables that were not measured in the survey designed for this research. The quality of fresh fruits and vegetables available may also be a factor that influences the decision to purchase fresh produce items. Stores located in urban areas, neighborhoods with low socioeconomic statuses and where food is secondary have been found to offer lower quality fresh fruit and vegetable items (Cummins et al. 2009; Koro et al. 2010). However, no measure of food quality was included in this particular analysis of the Lansing food environment.

Finally the primary focus of this research study was on the use of fresh produce items in the diets of Greater Lansing residents. While previous research has indicated that fresh produce items are a good measure to judge the nutrition on an individual's overall diet (Morland et al. 2002a; Bertrand et al. 2008) there are many other components that make up a healthy and balanced diet. Since the focus of this research was primarily on the consumption of fresh produce items a large part of an individual's dietary behavior was missing from the analysis of the overall Lansing food environment. Future research into the Lansing food environment should include a comprehensive approach that examines all components of dietary behavior.

Unfortunately, the models of the Lansing food environment established by Duval et al. (2010) and Goldsberry et al. (2010) that were used as the background measure of access for this research did not include restaurants within their definition of the overall food environment. The results obtained from this research clearly indicate that restaurants are a significant component of where Greater Lansing residents obtain food items, with a significant number of residents

obtaining food items from fast-food restaurants (39%) and restaurants (27%) at least one time a week. Information about the locations of fast-food restaurants and restaurants, however, is completely missing from the model of the Lansing food environment that was used for this research. This information will be essential to creating more comprehensive models of the Lansing food environment that completely capture how Greater Lansing residents interact with their food retail environment and is a major limiting factor in the models that were used of the Lansing food environment for this research.

Finally, most of the quantitative analysis that was conducted for this thesis was done with survey data that may have been subject to errors in data collection. This type of data is not considered to be ideal for inferential statistical models as the survey was not administered under perfect experimental conditions as is required by the assumptions of many of the models employed in this research (Wrigley 1983). This fact, however, does not negate the information that has obtained from the analysis that was conducted for this research. The findings presented in this thesis offer many insights into the behaviors of Greater Lansing residents and are important towards informing future studies of the Lansing food environment and more importantly creating better representative models of the Lansing food environment.

CHAPTER 6: CONCLUSION

6.1 Modeling the Lansing food environment

The primary objective of this research was to understand the interaction between Greater Lansing residents and their food environment. The findings of this thesis have clearly indicated that there is not a simple and easily generalizable way to understand the interaction that Greater Lansing residents have with their food environment. As a result establishing accurate and all-encompassing models of the Lansing food environment will require further research and much more sophisticated modeling techniques in order to fully capture the complete interaction. Lytle (2009) found that much of the previous research conducted on food environments has been, “...dominated by research using unsophisticated study designs and has frequently failed to see the role of social and individual factors and how they interrelate with the physical environment” (p.S134). As research concerning food environments moves forward it is important to make sure that social and individual decision making factors are included in representations of how people interact with the built environment, a fact which is strongly supported by the findings of this research. This research indicates that there is no relationship between calculated access to fresh produce and the use of fresh fruits and vegetables in the diets of Greater Lansing residents. Previous models of the Lansing food environment (Goldsberry et al. 2010) can be significantly improved upon using information about the behavioral interactions Greater Lansing residents have with their food environment gained through this research. Improving the representations of the food environment in Lansing may afford researchers greater insight into the relationship between the environment and dietary behavior.

While the models that were developed by Goldsberry et al. (2010) present an excellent initial examination of the Lansing food environment, new models can be developed utilizing some of the information gained from this research in order to further advance our understanding of the Lansing food environment as a whole. In particular gravity based models or probabilistic accessibility measures that introduce the variable of attractiveness of a particular location and the probability that a specific location will be visited could be utilized to provide a more comprehensive understanding of the Lansing food environment (Hansen 1959; Wang 2000). The findings of this research have indicated that almost all Greater Lansing residents shop for food items at supermarkets (94%), while they tend to do less of their shopping for food items at other food retail providers. The use of a gravity based models or probabilistic accessibility measures will allow researchers to give supermarkets a greater weight within the food environment model to more accurately represent their footprint in the community. Stores such as organic and health food stores that stock a large number of produce items but serve a smaller client base could be weighted down to decrease their impact on the overall food environment. Information on how far Greater Lansing residents are willing to travel to different categories of stores could also be used to better represent how Greater Lansing residents actually interact with the food environment.

One of the primary research questions of this thesis was; do Greater Lansing residents who receive nutritional assistance interact with the food environment differently than those who do not? This research has clearly indicated that there are differences in shopping behavior between Greater Lansing residents who receive nutritional assistance and Greater Lansing residents who do not. More specifically, the Greater Lansing residents who received nutritional assistance were more likely to shop at convenience and liquor stores for food items and were less

likely to purchase a diverse array of fresh produce products, believe they had a nutritious diet, or travel to stores that were not located near their home. These findings indicate that it is important to focus attention on the subpopulation who receive nutritional assistance and to make sure that models of the food environment are capturing how they interact with their surrounding environment, as well as the interaction of the general population with their food environment. Often those who receive nutritional assistance are constrained by the modes of transportation available to them and their socioeconomic status. While the food environment may be accessible for the majority of Greater Lansing residents, it is essential that the constraints and impacts that the food environment has on those who do receive nutritional assistance are further examined. Models such as relative accessibility measures (Golledge 1993) could be used to understand the different impact that the food environment has for those who receive nutritional assistance and those who do not. A relative accessibility measure would enable researchers to understand the relative access to a food retail store from a given location for a person who receives nutritional assistance versus a person who does not (Church and Marston 2003). This type of model would provide more detailed information to researchers on the complex differences between how Greater Lansing residents interact with their food environment.

Finally more complex agent based models could be utilized to better incorporate the different behavioral interactions that have been measured in this research into updated models of access in the Lansing food environment. Another one of the primary research questions proposed by this thesis was: are there variables other than the food retail environment that influence dietary behavior? Regression models indicated that few of the variables from the survey instrument had significant explanatory power. This finding was further confirmed through GWR analysis, which further indicated that this may be because the relationship

between dietary behavior and the variables presented might not be spatially constant. An approach using agent based modeling allows for the simulated interactions of different agents within the environment and enables the researcher to measure the impact of an agents decisions on the system as a whole. This methodological approach could enable food environment researchers to understand what the implications might be on the overall food environment if a particular store were to close or if a new store were to be added into a community that was determined to be at risk. By using this type of model a focus could be placed on the different market basket of goods an agent who receives nutritional assistance might purchase in a food environment in comparison to an agent who does not. This form of modeling could enable the researchers to easily incorporate more actual behaviorally based information into food environment research and potentially create more accurate representations of the food environment.

6.2 Policy implications

Until relatively recently food has been left out of the planning of American cities for the most part (Pothukuchi and Kaufman 1999) and because economic and political processes have favored the development of suburban neighborhoods many residents of the urban core have been left behind (Morland et al. 2006). Research has indicated that "...the public health significance of the local food environment on overweight and obesity is not a function of any independent effect of the environment on individuals; rather, it is a function of its casual role in facilitating or constraining individual choices and opportunities" (Morland et al. 2006, p.338). While having achievable access to a supermarket is an important part of providing those who are nutritionally at risk with access to fresh fruits and vegetables (Lavin 2005) what is more important is identifying who the populations are nutritionally at risk are and understanding how their local

food environment is impacting their dietary behaviors. Achieving a greater understanding of actual behavioral information is an essential step towards informing public policy that will effect change in dietary behavior.

When discussing food environments it is important to remember that the food retail industry is incredibly large, profitable, business and food retail outlets do not sell items that will not be purchased (Baker et al. 2006a). In addition to education programs that help inform Greater Lansing residents about how to eat a healthy and balanced diet some research has suggested that there may be the additional need to use policy approaches to incentivize stores in neighborhoods at risk for obesity to sell fresh produce items (Krebs-Smith et al. 2010). However, before people start gravitating towards these sorts of policy solutions a much greater understanding of how residents interact with their food environment must be achieved. Research has only begun to identify how residents utilize and interact with their food environment and it would be premature to assume that the development of a new grocery store would alter the dietary habits of residents who reside in the surrounding community. It is incredibly easy for researchers to fall in a “local trap” and fail to understand how the entire food environment functions as a whole (Born and Purcell 2006). The findings of this thesis indicate that most Greater Lansing residents are satisfied with their current food environment. Just because a food store is not located at a near distance to where a person lives does not mean that food store is inaccessible to that person, especially as a result of the fact that people function in a variety of different environments over the course of the day. This research has demonstrated that in Lansing consumers often loop together their shopping trips and sometimes shop on the way home from work. Focusing only on an individual’s residential context does not really give a complete picture of how residents are interacting with the food environment and current food

environment research does not contain enough information about the variety of different contexts that urban residents function in a given day to accurately inform large scale policy solutions.

6.3 Future research

Food environments are incredibly complex and therefore require a diverse research approach to help find solutions to the current dietary problems in America (Bertrand et al. 2008). This research attempts to help come to a better understanding of the Lansing food environment and how local residents interact with it in order to inform the development of better geographic models of the food environment in the future. The results of this research clearly indicate that the food environment is complex and is not necessarily easy to create accurate representations of. Food environments and dietary behavior are constantly associated with a variety of different factors, including behavioral preferences, socioeconomic status, culture, availability of food items, cost of food items and quality of food items. As a result when researchers attempt to model the food environment an equally complex model that takes into account all of these different factors should be used. Current geographic models of the food environment are very simple and have only used distance and the transportation network as limiting factors in where urban residents are able to purchase food items. Updated models of the food environment should be established using more advanced modeling techniques, such as agent based modeling, to fully capture the complex interaction that takes place between Greater Lansing residents and their food environment. Further research should look to examine and incorporate behavioral information into their analysis of local food environments before jumping to broad conclusions about the impact of the food environment on dietary behavior. Developing a comprehensive understanding of how Greater Lansing residents interact with their food environment will be

essential in understanding how to find effective solutions to the obesity and obesity related health issues.

APPENDICES

APPENDIX A: SURVEY INSTRUMENT

Survey # _____

SECTION 1: INTERVIEWER NOTES

Location of survey:

Store name: _____

Store category: _____

Address: _____

Date of survey: _____

Time interview was conducted: _____

Weather at the time of interview:

- a. Cloudy
- b. Sunny
- c. Rainy
- d. Overcast
- e. Other comments _____

SECTION 2: TRANSPORTATION

1.) What mode of transportation did you use for this shopping trip?

- a. Drove myself in a personal vehicle
- b. Ride in car/van/truck of family or friends
- c. Public transportation
- d. Taxi
- e. Walk
- f. Bike
- g. Other (Specify) _____

2.) Do you have regular access to an automobile?

- a. Yes
- b. No

2a.) **If Q2=Yes:** How many automobiles do you have access to in your household?

- a. 1
- b. 2
- c. 3
- d. 4

3.) Did you travel to this location directly from your home?

- a. Yes
- b. No

3a.) **If Q3=Yes:** How long did it take you to travel here today?

3b.) **If Q3=No:** How long would it take you to travel directly home from this location?

4.) Is this store closest to your:

- a. Home
- b. Work
- c. Child's school or daycare
- d. Church
- e. Gym
- f. None
- f. Other (specify): _____

5.) Do you plan on traveling directly home after shopping at this location?

- a. Yes
- b. No

SECTION 3: SHOPPING HABITS

6.) How much of a problem would you say that lack of access to adequate shopping is in your neighborhood?

- a. Very serious problem
- b. Somewhat serious problem
- c. Minor problem
- d. Not really a problem

7.) About how much of your household food shopping would you say is done within a 20 minute walk or about a mile away from your home?

- a. All or almost all of it
- b. Most of it
- c. About half of it
- d. Some of it
- e. None or almost none of it

8.) What is the name and location of the primary store where you typically do your food shopping?

Name: _____

Location: _____

9.) Are you the primary food preparer in your household?

- a. Yes
- b. No

SECTION 4: DIET / USE OF PRODUCE

Please indicate how much you agree with each of the following statements by choosing whether you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree.

		Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
10a.)	I am a healthy eater	1	2	3	4	5
10b.)	I am someone who eats in a nutritious manner	1	2	3	4	5
10c.)	I am someone who is careful about what I eat	1	2	3	4	5

11.) How often do you purchase food items from each of the following types of locations?

a. Fast-food restaurants?

_____ times per day
_____ times per week
_____ times per month

b. Restaurants (not including fast-food)?

_____ times per day
_____ times per week
_____ times per month

c. Convenience stores?

_____ times per day
_____ times per week
_____ times per month

d. Grocery stores (Goodrich's Shop-Rite, Horrocks, L&L etc.)?

_____ times per day
_____ times per week
_____ times per month

e. Supermarkets (Meijer, Kroger, Safeway etc.)?

_____ times per day
_____ times per week
_____ times per month

f. Farmers markets?

_____ times per day
_____ times per week
_____ times per month

g. Health food stores?

_____ times per day
_____ times per week
_____ times per month

Party Stores/Liquor stores?

_____ times per day
_____ times per week
_____ times per month

h. Department stores (Target, Walmart etc.)?

_____ times per day
_____ times per week
_____ times per month

i. Discounters / Warehouse clubs?

_____ times per day
_____ times per week
_____ times per month

12.) Do you consume fresh fruit and vegetable items in your diet?

- a. Yes
- b. No

12a.) **IF Q12= YES:** How often do you prepare meals with fresh fruits and vegetables?

_____ times per day
_____ times per week
_____ times per month

12b.) **IF Q12= YES:** In a typical week how many fresh fruit and vegetable items do you purchase?

12c.) **IF Q12= YES:** What fresh fruit and vegetable items do you typically purchase?

Apples	Cilantro	Onions
Asparagus	Cucumbers	Parsley
Avacados	Garlic	Peppers
Bananas	Grapes	Potatoes
Basil	Green beans	Raspberries
Blueberries	Green pepper	Radish
Broccoli	Lemons	Strawberries
Carrots	Lettuce	Squash
Celery	Mushrooms	Tomatoes
Cherries	Oranges	Zucchini

12e.) **IF Q12=NO:** Why do you choose not to consume fresh fruit and vegetable items?

13.) In a typical week how many canned fruit and vegetable items do you purchase?

14.) In a typical week how many frozen fruit and vegetable items do you purchase?

15.) If given the choice would you rather prepare meals with...?

- a. Canned fruit or vegetables
- b. Fresh fruit or vegetables
- c. Frozen fruit or vegetables

16.) Do you purchase organic fresh fruit and vegetables items?

- a. Yes
- b. No

17.) Do you have your own garden at home?

- a. Yes
- b. No

18.) Do you have a community garden plot?

- a. Yes
- b. No

19) **IF Q17=Yes or Q18=Yes:** Do you grow fruits and/or vegetables in your garden?

- a. Yes
- b. No

19a.) **If Q19=Yes:** Do you consume the fruits and/or vegetables you grow?

- a. Yes
- b. No

SECTION 4: LOCATION OF RESIDENCE

20.) What is your home address (Non PO Box Address)?

20a.) **If Q20= REFUSED:** What is the intersection that is located nearest to your home?

SECTION 5: DEMOGRAPHICS

21.) What is your gender?

- a. Male
- b. Female
- c. Don't know / refused

22.) What is your age?

23.) How many people are permanently living in your household?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5
- f. 6
- g. 7
- h. 8+
- i. Don't know / refused

24.) Do you have any children under the age of 18 residing in your household?

- a. Yes
- b. No
- c. Don't know / refused

25.) What is your ethnicity?

- a. White
- b. Hispanic
- c. African American
- d. Asian
- e. Other (specify) _____
- f. Don't know / refuse

26.) What is your annual household income?

- a. < \$10,000
- b. \$10,000 - \$20,000
- c. \$20,000 - \$30,000
- d. \$30,000 - \$40,000
- e. \$40,000 - \$60,000
- f. \$60,000 - \$80,000
- g. \$80,000 - \$100,000
- h. > \$100,000
- i. Don't know / refused

27.) Does anyone in your family receive food stamps/SNAP (Supplemental Nutritional Assistance Program)?

- a. Yes
- b. No

**APPENDIX B: LIST OF VARIABLES INCLUDED IN BACKWARDS STEPWISE
REGRESSION MODEL**

Variable:	Level of Measurement:	Min:	Max:	Mean:	Standard deviation:
Whether or not a respondent had access to an automobile	Nominal	1	2	1.124	0.331
Number of available automobiles in household	Ratio	1	23	2.191	1.961
Reported travel time to store	Ratio	1	60	10.413	9.048
How much of a problem respondent felt access to adequate shopping was in their neighborhood	Ordinal	1	4	3.368	0.935
Amount of shopping respondent did within a 20 minute walk or a mile away from their home	Ordinal	1	5	3.400	1.623
Whether or not respondent was the primary shopper in their household	Nominal	1	2	1.184	0.388
How healthy respondent felt their diet was	Ordinal	1	5	2.162	0.953
How nutritious respondent felt their diet was	Ordinal	1	5	2.232	1.014
How careful respondent was about what they ate	Ordinal	1	5	2.178	0.987
How frequently respondent visited fast-food restaurants	Ratio	0	28	3.659	4.986
How frequently respondent visited restaurants	Ratio	0	28	4.378	4.979

How frequently respondent visited convenience stores	Ratio	0	84	4.157	10.059
How frequently respondent visited grocery stores	Ratio	0	28	3.630	5.037
How frequently respondent visited supermarkets	Ratio	0	28	4.652	4.076
How frequently respondent visited farmers markets	Ratio	0	12	1.543	2.509
How frequently respondent visited health food stores	Ratio	0	84	1.766	6.932
How frequently respondent visited liquor/party stores	Ratio	0	28	1.484	4.845
How frequently respondent visited department stores	Ratio	0	28	0.788	2.369
How frequently respondent visited discount stores	Ratio	0	28	0.679	2.522
How frequently respondent purchased canned fruit and vegetable items	Ratio	0	20	1.852	3.391
How frequently respondent purchased frozen fruit and vegetable items	Ratio	0	20	1.747	3.001
Whether or not a respondent purchased organic items	Nominal	1	2	1.538	0.500
Whether or not a respondent gardened	Nominal	1	2	1.709	0.456
Gender	Nominal	1	2	1.508	0.501
Age	Interval	18	87	44.297	15.977

Number of people residing in household	Interval	1	9	2.681	1.471
Whether or not children under the age of 18 resided in their household	Nominal	1	2	1.709	0.479
Whether or not a respondent was a minority	Nominal	1	2	1.293	0.456
Income	Ordinal	1	9	5.440	2.732
Whether or not their household received nutritional assistance	Nominal	1	2	1.796	0.404

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