FOOD DESERTS AND MINORITY POPULATIONS IN AKRON, OHIO

A thesis submitted
to Kent State University in partial
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by

Mohammad Alnasrallah

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Thesis written by
Mohammad Alnasrallah
B.S., Kuwait University, 2008
M.A., Kent State University, 2012

Approved by

___________________________, Advisor
Jay Lee

___________________________, Chair, Department of Geography
Mandy Munro-Stasiuk

___________________________, Dean, College of Arts and Sciences
Raymond Craig
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CHAPTER 1

INTRODUCTION

Over the last several decades, many studies have been done on the identification and implication of the existence of “food deserts” in a variety of different disciplines in several developed countries. The concern of these studies has focused on the quantity and quality as well as the accessibility of fresh food outlets. This study focuses on identifying neighborhoods in Akron, OH where various conditions of food deserts exist. I identify these neighborhoods by a set of carefully developed analytical procedures in Geographical Information Systems (GIS), the socio-economic characteristics of these neighborhoods are then further analyzed providing a better understanding of these neighborhoods.

In this study, I perform a GIS analysis to examine how food deserts vary across different race and ethnic groups. This study makes comparisons between different ethnic groups in these neighborhoods to find out whether food deserts occur more frequently in neighborhoods that are dominated by ethnic minorities. I assembled a GIS data set for Akron at Census Block group level, which includes a selected set of attributes to describe the socio-economic characteristics of the block groups in Akron.

For this study, I am focusing on the African American ethnic group and whether areas that are dominated by this ethnic group are more likely to be food desert areas. The results are then compared with those of other ethnic groups to determine which ethnic
group is most affected in Akron. Specifically, the main objectives of this study are to identify the food desert areas in Akron in order to understand:

(1) The relationship between non-fresh outlets and the density of African Americans versus other ethnic groups who live in these areas.

(2) How non-fresh outlets vary across areas dominated by African Americans when compared to other ethnic groups regarding how they are affected by food deserts.

First of all, I determined whether the non-fresh food outlets are on the rise in any specific area where there are proportionally high numbers of African Americans. My research will classify all ethnic groups into four categories: White, African American, Asian and Hispanic. By examining the relationship between where African Americans reside and the locations of food desert areas, I can investigate the spatial patterns of environmental and socio-economic attributes of the neighborhoods that may contribute to negative conditions of public health at neighborhood level for African Americans.

Because most of the processed and non-fresh food outlets or similar outlets tend to sell foods that are high in calories and fat content, the density of such food outlets in a neighborhood has long been suspected to be associated with the area’s resulting public health issues (Moore & Diez-Roux, 2006).

My second objective is to determine if there is adequate access to fresh food venues for the African American population and how far they have to travel to access fresh food if they don’t have private transportation. Adequate access will also be assessed for the other ethnic groups. Identifying food desert areas is essential for community planning and research with the goal being to make policy makers aware of the health
effects of living in a food desert. In the following chapters, I will discuss my research problems and review existing studies in relation to food deserts and ethnicity. Then I will discuss the data used, the analytical methods applied and the results derived from the analysis.
CHAPTER 2

RESEARCH PROBLEMS

A food desert is a complex phenomenon that involves many factors. Currently, identifying food deserts is one of the important issues in public health. Today people are used to making their food choices based on the food outlets that are available in their neighborhoods. Rarely do people travel long distances or make extra effort to access fresh food, if they do not have the sufficient time, necessary budget, or the desire. Most residents that live in a food desert area have limited access to fresh food. At the same time, they have many options for unhealthy food in those areas. Therefore, residents tend to suffer from obesity and other chronic diseases, such as, diabetes, hypertension, cholesterol, etc. (Gallagher, 2006). Previous studies have shown that predominantly African American neighborhoods have more fast food restaurants than predominantly white neighborhoods (Block et al., 2004). This study focuses on the relationship between the distribution of minority populations and their respective distances to fresh or non-fresh food outlets which allows us to see how the distribution of different food outlets varies across different ethnic groups.

Greater rates of obesity tend to be found in neighborhoods with the lowest incomes, the lowest educational attainment and are also characteristically minority neighborhoods. African Americans have the highest rates of obesity in Summit County when compared to other racial groups (Ohio Department of Health, 2008). According to
the Ohio Department of Health (2004), the leading cause of death for residents in Summit County was heart-related disease. The result was an average of 1,342 deaths annually. Individuals who have high blood pressure, high cholesterol or low fruit and vegetable intake are at a higher risk for developing at least one of the leading causes of death which includes diseases of the heart, cancer, stroke or diabetes (Ohio Department of Health, 2008). These health effects indicate the importance of fruit and vegetable intake because these foods play a significant role in reducing obesity and other chronic diseases. Existing research suggests that there is evidence showing that people can reduce their risk of developing these diseases by increasing their fruit and vegetable consumption (Lock et al., 2004).

Obesity is one of the worst health outcomes for people who live in food desert areas because it leads to other chronic diseases. Being obese can cause serious related diseases such as, diabetes, cardiovascular diseases, cancer, and hypertension (Gallagher, 2007). In Summit County, Ohio, the percentage of obesity among African Americans is greater than other minority racial groups. Living in a food desert area might be one of the causes of being obese, as shown in Table 1. By identifying the food desert areas in the city of Akron and showing the health impacts of obesity, policy makers can encourage merchants and investors to increase the presence of fresh food stores in those areas, which would result in a positive impact on human health and well-being.
Table 1. Proportion of Obese and Overweight Population by Ethnic Groups and by Gender in Summit County, Ohio

<table>
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<tr>
<th>Chronic Disease Risk Factors</th>
<th>White Male</th>
<th>White Female</th>
<th>Black Male</th>
<th>Black Female</th>
<th>All Residents</th>
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<td>Overweight</td>
<td>43.20%</td>
<td>28.50%</td>
<td>39.20%</td>
<td>32.50%</td>
<td>35.70%</td>
</tr>
<tr>
<td>Obese</td>
<td>26.20%</td>
<td>22.60%</td>
<td>34.70%</td>
<td>40.00%</td>
<td>25.20%</td>
</tr>
</tbody>
</table>

Source: Ohio Department of Health, 2008

Specifically, I will carry out research to identify food desert areas in Akron, in order to understand the relationship between food outlets and African Americans versus other ethnic groups who live in those areas. Furthermore, my analyses will indicate how non-fresh food outlets vary across other ethnic groups and how these groups are affected by food deserts.

As the literature suggests, neighborhoods that are dominated by African Americans have more fast food outlets than white neighborhoods (Block et al., 2005). My study will adduce whether African Americans and other minority ethnic groups live in food desert areas. Living in a food desert area could contribute to weight gain and obesity. As shown in Table 1, African Americans have higher rates of obesity when compared to white populations. Living in food deserts might support the fact that African Americans are the most obese ethnic group. GIS techniques will be used to detect food desert areas at the census block group level in Akron. After identifying food desert areas and answering the questions posed by my research, field work such as surveys should
take place in future studies with the focus being a comparison between relationships to food outlets and the identified food desert areas.
CHAPTER 3

LITERATURE REVIEW

3.1 Food Desert

The first use of the phrase, food desert, is attributed to residents of public housing in the Western Scotland in the early 1990s. They used it to describe their experience in a deprived neighborhood where food is expensive and unavailable (Cummins & Macintyre, 2002). Most researchers used the term desert as a metaphor to describe the deprived area. Food deserts are defined as areas with no or only distant grocery stores or food outlets that offer fresh food (Gallagher, 2006). Some organizations such as the 2008 Farm Bill define a food desert as an ‘area in the United States with limited access to healthy and nutritious food, such as an area composed of predominantly lower income neighborhoods and communities” (USDA Economic Research Service 2009a:1). According to Hendrickson et al. (2006), food deserts are urban areas with 10 or fewer outlets and no stores with more than 20 employees. However this definition is not appropriate because it does not consider the distance between residential units and fresh food outlets. In addition, the number of outlets and the number of employees are not defined proportionally to the size of the neighborhoods.

Researchers have suggested many factors associated with food desert areas, such as economic, geographic, psychological and sociological as reasons why some people fail to consume a healthy diet (Shaw, 2006). All these factors may
interact with each other to create various types of food deserts. A food desert could also be defined as an area where there is very limited access to fresh food and the absence of supermarkets but which have various accesses to non-fresh food outlets. This concept has emerged as a critical public health issue because a healthy diet is linked to lower risk for many chronic diseases including heart disease, stroke, hypertension, Type 2 diabetes and certain cancers (Must et al., 1991; Segal et al., 1994; White, 2007). The existence of food deserts in the United States, United Kingdom, and Canada has been very much debated (Apparicio et al., 2007; Cummins & Macintyre, 2002; Shaw, 2006). In each of these countries there are different definitions of the term food desert. In the United States, low-income African Americans tend to dominate urban neighborhoods that are often considered food deserts where supermarkets have vacated these communities (Alwitt & Donley, 1997). While in the United Kingdom, there is no clear relationship between household income and food access (Cummins & Macintyre, 2002; Cummins et al., 2005). In Canadian cities the situation is mixed. In previous work in London, Ontario, it has been discovered that the presence of food deserts was in low-income and inner city neighborhoods (Larsen & Gilliland, 2008). A previous study about examining access to fruits and vegetables in Montreal found that 40% of urban residents without a car had poor access to fresh outlets (Bertrand et al., 2008).

McEntee and Agyeman (2010) discuss three main types of barriers that affect the accessibility to healthy and fresh food; (1) informational, (2) economic, and (3) geographical access. The first type of barrier depends on a range of factors that is related to education, culture and social constrains which influence how and why people choose
to eat certain types of foods. Wrigley et al. (2002) developed a binary regression model to show that low levels of fruit and vegetable consumption were strongly associated with low educational attainment. Morton and Blanchard (2007) found that food desert counties normally have a larger percentage of individuals lacking a high school diploma. This indicates that the most affected people that live in food desert areas have the lowest education because they are not aware of the risks of non-fresh food outlets. They also mention areas of higher poverty rates, lower median family incomes, a larger elderly population, and higher amounts of convenience stores and small grocery stores per capita.

The second type of barrier is economic in nature. Poverty literature indicates that food insecurity is linked to poverty level (Baker et al., 2006). This type of barrier involves the examination of not only poverty, but also financial factors that impact the individual’s ability to consume healthy food, such as food prices and transportation costs. Researchers have discussed the economic factors as being an essential one in identifying insufficient food access in some areas. Donkin et al. (1999) has created a price index to compare prices of food in a cluster of shops. In this study the comparison was made between compared the mean prices of food and the income level of the local population to determine how it is related to the average cost of a standard weekly shopping list items. The study found that the geographical access to food outlets is not as important as the economic access to healthy food outlets. Both types of access barriers are related to each other and they have particular effects on establishing the food desert areas.

The final type of barrier is the geographical access. The location of the fresh food outlets can play a significant role in one’s ability to maintain a healthy diet. In urban
areas five hundred meters is normally cited as an acceptable distance that urban residents can live from a food outlet before experiencing inadequate food access (Clark et al., 2002; Guy & David, 2004; Whelan et al., 2002). Donkin et al. (1999) estimated this distance to be a five to seven minute walk time by walking. In rural areas food access measurements cannot be used like those in urban areas because most people live further than five hundred meters from a food retailer and people rely more on automobiles than on walking. The distance in rural areas is defined by using GIS software in counties where residents live more than 10 miles to the nearest supermarket chain (Morton & Blanchard, 2007).

In the United States, the growth of large supermarkets on the outskirts of inner cities in wealthier areas offer consumers better options for quality, variety and price. These large chain stores tend to have longer business hours and better parking options, which attract consumers (Alwitt & Donley, 1997; Guy et al., 2004). Independent and smaller grocery stores that are located in those minority communities have difficulty competing with large chain supermarkets because of their lost competition with large chain supermarkets. This results in, areas where affordable, varied food is only accessible to those who have access to a car, or to those who can afford public transportation costs (Guy et al., 2004). This has led one independent retailer to defining a food desert as “an area where high competition from multiples (large chain) supermarkets has created a void” (Furey et al., 2001).

A recent study shows there is evidence of the influence of grocery stores and supermarkets on neighborhoods (Cummins & Macintyre, 2005). The availability of
healthy food might be an essential factor in the relationship between neighborhood environment, diet quality, and obesity (Swinburn et al., 1999). Finding supermarkets is more difficult in low-income neighborhoods. Typically, economically deprived areas lack supermarkets and small independent grocery stores (Cummins & Macintyre, 2005). It has been found that fast-food outlets are more prevalent in poorer areas, and for this reason there are higher rates of obesity in these neighborhoods (Swinburn et al., 2004).

In addition, different socio-economic groups have different levels of access to healthy food. A recent study on supermarkets in Detroit found that, on average, supermarkets were 1.15 miles further away for residents of African American compared with white neighborhoods (Gallagher, 2006). Most existing research on the food desert focuses on the relationship between the distribution/density of food desert areas and the socio-economic characteristics of their residents. Knowing the geographical distribution of fresh and non-fresh outlets is critical to understanding the relationship between the locations of non-fresh food outlets and where African Americans live.

Studies of the relationship between food desert and food costs have produced discrepant results (Wrigley, 2002). In Minneapolis, Chung and Myers (1996) distinguish that, supermarkets, which offer lower prices, are concentrated in suburban areas while small grocery stores are likely to be found in inner cities. In Los Angeles, Sloane et al. (2003) reported that availability of fresh fruits and vegetables is limited in lower income areas when compared to higher income areas. Block and Kouba (2006) suggest that predominantly black neighborhoods have fewer supermarkets and more small grocery stores. The grocery store prices were comparable to supermarket prices, but often lack
quality. This indicates that fresh food availability is different from one neighborhood to another depending on socio-economic and ethnic make-up.

In the United States, the Department of Agriculture (USDA) has identified all the food deserts in the country. According to their definition, food deserts are census tracts with low-income communities having more than 20 percent poverty rate and median family income below 80 percent. In the density population perspective, the USDA defines food deserts, as census tract with at least 500 people and the distance from census tracts to the closest supermarket should be no more than 1 mile in urban areas and less than 10 miles in rural areas. However, USDA does not define any distance for suburban areas.

Food balance theory is one of the significant theories in identifying food desert areas (Gallagher, 2006). In this theory, the authors develop a ratio score by dividing the shortest distance to any fresh outlet by the shortest distance to any non-fresh outlet. There are three different food balance scores in this theory: a score that is above 1 (one) is the worst outcome because the residents are closer to non-fresh outlets than to fresh outlets. A score around 1 is an average because the distance between fresh and non-fresh outlets is equal. The last score is below 1 and it’s the best outcome because the healthy food is closer than non-fresh outlets (Table 2).
Table 2. Food Balance Theory

<table>
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<th><strong>Food Balance Score</strong></th>
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<tr>
<td>&gt; 1: High score (Worst outcomes) Closer to fast food than fresh outlets.</td>
<td>Fresh outlet is 1 mile away, and non-fresh outlet is 0.5 miles away. 1/0.5 = 2</td>
</tr>
<tr>
<td>~ 1: Average score (Balance outcomes) Equal access to fresh and non-fresh outlets.</td>
<td>Fresh outlet is 1 mile away, and non-fresh outlet is 1 mile away. 1/1 = 1</td>
</tr>
<tr>
<td>&lt; 1: Low score (Best outcomes) Closer to fresh outlet than non-fresh outlet.</td>
<td>Fresh outlet is 0.5 miles away, and non-fresh outlet is 1 mile away. 0.5/1 = 0.5</td>
</tr>
</tbody>
</table>

Source: Gallagher, 2006

3.2 GIS and Food Desert

GIS is increasingly being used to study public health issues with neighborhood-level information in various disciplines. Pearce et al. (2006) used GIS to measure the distance from every mesh block (smallest unit used in New Zealand) to 16 specific community resources over a road network. In early food desert studies, GIS tended to be utilized just for mapping, but not for analytical purposes. Maps were used to present information about the study area (Wrigley et al., 2002), numbers of outlets in different geographic levels (Cummins & Macintyre, 1999) and percentage differences in socioeconomic variable per geographic unit (Guy et al., 2004).

Donkin et al. (1999) were the first to use GIS analysis to create maps of distances to stores selling food over a road network in London, UK. In this study the authors incorporated the availability of 123 food items and population density. In addition, they plotted the prices of food on a map to show areas of relative expensiveness. MacEntee
and Agyeman (2009) use GIS to identify food desert areas in Vermont, USA. They used supermarkets and residential locations in association with GIS to interpret the relationship between them. Distance between supermarkets and residential units were used as proxy for geographic access to food outlets.

Techniques and focus in identifying food deserts continue to vary by using GIS. Most of the earlier studies (Hendrickson et al., 2006) about food deserts are based on a qualitative approach, such as surveys, with current research on this topic being quantitative (Donkin et al., 1999; Pearce et al., 2006). Using this technology in identifying food desert areas means that results can be more accurate and achieved more quickly than doing qualitative methods such as surveys. GIS helps researchers to glance at affected areas in very efficient and effective way.

3.3 Access to Stores

In terms of access to stores, poor residents travel greater distances to access the same resources as non-poor residents (Alwitt & Donley, 1997). This means that poor residents have less access to large chain outlets. A recent study in Chicago found that African Americans have the lowest access to grocery stores and greatest access to fast food outlets (Gallagher, 2006). This study found that a decrease in grocery store access is associated with an increase in obesity. Supermarkets are the most important source of a wide selection of healthful foods, particularly fresh produce that can reduce the fats in the body (Schafft, 2009). In areas where access to grocery stores is limited, most residents suffer greater health challenges with diet as a risk factor (Giang et al., 2008). Access to healthy food is also related to the lack of transportation. Low-income residents may have
difficulty in affording transportation costs to the supermarket located outside their community, therefore limiting access to food options (Rose & Richards, 2004; Weinberg, 1995). Transportation is not the only obstacle in food access, the food environment, and individual characteristics are important factors as well (Rose & Richard, 2004). Unsafe neighborhoods and busy work schedules can affect access to the closest food outlet.

3.4 Obesity and Ethnic Groups

Obesity is an important public health issue in the United States (Kumanyika et al., 2008). Obesity emerges from an imbalance between energy input and output. Over the past three decades obesity rates increased substantially in the United States and other countries (Flegal et al., 1998; Hedley et al., 2004). These increases are found in different ages, races, and socio economic groups. According to the World Health Organization (WHO), the obese are defined as abnormal or having excessive fat accumulation which may impair health. One distinction made between an overweight and an obese person is the body mass index (BMI), which is used as a measurement of weight. It is commonly used to classify overweight and obese adults. BMI is defined as a person’s weight in kilograms divided by the square of his/her height in meters (Kg/m$^2$). Overweight people should have a BMI greater than or equal to 25, while obese people have a BMI greater than or equal to 30. Being overweight does not mean that one is obese but being obese means that one’s BMI is greater than or equal to 30 which increases the chances of having related diseases.

Recent experimental studies have found that dietary patterns and obesity rates vary between neighborhoods. Those neighborhoods that are located in a deprived area or
in a low-income area have residents who are associated with the prevalence of obesity and the consumption of a poor diet (Cummins & Macintyre, 2005). Rates of obesity are significantly higher among African Americans than among whites (Ogden et al., 2006).

According to the U.S Department of Health & Human Services (2000), African American women have the highest rates of obesity among different racial and gender groups. About four out of five African American women are obese. In 2009, African Americans were 1.5 times as likely to be obese as non-Hispanics (Department of Health and Human Services, 2000). Mari Gallagher Research and Consulting Group (2006) discovered that, in Chicago, African Americans have the lowest access to grocery stores and greatest access to fast food restaurants. Previous studies have shown that neighborhoods with a higher percentage of African American residents have limited access to supermarkets and less access to high-quality food options. At the same time, they have a disproportional number of fast food restaurants (Morland et al., 2006; Sloane et al., 2003). A decrease in access to grocery stores is associated with an increase in obesity (Gallagher, 2006) in these neighborhoods. This explains why most African Americans are obese when compared to other ethnic groups.

African Americans, as an ethnic group, have low-income levels when compared to other races (FASEB, 1995; Levedahl & Oliveria, 1999; DeNavas-Walt et al., 2007). Families that are considered to be poor are at high risk for food insecurity (Braithwaite et al., 2009). Assuming that (1) many of them do not have a car, (2) that the nearest access to fresh food outlets is beyond walking range, and (3) that fast food is readily available from gas stations or fast food outlets that are close by, it would be logical to assume that
people may not want to make the extra effort to get fresh food and would just settle for fast food. In time, such patterns will no doubt contribute to the development of obesity and other chronic health problems.

3.5 The Differential Influence of Non-fresh Food Outlets on Racial Groups

The development of the fast food industry has been an important environmental motivator for increased food consumption. In the last 20 years, the percentage of calories accounted for by consuming fast food has increased from 3% to 12% in the United States (Frazao, 1999). Some fast food restaurants offer food items that are up to 65% more energy-intense than the average diet. In addition, the intake of selected nutrients is lower in the population group who consume fast food (Prentice & Jebb, 2003). People who consume these foods tend to be heavier than those who do not. Fast food outlets are more likely to be found in poorer neighborhoods than in others (Cummins & Macintyre, 2005).

In New Orleans, there are more fast food outlets in predominately black census tracts (Block et al., 2004) than in other areas. Fast food is high in fat content. Several studies have found correlations between fast food intake and increased body mass index (BMI) and weight gain (Block et al., 2004). People tend to make food choices based on the food outlets that are located in their neighborhoods (Furey et al., 2001). This can lead to serious problems since many low-income and African Americans live in urban areas that have a higher density of fast food outlets (Hendrickson et al., 2006). The influence of fast food is obvious among non-white people because most of them live in areas with high-density fast food outlets. Living in areas where there are high numbers of non-fresh food outlets and limited access to fresh food outlets can influence people’s health and
may lead to obesity and other health outcomes. It is for the issues reviewed in this section of the study that make it worth identifying those neighborhoods that can be labeled as food deserts, the characteristics of such neighborhoods, and connecting how they are related with to spatial patterns of socio-economic attributes of the neighborhoods.

3.6 Summary

Several studies are focusing on the notion of food deserts in the United States and other developed countries. The first studies focused on qualitative methods, while most recent studies use quantitative methods such as GIS. Most of the literature on food deserts focuses on the socioeconomic factors, ethnic groups and access to fresh food outlets. After reviewing the food desert literature, I found that there are just a few studies that used the Network Analyst Tool, which is appropriate for measuring distance, by using road networks. Therefore, I used the Closest Facility tool in ArcGIS to calculate the distance to food outlets in such neighborhoods as are characteristic of food deserts.

The main contribution of this study on food deserts is to contribute towards the development of food desert identification as well as to focus on the distribution of ethnicity in food desert areas. I calculated the distance at census block group level rather than census tracts, which may affect the results in calculating the distance. The size of census tracts is larger than census block group therefore, the distance could be less precise than block group level. Furthermore, I used a geographically weighted regression tool to determine the correlation between the distance to food outlets and ethnic groups, which has not been used in recent studies of food deserts.
CHAPTER 4

DATA PREPARATION, AND METHODOLOGY

This chapter explains the process of the data preparation and analysis of this study. These processes were used to analyze and detect the food desert areas in Akron, Ohio. Different techniques were used in this study such as Network analysis tool (closest facilities), near analysis and geographically weighted regression – all in ArcGIS 10.0 (ESRI, Inc.).

4.1 Research Data

There are many types of data needed for this study on food desert in Akron, Ohio. Before collecting the data on fresh and non-fresh outlets, food outlets needed to be defined. Fresh food outlets are places where the consumer can purchase fruits, vegetables and fresh meat. Examples of fresh food stores include large chain supermarkets and grocery stores. The non-fresh outlets are those stores selling high calorie content products. Stores, such as convenience stores, fast food outlets and take-out or self-carry stores tend to sell grilled burgers, tacos and hot dogs, etc. This type of food increases fat in the body when consumed. After downloading the data from ReferenceUSA in an Excel file, I divided the data into two categories; fresh food which represents large fresh food outlets and non-fresh food outlets which includes every outlet that sells non-fresh food items such as convenience stores, gas stations and restaurants.
ReferenceUSA is an online database that has data tables in spreadsheets that include information on each food outlet in the study area (convenience, grocery, etc.) (Figure 1).

I used various shapefiles of Akron, Ohio such as: block groups, blocks, and roads obtained from ESRI. In addition, I downloaded the census data for population such as ethnic group, sex, age and household. I downloaded the data from the ESRI data download website (Census 2000 TIGER/Line Data) and the website of the U.S. Census Bureau (census.gov).
Distribution of Fresh and Non-Fresh Food Outlets In Akron

Figure 1. Distribution of fresh and non-fresh food outlets by census block groups in Akron, OH
4.2 Research Methodology

I used a quantitative approach that measures the relationship between spatial patterns of minority populations and various socio-economic attributes of food desert neighborhoods. This GIS software is used not only for graphical information, but also for statistical analysis (Pearce et al., 2006) and is one of the most efficient tools for analyzing and understanding quantitative data.

4.2.1 Closest Facility Tool (ArcGIS Network Analyst)

I used Network Analysis to calculate the distance from each group of block centroids to the closest fresh or non-fresh outlets. Using network analysis requires that I have a data layer that contains a road network of Akron, Ohio. Using distance as a newly added variable, I can use additional regression models to further explore the relationships between distance and food outlets and the socio-economic variables as well as the minority population density. With distance added in the models as one of the dependent variables, the outcome of the analysis will give me more detailed information about the relationship between the dependent variable and the independent variables.

4.2.2 Near Distance Tool

The NEAR distance tool is helpful and beneficial in calculating the distance from a particular point to its closest feature such as, fresh and non-fresh outlets. The NEAR analytical tool of Network Analyst in ArcGIS 10 is one of the tools in the proximity toolbox. The NEAR analytical tool can be used to determine, from each object in the
input features, the distance to the nearest object in the NEAR feature. For example, I used
the centroids of block groups as the input feature and the fresh food outlets as the NEAR
feature. Resulting from applying the NEAR tool is the distance from the centroids of
block group to the nearest fresh food outlets. A similar operation is also carried out for
non-fresh food outlets. The calculated distance is from each block group, and block
centroid to its closest fresh or non-fresh food outlet (Figure 2). This tool does not use the
road network to calculate the distance, however, this tool is helpful to get quick
information about the distance in our study area. In this study I calculated the distance in
two different levels, block groups and blocks. After calculating the distances, I used
geospatially weighted regression to see how the adjusted $R^2$ is different from the three-
scale level.

![Diagram](image)

*Figure 2. Calculating the distance between two features (NEAR analysis tool)*
4.2.3 Geographically Weighted Regression

There are many tools that can be used to identify food desert areas and to define which minority group is more affected. I used geographically weighted regression (GWR) in this research. GWR shows the correlation between the location of African Americans and the distance of either fresh or non-fresh outlets. This tool explains whether or not the presence of non-fresh outlets is increasing in neighborhoods where African Americans live. I used this analysis for other ethnic groups as well to determine the correlation between the distance to food outlets and the percentage of each ethnic group. This tool helps to show the location of the highest correlation of the variables and answers the question about the relationship between fresh or non-fresh outlets and ethnic groups.

I used geographically weighted regression to examine whether there is a positive relationship between fresh or non-fresh outlets and African Americans or other ethnic groups. GWR allows for modeling, examining and exploring spatial relationships between the dependent and independent variables by eliminating the factors behind observed spatial patterns and in predicting outcomes if the factors change. GWR goes beyond ordinary linear regression in that it accounts for the spatial relationship among data based on geo-references of the data (Mennis, 2006). In other words, GWR is a spatial statistical technique that is used to analyze spatial nonstationarity, which is defined as a property of geographically referenced data when the measured relationship among variables differs from a location to another location.
This study examines the relationships between the dependent variable (distance to the closest fresh or non-fresh outlets) and each independent variable (ethnic groups such as, African Americans, median household income, median age, and distance to bus stops). By using GIS techniques, such as GWR, the amount of variation in the dependent variable is explained by the variation in the independent variables. This study examines regression models for groups of census block units in order to see the overall pattern.

The outcome from analyzing such relationships with geographically weighted regression gives the measurements as the statistical significance of regression coefficient ($\beta$) for each independent variable, an $R^2$ and an adjusted-$R^2$. The value of adjusted-$R^2$ will provide an indication of the degree to which variation in the dependent variable is explained by the variation in the independent variables. The higher the adjusted-$R^2$ value is, the better the model.

In addition to the overall strength of the regression model as indicated by the adjusted-$R^2$ for the entire model, geographically weighted regression also gives an adjusted-$R^2$ for each area unit. By mapping these adjusted-$R^2$ values, we can know the relationship between food outlet types and socio-economic variables. Areas where the relationship is stronger will have higher values for adjusted-$R^2$. Alternatively, the lower adjusted-$R^2$ values occur in areas where the relationship is minimal.

Because food outlets are based on geo-referenced points, derived from geocoding, (x,y) coordinates, the calculation of distance from each unit centroid to the closest food outlet is straightforward. For each census unit, this step is repeatedly applied for the closest fresh food outlet and for the closest non-fresh food outlet (Figure 3 and 4). Using
network analysis, these distances can be calculated as real distances along streets rather than as Euclidean distance (straight-line) and the analyses will show the time it takes to reach the closest food outlet.

In this research, the distance equal to and greater than 1 mile is used as a maximum distance to the closest supermarket to define a food desert area in urban area. In addition, to qualify as a food desert the block group must also have a median household income or less than $30,000.
Figure 3. Block group centroids in Akron
Figure 4. Network Analyst Tool (closest facility) by census block groups in Akron
4.3 Study Area

Akron is one city in the state of Ohio and it is the county seat of Summit County. Akron is located in northeastern Ohio along the Cuyahoga River between Cleveland to the north and Canton to the south. Akron is the largest city in Summit County in terms of population. About 40% of Summit County’s population lives in the city of Akron. Furthermore, most African Americans in the county live in Akron.

It covers an area of 62.03 square miles with a population density of 3209.7 persons per square mile. According to the U.S. Census Bureau 2010, Akron has a total population of 199,110 people (See Figure 5). Figure 6 shows the majority of people in the city, 62.2%, are white, while African Americans represent about 31.5% of Akron’s population. The remaining population, 5%, is distributed among Asian, Native American, Pacific Islander and Hispanic (U.S Census Bureau, 2010).

*Figure 5.* Percentages of racial ethnic groups in Akron, Ohio 2010
In this study I focused on Akron because it is the largest city in Summit County and most of the minority population lives there. In Akron, where most African Americans live, there are more than 400 non-fresh food outlets and just 30 large fresh food outlets. Figure 1 showed the imbalance between the spatial distribution of fresh and that of non-fresh outlets. This type of spatial imbalance tends to be one of the reasons why food desert areas exist.
Figure 6. The study area by census block group level.
CHAPTER 5

ANALYSIS AND RESULTS

In this chapter I discuss the results of the analysis on the methodology described in the previous chapter. In this chapter I present and analyze the results from applying GIS techniques to the data sets assembled in this study.

5.1 Geography of Ethnicity in Akron

According to Census Bureau 2010, the total population in Akron is 199,110 people. Most of the residents are white and represent 62.2% of the total. African Americans are the second largest ethnic group and they account for 31.5%. Asians and Hispanics represent 4.2%. Almost all minority groups in Summit County, Ohio live in Akron. I chose census block groups as the level of analysis because block groups are the smaller geographic unit at which data are available beyond simple geographic counts. According to Census Bureau, a block group is a cluster of census blocks with 600 to 6000 people having the same first digit of their four-digit identifying numbers within a census tract. Every group of blocks has attributes and descriptive information such as, ethnic groups, age, sex, median household income and number of households.

As shown in Table 3, Whites are the dominant group in the census block groups with an average of 71%, while African Americans are 25% of the total. The other
ethnic groups represent a small percentage of Akron’s population. Some block groups do not contain any minority ethnic groups.

Table 3. The Percentages of Population by Racial Groups, by Census Block Groups

<table>
<thead>
<tr>
<th></th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>99.39 %</td>
<td>0.78 %</td>
<td>71 %</td>
</tr>
<tr>
<td>African Americans</td>
<td>97.64 %</td>
<td>0 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.34 %</td>
<td>0 %</td>
<td>1.08 %</td>
</tr>
<tr>
<td>Asian</td>
<td>12.81 %</td>
<td>0 %</td>
<td>1.33 %</td>
</tr>
</tbody>
</table>

I used Moran’s I index in this study to examine the spatial autocorrelation patterns of the four ethnic groups. The result of the Z-score shows the degree of cluster for the spatial distribution of the four ethnic groups. As shown in Figure 8 and Table 4, all the values of Moran’s index were positive. These positive values of Moran’s Index indicate positive autocorrelation. In other words, the spatial distribution of the four ethnic groups is clustered but to different degrees. By using this method, I was able to determine if any clustered or dispersed pattern of the ethnic groups is statistically different from a random pattern. The results showed that white populations are clustered; the second most clustered group was African Americans, then Asian and Hispanic.

The critical Z-score value I used to determine whether the spatial pattern is clustered or dispersed has a confidence level of 95%, which is between the critical values -1.96 and +1.96 (Figure 7). When the Z-score is located between the critical values, the distribution is random. In contrast, if the Z-score value is located outside the range of the critical value, the spatial pattern is either clustered or dispersed. The Z-score values of the
four ethnic groups are positive and greater than the critical value, which indicates that the spatial pattern of the four ethnic groups is clustered.

*Figure 7.* Results of applying spatial autocorrelation tool for the distribution of ethnic groups

*Figure 8.* Moran’s Index for each ethnic group
Table 4. Moran’s Index Values for the Four Ethnic Groups

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>Moran’s Index (Z-Score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>40.280419</td>
</tr>
<tr>
<td>African Americans</td>
<td>39.959644</td>
</tr>
<tr>
<td>Asian</td>
<td>18.686162</td>
</tr>
<tr>
<td>Hispanic</td>
<td>9.371854</td>
</tr>
</tbody>
</table>

Using the field calculator in GIS helped me to create block group attribute tables that show the percentage of ethnic groups in every block group. This tool is helpful in demonstrating where the dominant minority population lives. The distribution of white populations as shown in Figure 9, is concentrated around Akron, mostly along the city’s boundaries. African Americans are clustered and concentrated in the center of Akron. Asian Americans seem to cluster in small block groups while Hispanic people are distributed in different areas in Akron without obvious concentrations. The spatial pattern for the ethnic groups is more obvious for White and African Americans than for other ethnic groups such as, Asian and Hispanic (Figure 10). After calculating the percentages for ethnic groups, I chose 60% as a threshold for defining the majority of each ethnic group. For whites, I found that there are 201 out 277 block groups greater than 60%, while there are 46 block groups that are greater than 60%. Other ethnic groups account for 12.8% of the majority census block groups.
Figure 9. Distribution of Whites and African Americans by census block groups in Akron
Source: Census 2000
Figure 10. Distribution of Hispanics and Asians by census block groups in Akron
Source: Census 2000
5.1.1 Spatial Pattern of Income in Akron

The literature suggests that poverty and low-income areas are usually located in central urban areas and in inner parts of cities. I chose median household income as an indication of income. The median household income in Akron is $34,359 compared to $47,358 in the state of Ohio. I downloaded the 1999 census data for median household income from America Fact Finder website. A household consists of all people who occupy a housing unit. The income of households includes the income of the householders and all other individuals 15 years old and over in the household, whether they are related to the householder or not (Census Bureau). According to the Census Bureau, the median household income is the amount which divides households into two equal groups, one having incomes above that amount and the over having income below that amount.

The maximum median household income for census block group is $39,192, the minimum $6,783, and the mean is $35,311. After downloading the data as an Excel file, I joined the tables with census block group shapefiles to examine the overall spatial pattern of the median household income. Then I divided the median household income into three different categories: low-income (0 - $30,000), average income ($30,000 - $60,000) and high income (< $60,000).

Figure 11 shows the income distribution. Most of the low median household income is concentrated in the center of the city where most minorities’ ethnic groups live.
For the low-income category there are 99 block groups, with an average income of 161, and for the high-income 17 block groups. The majority of Whites in Akron live in places of average and high median household income, which supports the literature, which suggests the correlation between white people and high median household income (Figure 11).
Figure 11. Distribution of Median Household Income in Akron
Source: Census 2000
5.1.2 Transportation and Bus Routes in Akron

Riding buses is one transportation option for residents of Akron have for transportation, if they live in lower income areas. Metro Regional Transit Authority is the bus company that serves Summit County, Ohio. According to the METRO system map there are more than 30 bus routes. I digitized every bus route that serves the Akron area with all the stops. The general fare is $1.25 and a one-day pass is $2.50. Residents can access fresh food outlets if they use the bus. Figure 11 shows the distribution of bus routes in Akron. Most of the residents who live in the center of Akron have adequate access to bus routes, while residents that live on the north side of Akron have less access to bus routes. I calculated the distance from every bus stop to its nearest census block group centroid. I chose census block groups that are farther than 0.5 miles from centroids as the threshold to see which ethnic groups live far from bus stops. Figure 12 shows access to large fresh food outlets and reveals that most of Akron’s residents have access to these outlets via public transportation. However, the north side of Akron seems to have less access because the bus does not go to those block groups. Every large fresh food outlet has a bus stop nearby. There are 111 out of 277 block groups that are located farther than 0.5 miles from a bus stop. The number of block groups seems to be large; however, most of those block groups are located in the boundaries of Akron where there is a lower density of minority ethnic groups (Figure 12 and 13).

Table 5. The Distance to Bus Stops by Census Block Groups in Akron

<table>
<thead>
<tr>
<th>Distance (Miles)</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.89</td>
<td>0.5</td>
<td>0.79</td>
</tr>
</tbody>
</table>
Access to Large Fresh Food Outlets in Akron

Figure 12. Bus routes and the distribution of fresh food outlets in Akron
Figure 13. Distance to bus stops and bus routes by census block groups in Akron
5.2 Geography of Fresh and Non-Fresh Food Outlets

Based on the data that I downloaded from ReferenceUSA (http://www.referenceusa.com), there are 491 non-fresh food outlets and 30 large fresh food outlets in Akron. After digitizing bus routes, I found that most food outlets are located along bus routes. Residents have easy access to large fresh food outlets. The spatial pattern of large fresh food outlets is not evenly distributed. For example, in the center of Akron, there are fewer large food outlets than along the city’s boundary. The distribution of non-fresh food outlets is clustered in some areas, such as, the central part of Akron and around the bus stops.

As shown in Figure 14 and 15, some block groups that are dominated by minority ethnic groups have access to fresh food outlets while others have more access to non-fresh food outlets. For African Americans in some areas access to large fresh food outlets is sufficient. However, in some areas, where there is a high density of African Americans, the distance to the closest large fresh food outlet is farther than 1.5 miles. Most of the large fresh food outlets are located in places where there is a high density of whites and high medium household income. Asian and Hispanic ethnic groups live in places where there is a high density of non-fresh food outlets and nearby large fresh food outlets.

Figure 16, shows the distribution of median household income and food outlets. It is obvious that most large fresh food outlets are located in places where there is high median household income and most of the non-fresh food outlets are located in low-median household income.
Figure 14. Distribution of White, African Americans and food outlets by census block groups in Akron.
Figure 15. Distribution of Hispanic, Asian and food outlets by census block groups in Akron.
Figure 16. Distribution of food outlets and median household income by census block group in Akron
5.3 Geography of Food Desert in Akron

The application of Closest Facility tool of Arc GIS Network Analyst allows me to calculate the distance measured along streets blocks to the closest facility (food outlets) for every block group depending on road networks. Previous studies on food deserts have measured the distance by using Euclidean distance (straight line) method (Morton & Blanchard, 2007). The limitation of the Euclidean method is that it makes the distance shorter than it is in reality. The Network analysis tool overcomes the shortcoming by using the road network to calculate the distances. I calculated the distance from every block group centroid to its nearest food outlet. After calculating the distance I derived statistics of calculated distance for selected area, including, average, maximum, and minimum.

I used two methods to calculate the distance between census block groups and from every block to food outlets. I used the closest facility tool for block groups and near analysis tool for census blocks. Closest facility provides more precision because it calculated the distance depending on the road network. The average distance from all block group centroids to large fresh food outlets is 1.29 miles whereas to non-fresh food outlets the average is 0.49 miles. Figure 17 shows the results of applying the Closest Facility tool. The census block groups that are farther from large fresh food outlets are located in the middle of south Akron and on the north side of Akron. On the other hand, the distribution of non-fresh food outlets are clustered and concentrated around the center of the city and are less clustered along the boundaries of Akron.
As shown in Figure 18, I calculated the distances by using census blocks and the results reveal more details for the distribution of the distances by using census blocks than in using block groups.

The criteria that I chose to define food desert areas are any census block group that is located equal to or farther than 1 mile from any large fresh food outlet and that has a median household income of less than $30,000. After applying these criteria, I found 59 census block groups that meet the criteria (see Figure 19). Most of those census block groups are located in the center of Akron and in areas where minority ethnic groups dominate. I found that a high percentage of African Americans live in food deserts areas. The average percentage of African Americans living in identified food desert areas is 49% of the total, which is the highest average percentage when compared with other ethnic groups. White populations account for 45%, Hispanics and Asians represent 2.7% in the identified food desert areas (Table 6).

Table 6. The Percentages of Ethnic Groups by Census Block Group in Food Desert Areas

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Mean</th>
<th>Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Americans</td>
<td>97%</td>
<td>0%</td>
<td>49%</td>
<td>22866</td>
</tr>
<tr>
<td>White</td>
<td>97%</td>
<td>0.7%</td>
<td>45%</td>
<td>21699</td>
</tr>
<tr>
<td>Asian</td>
<td>9%</td>
<td>0%</td>
<td>1.3%</td>
<td>693</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3.7%</td>
<td>0%</td>
<td>1.4%</td>
<td>696</td>
</tr>
</tbody>
</table>

After investigating the variables of food desert areas by census block groups, African Americans are the highest population in those areas, comparing them with other ethnic groups such as Asians and Hispanics.
Figure 17. Distance per mile to fresh and non-fresh food outlets by census block groups in Akron
Figure 18. Distance per mile to fresh and non-fresh stores by census block in Akron
Figure 19. Food deserts in Akron by census block group
In Akron, there are 277 census block groups, 59 block groups are defined as food desert areas, while there are 218 block groups that are not identified as food deserts. The average median household income for the identified areas is $21,896 and for the areas that are not identified as a food desert is $38,941. As shown in Table 7, in food desert areas African Americans have the highest mean percentage when compared to other ethnic groups. On the other hand, in places that are identified as non-food deserts, African Americans have a lower percentage than in food desert areas.

Table 7. Average Percentage of the Four Ethnic Groups in Food Desert and Non-Food Desert Areas

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Food desert</th>
<th>Non-food desert</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>45%</td>
<td>77%</td>
</tr>
<tr>
<td>African American</td>
<td>49%</td>
<td>18%</td>
</tr>
<tr>
<td>Asian</td>
<td>1.3%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.4%</td>
<td>0.9%</td>
</tr>
</tbody>
</table>

It seems that minority populations in Akron more likely to live in places that are considered food deserts than do majority populations, which in this case is White. Non-food desert areas are neighborhoods that have an easy access to large fresh food outlets and high median household income. It is clear from the previous Table 7, White people tend to live in areas that are not considered food desert areas, while the minorities are the most highly affected people, especially African Americans.

The total populations that live in food desert areas are 47,051 people. As shown in the previous Table 8, African Americans are the greatest population in food desert areas, when compared to other ethnic groups. In non-food desert areas, Whites are the highest
population ethnic group, then African Americans, Asians and Hispanics. Using field
calculator tool in Arc Map is a useful tool because it can create an attribute for the four
ethnic groups and compare it to other groups.

Table 8. The Total Population for Each Ethnic Group in Food Desert Areas and Non-
Food Desert Areas

<table>
<thead>
<tr>
<th>Ethnic Group</th>
<th>Food desert</th>
<th>Non-food desert</th>
<th>Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>21699</td>
<td>174336</td>
<td>196035</td>
</tr>
<tr>
<td></td>
<td>(11.06%)</td>
<td>(88.93%)</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>22866</td>
<td>40897</td>
<td>63763</td>
</tr>
<tr>
<td></td>
<td>(35.86%)</td>
<td>(64.13%)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>693</td>
<td>3248</td>
<td>3941</td>
</tr>
<tr>
<td></td>
<td>(17.58%)</td>
<td>(82.41%)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>696</td>
<td>2174</td>
<td>2870</td>
</tr>
<tr>
<td></td>
<td>(24.25%)</td>
<td>(75.74%)</td>
<td></td>
</tr>
</tbody>
</table>

5.3.1 Geographically Weighted Regression

To examine the relationship between ethnic population and income level in
census block group, I looked at the variables such as demographic and socio-economic
data, ethnic groups, etc. By using the graph plot in ArcMap, I found that there are
correlations between median household income and Whites. Figures 18 and 19 show the
correlation between median household income and the two large ethnic groups in Akron;
African Americans and Whites.
Figure 20. Relationship between median household income and white population.

Figure 21. Relationship between median household income and African Americans.

From these figures we can see that there are some correlations between Whites and median household income by census block groups. This means, the higher density of White population, the higher the income distribution. On the other hand, the correlation between African Americans shows the opposite relationship.

Geographically weighted regression is a technique available in GIS for exploratory spatial data analysis. GWR model uses localized statistics techniques to analyze spatial variations in the relationship between dependent and independent
variables. When using GWR, we are assuming that there is not a stationarity in the features we are analyzing. This means that it allows the relationships to vary over space. I chose food desert census block groups as geographic units to run the geographically weighted regression. I chose two models for GWR, the first one is for large fresh food outlets and the second is for non-fresh food outlets.

One important consideration, while running the GWR, is to make sure that the spatial pattern of the residuals between the dependent variable and independent variables are not clustered. The spatial autocorrelation of the residuals should be a random pattern, if there are no underlying spatial trends. Even when the adjusted $R^2$ is high, the spatial autocorrelation needs to be random to be sure that no spatial trends exist. Once the residual of dependent variable and independent variables is random, the result of adjusted $R^2$ will be more meaningful. This means that the results are statistically significant and the variables of independent variables are affecting the dependent variable.

The reason I chose to measure distance to food outlets as a dependent variable is because I wanted to see if there are variables that might affect the distance to food outlets. As shown in Table 9, I used the percentage of ethnic groups, median household income, distance to bus stops, and median age as independent variables to see if they affect the distance to food outlets. I performed GWR four times for each model for the four different ethnic groups to see which ethnic group had a strong or weak relationship with the dependent variable. For the first model, the results are not statistically significant because the spatial pattern of the residuals for each ethnic group is clustered.
Furthermore, the adjusted $R^2$ is less than 0.50, which means the relationship is weak. (Table 9).

Table 9. Results from the Two Geographically Weighted Regression Models

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model (1)</td>
<td>(1) Percentage of every ethnic group.</td>
</tr>
<tr>
<td></td>
<td>(2) Median Household income.</td>
</tr>
<tr>
<td></td>
<td>(3) Distance to bus stops.</td>
</tr>
<tr>
<td></td>
<td>(4) Median Age.</td>
</tr>
<tr>
<td>Distance to large fresh food outlets</td>
<td>(1) Percentage of ethnic group.</td>
</tr>
<tr>
<td></td>
<td>(2) Median Household income.</td>
</tr>
<tr>
<td></td>
<td>(3) Distance to bus stops.</td>
</tr>
<tr>
<td></td>
<td>(4) Median Age.</td>
</tr>
</tbody>
</table>

For the second model, the results were significant because the spatial pattern of the residuals is random and the adjusted $R^2$ is greater than 0.50. The adjusted $R^2$ of African Americans and Whites is 0.60, which is a good result. This means that 0.60% of the variation in the dependent variable is explained by the variation in the independent variables. Figures 20 and 21 show the results of the application of model (1) to African Americans and Whites. The red areas show places that are somewhat explained by the independent variable and the blue areas are not well explained. For African Americans there are more census block groups that are affected by the dependent variables than Whites. For Hispanics and Asians, as shown in Figures 23 and 24, the results are statistically significant because the spatial pattern of the residuals is random. GWR model of Asian groups has the highest adjusted $R^2$ 0.62, when compared to other ethnic groups, while the Hispanic groups showed 0.57.
Figure 22. Results of applying GWR (Model 1) for White and African Americans in food desert areas
Figure 23. Results of applying GWR (Model 1) for Asian and Hispanic in food desert areas
Figure 24. Results of applying GWR (Model 2) for White and African Americans in food desert areas.
Figure 25. Results of applying GWR (Model 2) for Hispanic and Asians in food desert areas
The results of model (2) indicate that once we have a high percentage of ethnic groups in the block group population, we see high median household income level, further travel distance to bus stops, and increased median age, with respect to non-fresh food outlets increases. This means the lower the percentage of ethnic group with low income, the closer the distance to non-fresh food outlets. Geographically weighted regression is a useful tool once we have good independent variables that influence our prediction (dependent variable).

5.4 Discussion

The literature suggests that poor neighborhoods have lower access to fresh food outlets when compared with non-poor neighborhoods. Non-poor neighborhoods were less likely to have smaller grocery stores (non-chain), convenience stores, and specialty stores when compared with poor neighborhoods (Morland et al., 2002b). This is true for cities, such as Akron, because, after looking at the low-income areas, it seems that they have fewer large chain stores when compared to high-income areas. I defined food desert areas as an area that is located equal to or greater than 1 mile from the census block group centroid and its nearest large fresh food outlets and at the same time has a median household income of less than $30,000. However, if additional data, such as employment is linked with GIS, the results would be better for defining food deserts areas. The USDA uses tract to define food desert areas, which is not precise because the size of tracts vary from one to another.

The method that I used to calculate the distance is more precise because it measures the distance based on road networks. After calculating the distances for all
census block groups to food outlets, I found that most people living in identified food
desert areas are minority groups. The highest percentages of ethnic groups living in food
desert areas are African Americans. The average percentage of African Americans who
live in food deserts areas is 49%. These results support the idea suggested in the
literature, which is that African Americans are the most highly affected ethnic group
living in food deserts areas (Lewis et al., 2007). However, high percentages of African
Americans living in Akron do have adequate access to large fresh food outlets resulting
from their access to public transportation. After looking at transportation and bus routes,
almost all minority ethnic groups have access to public transportation, but differences
exist between ethnic groups in terms of distance and travel time to the closest large chain
fresh food outlets. Since minority groups may lack their own transportation and travel by
bus typically takes much longer, reaching food outlets can be more time consuming and,
as a result, less practical. Geographically weighted regression helped to know the
correlation for the model (2) between the distance to non-fresh food outlets and different
ethnic groups. However, the results might not be strong because of the limitation of the
available data. GIS techniques, such as closest facility tool and GWR, can provide more
precise information about the areas that we define and therefore, save time.
CHAPTER 6

CONCLUSION

Food deserts are a complex phenomenon and are becoming a popular issue to study in developed countries such as the United States, United Kingdom and Canada. The concept of food desert has been identified by different disciplines. However, there is a common notion concerning food deserts, which is that any deprived area with limited access to fresh food outlets will, at the same time, having various options of non-fresh food outlets. Identifying food desert areas has been done by different methods such as qualitative and quantitative. Most recent studies use quantitative methods such as GIS techniques. GIS is rapidly becoming popular in identifying food desert areas. This study demonstrates how effective GIS technology can be to identify food deserts.

The purpose of this study is to identify food desert areas in Akron by census block group level. Furthermore, I wanted to determine which is most affected among different ethnic groups and to make comparisons between different ethnic groups. After the analysis carried out in this research, the most affected group appears to be African Americans because they have the highest population density in food desert areas. The GIS tools, such as closest facility, near analysis and geographically weighted regression, which were used in this study, are useful and effective.
Based on the quantitative analysis and the criteria used in this study, there are 59 block groups considered to be food desert areas. African Americans are the highest population living in food desert areas. Whites are the second largest ethnic group, Asians are the third and then the forth is Hispanic. The city of Akron has sufficient access to large fresh food outlets when we considered all ethnic groups as a whole. Furthermore, geographically weighted regression helped to determine the correlation between distances to food outlets from various neighborhoods dominated by different ethnic groups. Identifying food deserts areas by census block groups is more precise and efficient than census tracts, which is used by the USDA.

6.1 Limitation

The limitation of this study is the availability of data that can be linked with GIS in census block group level such as, obesity rates, education level, employment etc. Those data are important in identifying the food desert areas in places like Akron. Furthermore, the road network that I downloaded from ESRI tiger shapefile is not updated (Census, 2000). This could affect the results when calculating the distance, depending on the variation between the updated versions of road networks. In addition, the sizes of the census block groups are different from each other, which may affect the results when calculating the distance between census block group centroids and the closest food outlet. Furthermore, the boundaries of Akron city do not match the boundaries of census block group and blocks. Therefore, I selected the block groups and blocks that touch the boundaries of Akron (see Figure 26). Another limitation in this research is the length of time a person has lived in a food desert, as this information is
essential when determining obesity outcome. Obesity is not caused overnight or over few months, but it is a longer health effect partially due to a lack of nutritious food consumption. Therefore, the time a person lives in a food desert area is important for this study.

*Figure 26.* The boundaries of Akron and census blocks and block group.
6.2 Future Direction

The future direction of this study is to further investigate the identified areas like surveys and know the rates of obesity and body mass index, which are used to determine whether a person is obese or not. There are numerous variables that can provide more information about the affected areas such as employment, education level, fresh food prices, food quality, etc. Food desert is a complex concept that interacts with social, economic and geographic factors. Using the geographic factors, like distance to food outlets, might not be helpful all the time; therefore, using social and economic factors will help in knowing food desert areas in a more efficient way.
REFERENCES


(http://www.ers.usda.gov/data/fooddesert/)


