USING GIS TO STUDY AND IMPROVE THE FOOD AND PHYSICAL ACTIVITY ENVIRONMENT OF MUNCIE, INDIANA

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CHAPTER 1: INTRODUCTION

Introduction

With caloric intake increasing across race, gender, age, and socioeconomic status, obesity has prompted a national initiative to promote healthy lifestyles and study the epidemic (Baker, Schootman, Barnidge, & Kelly, 2006). This research hopes to follow that initiative and study how we, as planners, can use GIS to not only study the food and physical activity environment, but also how we can use it to promote changes that increase accessibility to healthier options.

For Indiana, obesity levels increased the state’s rank from 15th to 8th as of studies from Trust for America’s Health (2013). From individuals all the way up to the White House, people are looking at ways to increase access to healthy foods, encourage a more physically active lifestyle, and promote better personal health habits. Studies of the food and physical activity environments of various cities have shown environmental features to often influence obesity, meaning that how planners direct the design and amenities of a city greatly influences the health of its constituents (Jilcott, Wade, McGuirt, Wu, Lazorick, & Moore, 2011; Lee & Moudon, 2006; Leung et. al, 2011; Pearce, Witten, & Bartie, 2006; Popkin, Duffey, & Gordon-Larsen, 2005; Smith, Brown, Yamada, Kowaleski-Jones, Zick, & Fan, 2008; Wolch et. al, 2011; Wong, Stevens, O’Connor-Duffany, Siegel, & Gao, 2011).

As urban planners, it is our goal and duty to promote the betterment of the communities in which we work and live. It is important to understand that the design of a city can greatly influence the overall health of the community. Zoning restrictions separating land uses has largely resulted in sprawling cities, which can be incredibly detrimental to downtowns and low-income neighborhoods as quality shops and venues move further away. Another issue that is thought to have manifested from urban sprawl is the occurrence of food deserts, denoted usually by low-income areas with essentially no access to healthy food options like a supermarket (United States Department of Agriculture, n.d.). The issue is especially
problematic for what are considered “vulnerable populations” or those who face restrictions in mobility due to age, disability, or no access to a personal vehicle (Kelly, 2012).

The decisions made in the planning office have the ability to influence whether people are more inclined to walk, engage in physical and recreational activities, and make healthier choices in general. The walkability of a neighborhood, the availability of quality parks and trails, and safer biking facilities can all contribute toward people choosing more active lifestyles. Similarly, vulnerable populations can be limited in their ability to access healthy food when none is directly available in their neighborhood. By promoting mixed-use developments, encouraging farmer’s markets and urban gardens, and strategically developing areas, a planner has the ability to increase the access to healthy food for community members. For physical activity initiatives, the review of research in the second chapter will show how even the type of facilities offered in a park can greatly change how much it is utilized.

It is important to acknowledge that, as a planner, some of the correlating factors to higher or lower community obesity rates are ones that sound planning can help correct. One example rapidly gaining recognition and importance nationwide is walkable cities. People who live in communities with high levels of accessibility and recreational spaces are less likely to be obese (Sallis & Glanz, 2009). In a study of people who moved to a new city, individual activity levels increased or decreased based on what the new residence had to offer, especially in the form of walkability (Handy, Cao, & Mokhtarian, 2008). People who may have been typically active before became more sedentary after moving to a city with fewer healthy and active amenities, for example. This is drawing more attention to the outside influences and the community environment in general that may be contributing to this phenomenon—e.g. we cannot expect someone to walk every evening when the roads surrounding them are dangerous to do so.

It may not be reasonable to approach this by trying to eliminate negative influences (e.g. banning fast food) but it is reasonable to approach this by providing convenient, accessible, and quality healthy resources for positive influence. Though some cities have decided on moratoriums on fast food, it may actually further limit the options that a low-income or minority neighborhood has and increase the food
If a healthy choice is just as attainable, convenient, and accessible as an unhealthy one, it might encourage individuals to consider the healthy option more than if it requires extensive effort. For example, having a park nearby may make playing basketball a more desired recreational pastime than watching television. With no park nearby, that might not even be an option. It is becoming increasingly clear that the best interventions will need to follow a multi-level approach that not only accounts for the individual but the city and its amenities as well (Sallis & Glanz, 2009).

GIS as a software has been hugely successful in many fields of research and professional practice. With the ability to display complex data in user friendly graphics and to cover multiple forms of analysis and statistics, GIS technology is approachable to more than just the avid software enthusiast. Software technology such as this can show areas that are in need of targeting or identifying areas needing to be studied in more detail. For these reasons, GIS was chosen as the primary tool for analysis in this research.

The largest difference in this to other research is that the end product will generate different scenarios under which accessibility to healthy food or physical activity options can be increased. This research will use Muncie, Indiana, as a case study to review the current environments, healthy options, and areas of limited accessibility to generate suggestions on how to improve the overall health environment. This may come in the form of a bus route, a targeted food venue or community garden, a new park, etc. By modeling various outcomes and seeing how the environment and accessibility changes, it can provide insight not previously had in a community on where focus should be put. Another difference from some past research will be the use of network buffers instead of airline buffers. With the various modes of transportation accounting for different populations, this level of the analysis will provide a realistic and accurate travel network to better show what accessibility looks like in Muncie, Indiana. Finally, not all research has taken into account both proximity and density of food and physical activity venues, which this research will do as well.
Background

Site Background

As cities have grown, many businesses have moved from the core area of cities to the periphery or specific strategic locations along major development corridors. This has resulted in the economic struggle of downtowns across America and specific sections of cities, especially in Rust Belt cities like Muncie, Indiana. Incorporated in 1865 and located approximately sixty miles northeast of Indianapolis, Muncie is located in Delaware County and accounts for approximately half of the total county population (City of Muncie, 2014).

Muncie is one of the many cities in Indiana that saw considerable growth and expansion after the gas boom of the 1800’s. The “Trenton Field” spanned more than five thousand square miles, making it the largest natural gas field known in the world (American Oil & Gas Historical Society, n.d.). Within just a few years, hundreds of companies were involved with natural gas with over three hundred wells. Muncie, Kokomo, Anderson, and Marion were suddenly all in competition on trying to attract companies with free or drastically cheap gas prices. Between 1880 and 1900, the population skyrocketed from approximately five thousand to over twenty thousand (Historic Muncie, 2012). Inexpensive gas was one of the main draws for many manufacturing companies, inspiring the Ball Brothers Glass Manufacturing plant to relocate from Buffalo, New York, to Muncie, Indiana, cementing what would be a long remembered connection with the city (American Oil & Gas Historical Society, n.d). Railways were laid, manufacturing plants dotted the cityscapes, and places like Muncie flourished around this driving force in their economy. However, it was a short-lived boom, with much of the gas being depleted or completely gone by the early 1900’s (American Oil & Gas Historical Society, n.d). Throughout the next few decades and through the various ups and downs of the economy, Muncie would go from a bustling city with a thriving downtown to a city with a struggling downtown and a difficult economic environment. Many of the largest manufacturers were lost to other cities throughout the late 1900’s.
The demographics of Muncie have changed dramatically over its existence. The 2010 population data from the United States Census shows Muncie at 70,080 and 2,577 people per square mile. From the 2010 data, the population demographics were 84% Caucasian, almost 11% African American, with the remaining spread across other ethnicities. Eighty percent of the population was a high school graduate or higher, with 21% of the population over 25 years old having a bachelor’s degree or higher. Median household income was $30,200. Over thirty percent of the population was below the poverty level. Retail sales accounted for the highest amounts between manufacturers, merchant wholesaler, and accommodation food services, according to the Census data, whereas for the state as a whole manufacturing was vastly higher than any other category (United State Census Bureau, 2013).

Much of the demographics and history of Muncie are why it was chosen for this research. Midwestern cities represent a much smaller proportion of studies than those done in larger cities and coastal areas. Mid-sized cities often lack the density of larger cities, and Midwestern culture and city development tends to be centered on automobile travel. Another input is the economic decline that Muncie and many other Rust Belt cities are currently suffering. With many residents below the poverty level, accessibility can be far more limited in terms of what means of travel are available to those populations. Similarly, according to County Health Rankings, Delaware County is ranked 82nd of 92 Indiana counties for health outcomes. Muncie accounts for the majority of the population of the county, and therefore could be well represented by these statistics itself. For the county, a third of the population is obese, 30% are physically inactive, and the premature deaths are higher than that of the state (County Health Rankings, 2013).

**Shortcomings and Criticism of Previous Research**

Shortcomings noted in both food environment and physical activity environment research includes the aggregate level of data (most commonly various census delineated levels) that can mask geographic effects (Forsyth, Hearst, Oakes, & Schmitz, 2008; Papas et. al, 2007). Issues such as obesity are not bound by geographic areas, and the interior of a large boundary may show very different
responses than the exterior. Another issue that can factor into both researches is various modes of transportation. Not everyone has a vehicle, and some may rely on walking, biking, or public transit to get to grocery and other daily needs.

Other criticisms specifically related to food deserts cite a few recent studies that suggest that low-income neighborhoods have ample access to food and produce. Both studies were done in California and found that low income neighborhoods did in fact have twice as many fast food locations and three times as many convenience stores per square mile as wealthier communities, but had nearly twice as many supermarkets and large scale grocers per square mile as well (Kolata, 2012). The research in the article found no relationship between what students said they ate, weight, and nearby food within a mile and a half of their homes. Both of these researches do lend to the overall call for more research to get a more definitive idea of the complexity of the issue. However, with the study by Lee (2012), it follows the same issue of many previous research methods with data aggregated at a large level of census tracts. Neither of these studies specifically takes into account direct lines of transportation or economic accessibility of what is offered. Similarly, fast food and convenience stores being prominent and accessible does not necessarily equate to having healthy food access, and has been pointed to in multiple researches as factors that contribute to higher obesity risks, which will be discussed in detail with the literature review. With both researches being based in California, it also only utilizes a very small sample study and area and may not be applicable to areas of starkly different development, living, and lifestyle patterns such as the Midwest. The other issue, as noted in the literature review, is that it is not students that are the primary acquirer of food. Parents, with possibly very different areas where they work compared to the school and home environment, are the prominent provider of food and the food in the home may relate more to what is around their work environment or on their way home more than what is directly around their residence. Students, on the other hand, may consumer more meals after school at nearby fast food or convenience store locations, and so it is important to acknowledge that food is very dependent on the primary purchaser.
A challenge of current research is striking a balance between the level of detail desired and what is actually feasible through time and money constraints. Few studies have the time and resources to account for density, proximity, transportation access, economic access, demographics, and other variables such as crime that can affect perceived safety of using things such as parks and trails. Many studies have to reduce the number of variables, though obesity and the utilization of healthy options remains a highly complex issue.

**Objectives**

There are three main objectives of this research. The first two objectives are to use geographic information systems to study 1) the density of food and physical activity environment variables and 2) the proximity in the form of service areas to show what parts of the population have access to these facilities by a 5-, 10-, and 15-minute walk or bike ride. To also account for bus ridership, the same time networks will be generated for walk and bike rides from MITS bus stops to show what is in the service area of those stops. This will generate a more comprehensive picture of both the food and physical activity environment, which has been noted as a flaw in past research (discussed in detail in Chapter 2). Variables that will be studied include supermarkets and smaller food stores, farmer’s markets, convenience stores, fast food locations and restaurants, and recreational areas. The literature review in Chapter 2 will show extensive support for these variables through previous research. The third objective will be to synthesize the resulting layers and outputs to generate various options for increasing accessibility to healthy features of the city.

The scope of this research is limited to the city of Muncie, Indiana. This geographic limit was chosen so that it can look more closely at the food and physical activity environments of the city and be more comprehensive in nature. Other larger scopes were considered, but analysis would have had to be more generalized and some degree of detail may have been lost. Due to the desire to create detailed network buffers and bring in a wide range of variables determined through the literature review, the city level and a middle sized city was deemed the best scenario.
As with many cities in Indiana and the Rust Belt at large, I expect to see the majority of food venues such as restaurants located along the major economic corridors and less within the older parts of the city. If past research holds true for this area, access to supermarkets will likely be less in lower income portions of the neighborhood, though some of these may have community garden initiatives. As somewhat of a counter relationship, the park and/or trail access may be much different, as the largest park in Muncie is quite distant to the more affluent and economically focused areas of the city. From my basic intuition and more limited previous knowledge of different sections of the community, I would expect that the southern and southeastern portions of Muncie will be the most likely to have limited or no access to healthy food variables, though as stated above they may have ample access to park and recreational areas.

Significance

As stated above, Delaware County is currently ranked 82nd of 92 counties for health outcomes, according to the County Health Rankings website (2013). A third of the county is obese, and 30% of the county is considered physically inactive. In contrast, Hamilton County obesity is lower at 22%, and physical inactivity comes in at 19%, helping the county rank as the best for health outcomes (County Health Rankings, 2013). This research is important because it is solutions-oriented and will provide ideas and methods to increase accessibility to healthy resources. By generating a variety of ideas, such as new transportation stops or lines, areas that could benefit from a supermarket or community garden, and similar, it can help cities to know specific ways that they can improve their neighborhoods. One example of this is park space in Muncie, Indiana. A quick view of a map of city parks shows no large parks on the north side of the city. This could turn out to be something that may greatly improve the physical activity dynamics of the city as a whole through this analysis. Similarly, for many state and national grants available to cities, plans on improving the community health environment are prerequisites to applications. This research has the potential to contribute to the creation of those plans.
To the field of food environment and physical activity environments as a whole, this research may show the importance of studies generating solutions. Once areas lacking accessibility are discovered, many studies could go one step further and show ways to eliminate the issue, or at least greatly reduce it. Obesity is skyrocketing into a massive issue, and it is more important than ever for research to be multifunctional in that it should both show what the problem is and also provide a way to correct it. Detailed research is not always accessible to many community leaders or officials due to time constraints and budget restrictions. As researchers and active participants in a community we can provide the research that lays the groundwork for fixing the problem, and then we can generate different ways to solve it. Active research that is solutions oriented is imperative, especially for issues like obesity.

This research will also provide a somewhat different approach in being more comprehensive than some research in the past. The synthesis of the two environments in studies has become increasingly recognized as important and more commonplace. This research will help with that movement by combining the two environments with realistic transportation networks and demographic data to show at-risk areas. Though this research will not include survey data to determine exactly where people are eating and their perception of their environment, it essentially lays the groundwork for targeted future studies.

This may be a realistic approach to studies in the future as resources become more limited in narrowing down where more intensive research should occur. At the core of this research, a valuable set of resources should be generated for the host city in providing a clear spatial picture of the healthy dynamics of the community.

**Methodology**

This research will use geographic information systems (GIS) to measure the density and proximity of healthy resources in Muncie, Indiana, using ArcGIS 10.1 (ESRI, Redlands, California). The research will analyze food establishment data (including supermarkets, restaurants, convenience stores), nonprofit food resources and farmer’s markets, park and trail data, MITS transportation lines and stops,
street and sidewalk networks, demographic census data such as age, poverty status, ethnicity, all of which have either already been attained or are easily accessible from other sources (such as Census data).

The venues will be geocoded using the built-in tools of ArcGIS. This usually does not result in 100% accuracy in the first run, and requires some remaining establishments to be geocoded manually. Through the computer geocoding nearly all venues and the remaining being appropriately located manually, all venues should be matched to their proper geospatial location. This research will then generate density layers within the program to show where different variables cluster versus where there are no features of that type (e.g. fast food venues clustering on McGalliard Road versus not appearing in some residential neighborhoods).

Next, the Network Analyst toolset will be used to recreate ideal networks around the different variables using the road network to show what parts of the city are within the service areas of each venue. This will be done for five to fifteen minute walking and biking to account for pedestrian modes of travel. As a secondary layer, the same networks will be generated from MITS bus shelters. The road network generates the ideal output, in that it assumes that sidewalks or safe passages are available the entire way. Once these layers are created, it will be compared to the existing sidewalks in the city to determine areas in need of improved or added sidewalks.

In the next step, demographic data will be brought in and compared to the research to show how much of the population is covered within fifteen minute walks or bike rides to the variables. This will show areas that are in the most need of attention and action. Gaps in coverage may show where new locations of each variable could be added, and some variables may be best served by infrastructure improvements. When reasonable, new network coverage areas will be created to show how a hypothetical addition to the facilities would change the coverage.

The disadvantage to any detailed study is the time requirements. However, the vast majority of that time in a new study is spent gathering, cleaning, and prepping data for use within the system. For this study, it is using data that is, for the most part, already created and ready for use. The advantage of
the detailed level of study is that it provides superior focus in the results in giving smaller locations and areas where resources and attention should be focused. The food dynamics on the perimeter of a Census tract may be vastly different than that of the interior, and it is the premise of this research to say that smaller and more focused results are critical and far more beneficial to officials with limited time and budgets.

Another disadvantage to this particular style of research is that it will not account for actual survey data, which would verify where higher rates of obesity throughout the city are occurring. However, with the nature of this study it will still provide valuable insight to the obesogenic nature of some parts of the city by examining features based on extensive previous research on contributors to health risks. Past research will be extensively covered in the literature review in chapter two. A strong advantage to this research is that by sacrificing the survey it provides time and resources to be devoted to generating potential solutions. Providing the basic research may not be enough in the future to see much accomplished by way of public policy. By providing ideas and solutions as a complement to our research initiatives, it may incline officials more toward acting on the results, and in general may be significantly more helpful to communities and leaders. It is no longer sufficient to just prove that a problem exists, but rather it is necessary that we also offer reasonable solutions and ways to move forward. Regardless of whether obesity is the question, it should always be the goal of a city to provide ample access to park and recreational space to all members of the community in a readily accessible fashion. It is also important and highly beneficial to residents if they can decrease time spent driving or traveling to a grocery center by one being in their community. The results of this research can therefore be beneficial to leaders and future researchers on multiple levels.

Outline of Chapters

In the next chapter, the Literature Review, previous research will be covered to determine what has been done up to this point. This will include a review of research that combined the food and physical activity environments first, as that is most applicable to the nature of this study, followed by
research that has been done on the two environments separately. Following those sections, a review of criticisms and noted shortcomings of the research will be included, then a review of available data on different solutions to the issues raised in research and in community resource allocation will be provided to generate ideas on what has worked and been attempted elsewhere. The goal of this chapter will be to provide a well-rounded groundwork on which to build the analysis.

Chapter three will begin the analysis portion of this thesis. Detailed processes, diagrams, and maps will be included to guide the reader through the software analysis and results. This chapter will detail the findings from the data and what was determined in the form of ways to correct the levels of accessibility throughout the community. This section will also include any limitations, issues, and similar with the data and analysis. Finally, chapter four will conclude the thesis with conclusions and recommendations. Also included in the final chapter will be ways in which this research can be improved, expanded, and utilized in the future, as well as general recommendations and insight for similar research.
CHAPTER 2: LITERATURE REVIEW

Introduction

As waistlines in the country expand, the research and knowledgebase is working to do the same to find new ways to curb the crisis. The literature linking obesity to aspects of the built environment is diverse in nature and growing rapidly to correspond with the spread of the national epidemic. For example, a quick search on google scholar for “food and physical activity environment AND obesity” with the year requirements of 2000-2010 returns over 34,000 results. That same search with articles from 2010 to present returns over 16,000 results, and a search of current articles (“Since 2014”) returns over 3,000 results for research published using Google Scholar. Research is synthesizing both food and physical activity environments into the same studies more often as studies are consistently pointing toward a need for comprehensive approaches. Obesity is a complex and intricate issue, and therefore requires a complex level of study. This literature review will first consider research synthesizing the topics, followed by studies focusing on a single topic.

Food and Physical Activity Environment Research

The environment that surrounds homes and schools influences life choices such as diet, activity, and substance use (Liu, Wilson, Qi, & Ying, 2007; Witten, Exeter, & Field, 2003; Wong et al., 2011). Pearce et al. (2006) used GIS to directly measure resources promoting healthy lifestyles. This research uncovered a wide range of travel times to food venues. GIS was determined to be able to allow for neighborhood level study of access to healthy features and to do so with greater precision (Pearce et al., 2006). Lower amounts of vegetation and higher amounts of food retail “significantly predicted” increased risk of weight issues (Liu et al., 2007). Not having a nearby park, or the perception that a park was unsafe, correlated directly with increased risks of obesity (Boehmer, Lovegreen, Haire-Joshu, Brownson, 2006; Casey et al., 2012; Wall et al., 2012). Similarly, nearby proximity to a supermarket was associated with reduced health risks, while further distance to a supermarket was associated with
increased health risks (Boehmer et al., 2006; Harrison, Jones, van Sluijs, Cassidy, Bentham, & Griffin, 2011). Physically active parents and those with better dietary habits also associated with reduced childhood Body Mass Index (BMI) risks, indicating that parental lifestyle choices significantly influence that of their children (Bauer, Neumark-Sztainer, Fulkerson, Hannan, & Story, 2011; Crawford et al., 2012; Grunseit, Taylor, Hardie, & King, 2011, Hendrie, Coveney, & Cox, 2011).

In summary, accessibility and proximity to facilities was unsurprisingly deemed important for aspects of both the food and physical activity environment. Perceived safety of using or getting to these facilities was also important. Increased number of healthy resources nearby was associated with lower BMI and health risks, while distance and danger related with higher risks. To summarize, community environment influences the home environment, where children are especially susceptible to decisions made by their parents. This particular point seems to merit more attention and research, as it could be the basis for targeted promotions and awareness. Some parents may not realize just how much their food and behavioral choices influence the health of their children, and widespread programming needs to consider what is happening at home when trying to reach children and encourage healthier lifestyles. As planners, and essentially stewards of the communities where we work, we have to make sure that we are not making the choice for someone to live an unhealthy lifestyle by not providing resources for healthy living within neighborhoods.

Food Environment Research

Food environments, often garnering the most attention as a direct player in the obesity game, are most often focused at the community level to determine where food can be obtained (Sallis & Glanz, 2009). The community food environment focuses on the distribution of food from the standpoint of number of facilities, type, proximity, and accessibility (Glanz, Sallis, Saelens, & Frank, 2005). As more meals are being consumed outside the home, it is increasingly important that healthy options be available within neighborhoods (Kant & Graubard, 2004).
Food served within the home is often affected by what is available near the home, with eating habits of parents being influential to those of their children (Campbell, Crawford, Salmon, Carver, Garnett, & Baur, 2001). A large association between supermarket availability and weight in students who had a mother that worked full-time was also noted in research (Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007). In a day and age of busy schedules, single-parent families, and some parents having to work long hours or multiple jobs, it is increasingly important to many that meals be efficient. Time consuming trips on a bus to get to a grocery may be restrictive to tight schedules, inclining some to delivery, fast food, and quick meals. Having a nearby supermarket, as well as meals being eaten within the home, correlated with higher intake of fruits and vegetables (Larson, Neumark-Sztainer, Jannan, & Story, 2007; Moore, Diez Roux, Nettleton, & Jacobs, 2008; Morland, Diez Roux, & Wing, 2006; Powell et al., 2007; Sallis & Glanz, 2009). Lower BMI, however, has not always associated with more family, in-house meals, which could be attributed to the type or quality of food being consumed (Fulkerson, Neumark-Sztainer, Hannan, & Story, 2008). Preparation of and inclination to unhealthy options such as junk food, quick meals, and frozen dinners is an issue that can perpetuate through generations, resulting in children and adults that legitimately do not know what some vegetables even are, much less how to prepare them, which can make meals at home just as poor in nutrition as meals eaten outside the home (Oliver, 2010).

Sallis and Glanz (2009) concluded that a growing body of evidence supports proximity to a supermarket is influential to fresh produce intake, while proximity to fast food outlets increased the likelihood of non-nutritional food consumption. They also concluded that future research on food decisions made outside the home after menu labeling would be beneficial to determine the influence and success of the program on individuals making healthier decisions. Maddock (2004) determined that lower numbers of residents per fast food venue and lower number of square miles per fast food venue was associated with higher levels of state obesity ratings. This seems to be a potential offshoot for future research to determine if higher density areas of fast food within a community correlate to higher
surrounding obesity levels, or if the phenomenon is restricted to larger scales. Similar to the research by Maddock, density and proximity of convenience stores were determined by multiple studies to affect obesity, with increased numbers of venues being associated with increased health risks (Gerbaur and Laska, 2011; He, Tucker, Irwin, Gilliland, Larsen, & Hess, 2012; Powell et al., 2007; Sturm & Datar, 2005; Zenk & Powell, 2008). However, other studies disagree and did not find the two correlated (Lee, 2012). Typically, convenience stores offer high fat and low nutrition snacks and fewer fruit and vegetable options. Hot meals typically include hot dogs, pizza, nachos, and few healthier options. It is reasonable that for some populations (e.g. truck drivers, teenagers after school, morning commuters) convenience stores would be especially influential to their diet. With a main promotion of convenience stores being inexpensive but excessively large soft drinks, the likelihood of increased unhealthy purchases is not surprising.

Closer farmer’s markets related to lower BMI, while fast food and pizza places nearby showed a relationship to higher BMI (Jilcott et al., 2011). Food within a mile or less of homes was shown to have direct influence on obesity risks in youth (Day & Pearce, 2011; Leung et al., 2011). Other studies determined that a lack of supermarkets and increased density of fast food outlets increased the likelihood of unhealthy lifestyles and obesity in older adults as well (Li, Harmer, Cardinal, Bosworth, & Johnson-Shelton, 2009; Moore et al., 2008).

In conclusion, the availability of healthy food venues in communities is more important than ever. In a day and age where McDonald’s and other fast food venues seem to be on every corner, it is important to promote farmer’s markets, urban gardens, supermarkets, and other venues that provide quick access to healthier food. We have to recognize that parents play a large role in the dietary lifestyles of children. Though education in schools and directed at children may be a start, they do not have the purchasing power of the family and it is imperative that healthy initiative educators also reach out to parents. It is a reality that some households may be the third generation of adults who only know how to prepare quick and highly processed food, and education efforts and community programming needs to reflect this. This
combined with the effort on behalf of community planners and leaders to ensure that healthy options are available and highly accessible could create better and more effective results in reducing health problems. As research continues to show that supermarket and fast food availability influences the health habits of the entire age spectrum, it is imperative to understand how economic development and community decisions will impact our residents.

**Physical Activity Environment Research**

Physical activity environments include places designed to promote activity ranging from sidewalks to playgrounds to parks to private facilities (Sallis & Glanz, 2009). One review determined that 17 out of the 20 reviewed articles involving physical activity showed various aspects of the built environment affected BMI (Papas, Alberg, Ewing, Helzlsouer, Gary, & Klassen, 2007). Nearly all reviews studied by Sallis and Glanz (2009) determined that sidewalk availability and connectivity positively correlated with being physically active. Measures of the physical activity environment, however, do not always overlap between studies as different methods, processes, or distances may be utilized. Many studies utilize 5-, 10-, and/or 15-minute walking networks, but others may consider networks that start at a mile or more. Common measures of the physical activity environment include proximity, density, sidewalk availability, and walkability of the neighborhood (Papas et. al, 2007).

Shortcomings of past research include aggregate levels of data (commonly census delineated levels such as tracts) which can mask geographic effects. Obesity is inherently complex and not restricted to boundaries, and large scale data has often been cited as an issue.

Wolch et al. studied park and recreational resource proximity and determined that youth with access to parks and recreation facilities show fewer increases in BMI. This study utilized buffers of 500m for park distance from a child’s home and recreational programs within 10km (Wolch et al., 2011). Smith et al. (2008) geocoded obesity information, and determined that neighborhoods with increased walkability correlated with lower BMI. Forsyth, Hearst, Oakes, & Schmitz (2008) studied over two hundred measures to determine the role of walkability and physical activity and determined that purpose-driven
walking varies in accordance with the physical environment. They concluded that having a variety of points of interest clustered nearby was important, as well as various types of businesses that increased the likelihood of someone walking to them (e.g., nearby supermarket, bank). The type of park or open space may also play an integral role to physical activity, and researchers determined that more attention should be paid to users’ preferences (Hino, Reis, Ribeiro, Parra, Brownson, & Fermino, 2010). A Davidson and Lawson review of physical activity research from 2006 also found that activity was increased in parks with basketball courts over those with other amenities such as baseball fields and passive recreation options such as picnic tables.

People who live closer to recreational facilities are more likely to have increased levels of physical activity (Bauman & Bull, 2007; Davidson & Lawson, 2006; Sallis & Glanz, 2009). As stated above, the design of a park and the features it included was also shown to affect the levels of activity within the park (Davidson & Lawson, 2006; Hino et al. 2010). Trees, fountains, and attractive buildings were positive influences in park design and correlated with increased park usage (Bauman & Bull, 2007; Floyd, Spengler, Maddock, Gobster, & Suau, 2008; Hino et al., 2010). In essence, a park that made a user want to be there and interact with the surroundings often resulted in increased activity levels.

Neighborhood design was also important to activity levels. Walkable neighborhoods and areas showed higher likelihood of residents utilizing walking as a means of transportation, as well as recreation. Twice as many residents in neighborhoods of high walkability levels met daily recommendations for physical activity than those in low walkability neighborhoods (Bauman & Bull, 2007; Frank, Schmid, Sallis, Chapman, & Saelens, 2005). Residents who used public transit were also more likely to meet physical activity level recommendations than those that used automobiles (Besser & Dannenburg, 2005).

Street design and perceived danger from traffic also affected levels of activity. Poorly defined pedestrian walkways and lack of sidewalks were shown to discourage walking and decrease physical activity levels (Davidson & Lawson, 2006; Kerr, Rosenberg, Sallis, Saelens, Frank, & Conway, 2006; McGinn, Evenson, Herring, Huston, & Rodriguez, 2008; Smith et al., 2008; Zhu & Lee, 2008). Handy et
al. (2008) concluded that moving to a new neighborhood affected an individual’s activity levels based on what the city had to offer. If a person moved to a city of lower levels of walkability, fewer parks, and similar amenities it tended to reduce their activity levels, whereas those that moved to more active communities often exhibited an increase in personal activity levels (Handy et al., 2008).

Chin, Van Niel, Giles-Corti, & Knuiman determined that using a true pedestrian network versus just a street network returned very different results (2008). In essence, by including alleyways and other typical paths of pedestrian travel outside of sidewalks, a more accurate picture of what was within walking distance was returned. The difference could be similar to that of using straight airline buffers instead of more accurate network buffers. Chin et al. determined that understanding the way pedestrians move was integral to determining what they likely consider accessible (2008). McGinn et al. determined that crime, perceived and actual, correlated to a lower level of participation in leisurely physical activity (2008).

In summary, accessibility and desirability are important premises for physical activity level studies. As planners, we have to think about not only providing a means to get from one place to another and multi-modal transportation, but we also have to think about giving people a reason to go there or want to go there in the first place. As indicated by the above research, a basic park may not increase physical activity as much as an active one with trails, basketball courts, and a beautiful setting. Similarly, we can encourage levels of physical activity elsewhere in the community by providing clean, safe sidewalks and a variety of destinations nearby.

**Solutions from the Planning Perspective**

Multiple studies have shown that environmental changes and modifications to increase healthy resources available can change levels of physical activity, though it is not agreed upon which methods have the strongest positive effects (Sallis & Glanz, 2009). Various methods and solutions are available to improving the overall environment of communities, and often these align well with many of the current initiatives in planning, such as smart growth and new urbanism (Sallis & Glanz, 2009). As mentioned
throughout this review, walkability is one of the ways to increase the likelihood of people being active. Walkability is not just limited to well-kept sidewalks, however. Again, it is critically necessary to not only give people the ability to walk, but also a reason to walk. This can be done in mixed zoning practices that offer a variety of destinations within a walkable distance. Restrictive and homogenous zoning practices within cities have resulted in the majority of work places, retail centers, and basic needs requiring an automobile or sometimes lengthy bus trip in order to get there (Sallis & Glanz, 2009). Land-use changes are recognized by the Centers for Disease Control and Prevention (CDC) as an evidence-based intervention method that promotes a more physically active lifestyle (Heath, Brownson, Kruger, Miles, Powell, & Ramsey, 2006).

Hand in hand with increasing sidewalk connectivity and walkability of a neighborhood is increased safety of walking. Traffic and crime have both been associated as deterrents to walking (Sallis & Glanz, 2009). From a planning solution standpoint traffic calming, separated bicycling lanes, and increased signage and signals for pedestrians can greatly contribute to the perceived safety of walking in a neighborhood. We have to realize that our decisions and designs make a huge impact on the lives and choices of everyone within a community, and it should be the goal of a planner to provide a safe zone of travel for multiple modes of transit.

One of the most important components to planning as a whole, and subsequently the issue of food and physical activity environments, is community participation. It is critical to keep in mind that an outside perspective cannot necessarily come up with the best solution to the problem. Though moratoriums have been imposed in some communities for fast-food establishment construction, this can be taken as a punishment to the community members if it is their prominent source of food or few other options exist, and it can actually create a tougher scenario for those residents to access food (Sallis & Glanz, 2009). Similarly, urban gardening initiatives can be a great way to increase fresh produce in a community, but may not solve the end users issues of still needing to travel a great distance to get other basic needs. If we can increase communication with residents, we may find out exactly what would best
suit their needs and help them thrive and take that into account in our plans and strategies for
development. Similarly, communities around Indiana and the country are discovering that neighborhood
residents are a great source of activity and means of getting things done. As more and more community
members look to start their own gardening initiatives and outreach programs, it can be a great resource
and partnership for planning agencies. The next chapter considers the variables that need to be assessed
in providing the amenities that promote physical activity and healthy food choices.
CHAPTER 3: ANALYSIS AND FINDINGS

ANALYSIS

Data Retrieval and Manipulation

This chapter discusses the procedure used in the research to study the density and proximity of different resources within Muncie. The first step was to collect the variables data from various sources and make any necessary corrections within the GIS system. Variables were separated by type, as shown in Table 1. All variables were used as layers within ArcGIS. The next level of analysis involved adding demographic and socioeconomic data to compare levels of accessibility to vulnerable populations (e.g. older populations, youth under 16, low-income, minority).

<table>
<thead>
<tr>
<th>VARIABLES (Presented as Layers within ArcGIS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD ENVIRONMENT</td>
</tr>
<tr>
<td>Major Grocery Stores</td>
</tr>
<tr>
<td>Fast Food</td>
</tr>
<tr>
<td>Convenience Stores</td>
</tr>
<tr>
<td>Nonprofit Food</td>
</tr>
<tr>
<td>Limited Grocery</td>
</tr>
<tr>
<td>Other Restaurant</td>
</tr>
</tbody>
</table>

Data was retrieved from a variety of sources, including the Ball State University Library servers, Indianamap.org, and Census data. The “food establishments” layer from the BSU servers included all food resources. The resources were separated by their attribute data and broken down into categories of major grocery (e.g. Meijer, Wal-Mart), limited grocery (e.g. Family Dollar, Dollar General), fast food restaurants, other restaurants (e.g. exclusive, sit-down), convenience stores, and farmer’s markets.

Muncie city parks were also retrieved from the Ball State University Library servers. These included small (less than 10 acres) neighborhood parks and larger parks. Parks that were greater than 10 acres and within the city boundary (Prairie Creek Park excluded as it is located outside of the city limits)
were also exported to a separate layer to compare the networks and areas serviced by all versus large parks. Trails and sidewalks were also included in the analysis and retrieved from the library servers.

The Muncie boundary was generated from the “Incorporated Areas” layer from Indianamap.org. This includes incorporated areas for the entire state, from which Muncie was extracted by the name attribute into its own layer. Using this layer to run a clip (similar to a cookie cutter operation), roads were extracted for Muncie as well. This resulted in a layer that was directly workable through network analysis, as roads were broken into small segments connecting at intersections. The data was then added to a geodatabase, and a feature dataset was created to include the roads layer.

The demographic data used was also retrieved from the library servers. This data included the 2000 Census data at the block level for a more detailed level of study. Since the database containing the Census data on the servers was from the City of Muncie for the 2013 year, the 2000 Census data was deemed an acceptable dataset to use as it is what the target city is often referring to and it is very comprehensive and detailed. New fields were created and the “field calculator” tool was used in ArcGIS to compute the total number of people over 65, the total number of people with income levels less than 20% AMI, and to aggregate the number of people in minority groups.

Few layers had to be manually created for this research. One layer that required digitization was a current layer for MITS bus shelters, as the available data from the library server included multiple outdated routes. Current stops were located using the map on the MITS website and created as a point layer file. For sidewalks, placeholder crosswalks were put in to allow the service areas to run properly.

**Density Analysis**

The first step of the analysis was to determine the density of each of the food environment variables. This was done using the “Kernel Density” tool in ArcGIS 10.1 with a search radius of a quarter mile (the prime distance for walking). The goal of this step was to show where various features cluster. The results were then reclassified into 5 tiers to show a range of no food variables within the search boundary up to a high density of food variables within the search boundary. Density is an important
measure for food environment research and walkability issues, because dense clusters often can encourage walking from place to place. They also may be more attractive and desirable for people to travel to, in that they hold multiple options and resources. These components of attraction make it important to study what is within the clusters to see if healthy options exist. Density layers were generated for food variables as a whole and also for individual categories. Density maps are included with the discussion of some of the variables later in this chapter. Density maps were beneficial only when variables had a larger number of locations in the first place, and therefore are not included for all variables studied. However, future recommendations for projects like this would be density analysis of cumulative healthy versus unhealthy categories, to determine where major influential zones are for each.

**Proximity Analysis**

*Network Dataset Creation*

The next phase of the analysis involved generating network service areas for each of the variables. Three network datasets had to be created: roads, sidewalks, and bike infrastructure. A network dataset was generated from roads using line endpoints as places where turns could be made (representing intersections, ends of roads). Due to the elevation of roads not being available, this research was not able to take into account overpasses or varied heights in roadways, but the expected issue from this is limited. The road network was used to create an ideal network of where people *should* be able to walk if the sidewalks or safe passage routes are in place. For sidewalks, an existing sidewalk layer was retrieved from the Ball State library server. Placeholder crosswalks had to be created to connect the sidewalks, and local roads were added in on the theory that the low amounts of traffic would make some people more likely to walk alongside those roads. For biking infrastructure, local roads were also included with existing bike lanes and roads identified as safe, which were two layers available through the library website.

Using the network analyst window and toolbar, each of the variables were added separately as a facility, and corresponding networks were generated using 5-, 10-, and 15-minute equivalent distance
breaks to create 3 concentric zones for each facility. These were based on an average walking speed of 1.1 meters per second. Next, polygons were generated with similar time buffers but for walking speeds of .8 meters per second, to account for people with disabilities. Walking times were based on recommendations by Federal Highway Association (FHWA, 2006).

All food variables were located and subsequent networks generated. For parks, which were originally polygons, point features were generated in the center of each to use in the network analysis. Trails were done in a similar way, as network analysis is based off of starting points as opposed to lines or polygons. The 5-, 10-, and 15- minute walks were used as breaks for these as well. A similar process was used for bike service areas, with break inputs of .92, 1.83, and 2.75 miles based on an average speed in the city of 11 mph (Haas, 2013). The same two processes for walking and biking were then generated around MITS Bus shelters.

Demographic Data

Demographic data was then synthesized to determine how the service areas of different variables related to general population, youth under 16 years of age, adults over the age of 65, income less than 20% of the area median income, and minority populations. This was accomplished by using the service area polygons as a cookie cutter to clip the demographic data layer. After, summary statistics were calculated on the fields to determine the total sum of each category accounted for in the service areas. This resulted in a sum of people within a fifteen minute or less walk or bike ride to the facilities. One reason for doing this is that it generalized the data instead of pinpointing areas, which can be an issue when using data at the parcel or block level.

FINDINGS

In the network analysis, one of the first things noticeable after the generation of the maps is the ideal biking and walking categories typically cover a large portion of the city. Nearly all ideal biking service areas resulted in nearly full coverage, and many of the ideal walking service areas covered a large portion of the city, depending on the variable. Table 2 shows the percentages of total population,
minority, age over 65, income less than 20% AMI, and age under 16 that occur in each scenario. Each variable is broken into the scenarios of walking (W) and biking (B), and the demographics for each scenario are available for the ideal infrastructure scenario (I), existing infrastructure (E), and reduced speed infrastructure (R). Due to the extensive coverage of most ideal biking scenarios and the lack of need for reduced speed calculations for biking coverage, demographics were only calculated for existing biking service areas. Percentages were calculated by summing the total of clipped service area block data for each category and dividing by the total sum of the city data for each category.

Table 2 Percentage of studies categories overlapped by service areas. Percentages were calculated by dividing the number of each category within the Census blocks divided by the total of that category for the city.

<table>
<thead>
<tr>
<th>COVERAGE of SERVICE AREAS</th>
<th>% Population</th>
<th>%Minority</th>
<th>% Over 65</th>
<th>% Income Less than 20%AMI</th>
<th>% Under 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I  E  R</td>
<td>I  E  R</td>
<td>I  E  R</td>
<td>I  E  R</td>
<td>I  E  R</td>
</tr>
<tr>
<td>Major Grocery</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>W</td>
<td>40  13  10</td>
<td>27  8  7</td>
<td>46  15  12</td>
<td>40  14  11</td>
<td>47  16  13</td>
</tr>
<tr>
<td>B</td>
<td>--  50 --</td>
<td>--  53 --</td>
<td>--  55 --</td>
<td>--  55 --</td>
<td>--  60 --</td>
</tr>
<tr>
<td>Limited Grocery</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>37  21  16</td>
<td>27  15  11</td>
<td>42  24  19</td>
<td>37  22  16</td>
<td>45  26  20</td>
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<tr>
<td>B</td>
<td>--  48 --</td>
<td>--  53 --</td>
<td>--  52 --</td>
<td>--  54 --</td>
<td>--  58 --</td>
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<tr>
<td>All Parks</td>
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</tr>
<tr>
<td>W</td>
<td>71  57  44</td>
<td>78  67  53</td>
<td>66  49  36</td>
<td>73  57  43</td>
<td>69  55  40</td>
</tr>
<tr>
<td>B</td>
<td>--  78 --</td>
<td>--  85 --</td>
<td>--  76 --</td>
<td>--  82 --</td>
<td>--  76 --</td>
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<tr>
<td>Large Parks</td>
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</tr>
<tr>
<td>W</td>
<td>34  22  13</td>
<td>42  27  14</td>
<td>28  19  11</td>
<td>43  28  16</td>
<td>36  26  16</td>
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<td>B</td>
<td>--  47 --</td>
<td>--  48 --</td>
<td>--  38 --</td>
<td>--  49 --</td>
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<tr>
<td>Trails</td>
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<td></td>
</tr>
<tr>
<td>W</td>
<td>55  30  19</td>
<td>60  45  23</td>
<td>46  30  20</td>
<td>56  36  22</td>
<td>49  30  20</td>
</tr>
<tr>
<td>B</td>
<td>--  49 --</td>
<td>--  52 --</td>
<td>--  52 --</td>
<td>--  56 --</td>
<td>--  58 --</td>
</tr>
<tr>
<td>Convenience Stores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>87  72  60</td>
<td>92  75  51</td>
<td>85  66  52</td>
<td>91  76  60</td>
<td>86  82  54</td>
</tr>
<tr>
<td>B</td>
<td>--  89 --</td>
<td>--  91 --</td>
<td>--  87 --</td>
<td>--  89 --</td>
<td>--  86 --</td>
</tr>
<tr>
<td>Fast Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>72  63  52</td>
<td>66  54  44</td>
<td>66  55  43</td>
<td>76  67  55</td>
<td>67  56  45</td>
</tr>
<tr>
<td>B</td>
<td>--  78 --</td>
<td>--  69 --</td>
<td>--  75 --</td>
<td>--  78 --</td>
<td>--  76 --</td>
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<tr>
<td>MITS Stops</td>
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</tr>
<tr>
<td>W</td>
<td>92  76  62</td>
<td>96  83  66</td>
<td>90  69  56</td>
<td>94  80  64</td>
<td>91  75  60</td>
</tr>
<tr>
<td>B</td>
<td>--  83 --</td>
<td>--  89 --</td>
<td>--  79 --</td>
<td>--  83 --</td>
<td>--  81 --</td>
</tr>
<tr>
<td>Schools</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>70  55  41</td>
<td>78  67  49</td>
<td>71  53  37</td>
<td>67  52  37</td>
<td>67  52  38</td>
</tr>
<tr>
<td>B</td>
<td>--  79 --</td>
<td>--  86 --</td>
<td>--  80 --</td>
<td>--  78 --</td>
<td>--  78 --</td>
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<tr>
<td>Other Restaurants</td>
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</tr>
<tr>
<td>W</td>
<td>88  76  66</td>
<td>86  78  65</td>
<td>86  69  58</td>
<td>92  82  70</td>
<td>87  71  61</td>
</tr>
<tr>
<td>B</td>
<td>--  90 --</td>
<td>--  92 --</td>
<td>--  87 --</td>
<td>--  91 --</td>
<td>--  87 --</td>
</tr>
<tr>
<td>Non-Profit Food</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>W</td>
<td>19  16  11</td>
<td>32  30  20</td>
<td>18  14  9</td>
<td>26  22  15</td>
<td>25  21  15</td>
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<tr>
<td>B</td>
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<td>--  34 --</td>
<td>--  24 --</td>
<td>--  31 --</td>
<td>--  32 --</td>
</tr>
<tr>
<td>Specialty Food</td>
<td></td>
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</tr>
<tr>
<td>W</td>
<td>20  14  10</td>
<td>23  19  10</td>
<td>16  10  7</td>
<td>27  22  13</td>
<td>17  11  7</td>
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<td>B</td>
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<td>--  14 --</td>
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</tr>
</tbody>
</table>

In general, we can see from the results that many of the variables commonly cited as unhealthy have service areas that overlap a much larger portion of the overall population and specific categories
than many of the healthy variables (e.g. fast food locations versus major grocery stores). This would be due in part to the fact that there are more of the unhealthy resource locations to begin with than the healthy resources, and they are typically spread out through various economic corridors and neighborhoods. Fast food venues have 76 locations in Muncie, whereas major grocery only has 14 locations. Due to the vast differences in building footprints, fast food venues can also locate a lot of places that a major grocery retailer cannot, which typically build in greenfield sites and may even have fast food venues in outlots in front. So an understandable part of the discrepancy in coverage would be due to the spatial distribution and number of locations at a basic level.

What is also identifiable from this table is that the ideal network for walking and the actual, existing network for walking vary drastically in many cases. Major grocery declines by nearly 70% from one to the other, whereas nonprofit food resources decline 15% even while being a much smaller original service area at the start. Bike routes and low traffic lanes that make up the existing biking network return an average of 61% coverage, with some being as high as low 90s while others do not even break double digits.

Clearly, infrastructure improvements that make it safe and desirable to walk and bike around the city are important aspects of improving community health. As it stands right now, the most convenient places to walk to are likely fast food and/or convenience stores, and they are commonly cited as increasing health risks. The findings and specifics for each variable will be discussed in the following sections.

*Major Grocery*

As shown in the literature review, there are aspects of the food and physical activity environment that are consistently shown to affect the risk of obesity. Major grocery stores, a potential source for healthy foods, generally decrease the risk of obesity when easily accessible. In this study grocery stores include Meijer, Wal-Mart, Target, and Marsh. Figure 1A on the next page shows the existing network
coverage from grocery stores at a full speed, with **Figure 1B** showing the reduced speed networks to account for people with disabilities and the elderly.

The existing network of sidewalks and low traffic volume roads returns a drastically reduced 13% coverage for the total population at the average speed. For reduced speeds that take into consideration the elderly and people with disabilities, only 10% of the total population is covered by the service areas. In an ideal scenario, shown in **Figure 1C**, 40% of the population should be within a fifteen-minute or less walk of a grocery store. Moreover, none of the remaining demographics for existing walking coverage come to even 20% of the respective portion of the population being within fifteen-minutes of grocery stores.

Biking, existing conditions (**Figure 1D**) are potentially much better, putting 50% or greater of the general population and the individual categories within the service area. As mentioned before, an ideal
biking coverage where all streets and connections were safe for cyclists would result in a nearly full coverage of the city. For this reason, ideal bike network maps were omitted for many of the variables unless substantially different coverage occurred.

Unlike other variables, grocery stores typically take up a large amount of space with extensive parking and building footprints, so it would be unreasonable to think that the service area for walking would be very high, as they just may not be located in a downtown or more dense area where sidewalk connectivity would be higher. What is not unreasonable, however, is to say that the existing network and coverage could be improved. Specific results and recommendations will be discussed in the following chapter.

The density map in Figure 1E shows the results for major grocery. As there are so few locations,

Figure 1E shows the density map for major grocery locations in Muncie showing low (ight green) to high (tark green) density.
it is not as helpful to use a density map for the analysis of this type of variable. Few are located very close together, and the results are very similar to the network analysis, though far more generalized. However, even with the density map, it is clear that gaps exist in the downtown and in the middle part of the city. Many of the grocery variables are located somewhat near the city boundary.

**Limited Grocery**

Limited grocery includes things such as Family Dollar and Dollar General that may have grocery options but will typically include a smaller variety and predominantly processed foods with longer shelf-lives as opposed to fresh produce and meats that would be found at the larger stores. However, most of these stores do carry dairy products like milk and yogurt. They may also have healthy snacks such as applesauce, oatmeal, and protein bars. For these reasons, though not the most desirable source of food

*Figures 2A through 2D show the changes in network coverage for limited grocery*
compared to major grocery, these were included in the analysis. They may also be perceived as more affordable to some residents, and therefore their locations and coverage were important as well.

With the network analysis of limited grocery locations, we can determine that 21% of the entire population is within a 15-minute or less walking distance of the venues, as shown in **Figure 2A**. This changes over the other demographics to 15% for minority populations, 24% for people over 65 years of age, 22% for those with income less than 20% AMI, and is the highest at 26% for youth under 16 years of age. The ADA and elderly reduce speed coverage can be seen in **Figure 2B**. In an ideal scenario with all of the connections and safe passages being available, 37% of the total population should be within 15 minutes of a limited grocery venue with the current arrangement, as shown in **Figure 2C**.

For biking in **Figure 2D**, the existing network of safe biking routes and local streets results in 48% of the total population being covered in a 15-minute or less service area. The selected demographics

![Figure 2E](image)

**Figure 2E** shows the density results for limited grocery.
are actually higher, ranging from 52% (over 65 years old) to 58% (youth under 16 years old). The ideal network covers nearly all of the city.

From the results it can be determined that the southern portion of Muncie has far better access by bike and somewhat better access via walking to limited grocery stores, which is similar to the major grocery results. Following the lines of major grocery, the eastern and western portions of the city in the central part have very little, if any, access to limited grocery locations. This was also the case with major grocery, meaning that those residing in these areas have little to no access to either one via walking or biking.

The density map shown in Figure 2E is similar to the major grocery density map. Again, with so few locations density may not be as descriptive as a network analysis in determining accessibility, and the singular study of variable density may not be as beneficial as combining variables into larger categories like “healthy resources” and “unhealthy resources”.

Convenience Stores

Convenience stores, commonly seen as increasing the risk for obesity when nearby, include gas stations and mini-marts with food options. Food items will typically be lacking in nutrients but high in fat and sodium content as they are more grab-and-go meals and snacks (e.g. candy bars, hot dogs, pizza, etc.). Fresh produce options are typically limited at these locations.

Seventy-two percent of the total population of Muncie is within a fifteen minute or less walk to a convenience store. This number is somewhat consistent over the different demographic categories, ranging from a low of 66% in people over 65 years of age to a high 82% for youth under sixteen years of age. The existing service area network is shown in Figure 3A. When considering people with disabilities and the elderly, a reduced speed network still returns an average of approximately 57% coverage of each category, with all numbers being in a close range of nine percentage points or less. This reduced speed network is shown in Figure 3B. In the scenario that all sidewalks and pedestrian paths were in place, the coverage of the total population would increase to 87%. Minority populations would
be 92% covered by the service areas, and the lowest coverage would be 85% for elderly populations. These numbers are more than double the coverage for grocery locations, but again part of that is inherently attributed to the vastly different numbers of locations for the different variables. The existing biking network covers 89% of the total population, with the remaining demographics ranging from 86% of youth to 91% of minority population coverage. The ideal network is shown in Figure 3C, with the bike network in Figure 3D.

The density map, as shown in Figure 3E, shows much larger cluster of high density areas than previous maps of grocery venues. This underscores the fact that the number of locations changes the results of a variable dramatically. It can also be determined that certain intersections of the city may be

Figures 3A through 3B show the changes in network coverage for convenience stores
less passable for bikes and pedestrians due to the clustering of multiple variables, if such clustering occurs. On this map, it may be determined that McGalliard and Wheeling could be a troublesome intersection for multimodal traffic, but may also represent an area with multiple attractions. If this northern high density cluster matched with clusters of other variables, it may be telling of an area where a lot of people want to go. The greater variety, the more likely a person is to utilize that area for errands and enjoyment. There are stark differences, however, in the density and actual pedestrian and cyclist maps. This underlines the importance of utilizing realistic networks in studies such as this. The density map may lead someone to believe that there is far wider coverage and ease of access to a variable than there actually is in some cases.

With the extensive coverage of this variable to the population, it should not require immediate action to enhance the connectivity to these venues, but should underline the importance of increasing

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*Figure 3E* shows low (light red) to high (dark red) density of convenience stores.
access to healthy venues. When considering that the workforce often grabs quick snacks and/or meals throughout the day at work, convenience stores and fast food places are attractive options for a tight schedule. Some grocery stores are beginning to carry healthier options, with many communities encouraging it, and programming such as this could be feasible in a city like Muncie. Options and recommendations will be further discussed in the final chapter.

Restaurants

Restaurants were divided into fast food and other restaurants. Fast food was typically linked to greater obesity risks when easily accessible, whereas other sit-down style restaurants may offer healthier options and more balanced meals. There is less literature on restaurants outside of fast food, and

Figures 4A through 4t show the changes in network coverage for fast food.
therefore this category was not broken down any further. The inclusion of the variable came from the
goal to develop a comprehensive view of the city.

For fast food venues, the existing coverage was surprisingly less than that of convenience stores,
the other major culprit typically pointed to in obesity research. The total population covered by a 15-
minute service area was 63%, with the lowest demographic category being minority at 54% and the
highest of all categories being low-income populations with 67% coverage. The percent for reduced
speed networks was between ten and twelve points lower for all categories. The existing network is
shown in Figure 4A, with the reduced network in Figure 4B. If these networks were complete, the
coverage for fast food would increase to a high of 76% of low-income populations, 72% for the total
population, and 66-67% for the remaining categories. This network is shown in Figure 4C.

The bicycle network coverage was also lower than the convenience store service area, with a high
of 78% coverage for both the total population and low-income populations. A fully developed bicycle

Figure 4E shows low (light red) to high (dark red) density of fast food venues.
network would cover nearly all of the city within a fifteen minute bike ride of a fast food venue, as was the case for nearly all of the studied variables. The existing bike network is shown in Figure 4D.

A density map for fast food variables is shown in Figure 4E. The density rings stop just north of McGalliard due to no features being within a searchable distance past that point. However, it is clear that there are certain spots within the city where fast food clusters. Half of the clusters appear along McGalliard, with almost all appearing on the north side of the city. However, when this is compared to the actual networks in the previous images, the accessibility to these sites by anything other than car is drastically reduced.

This is another scenario where the primary goal should not necessarily be to directly enhance access to these variables, as their access already far outweighs the healthier options. What it should underline is the need to promote and prioritize projects for healthy resources. Fast food is inherently only as bad as the user makes it, but it is a very easy and convenient option. By increasing connections and ease of access to healthier resources, planning can help make those a little easier and more convenient as well.

As for remaining restaurants, the existing coverage ranges from 69% of elderly populations to a high of 82% for low-income populations (Figure 5A). Reduced speed numbers result in coverage of 58% in elderly populations and 61% of youth populations, with low-income staying above 70% coverage (Figure 5B). Sit-down restaurants and better quality quick food (e.g. Panera, Qdoba) have not had as much research devoted to them, and therefore it is difficult to say whether they specifically contribute to or help mitigate obesity. This analysis considers them fairly resource-neutral, as many may offer better quality meats and side options but also offer extremely large portions in many sit-down venues. However, with so many meals being consumed outside the home, this is an area that could be important to devote more research and resources.

Fully developed networks would result in every category being covered 86-92%. For existing biking networks, the lowest categories come in at 87%, with three being over 90%. Figure 5C shows the
existing bike coverage areas for restaurants in Muncie. The coverage of this particular variable is fairly extensive, and like some of the other variables may not require immediate action. However, a better connected sidewalk system could potentially benefit multiple variables, and in general would be a benefit to the entire city.

Figures 5A through 5D show the changes in network coverage for other restaurants.
Other Food Variables

Nonprofit food resources were included due to the effect of food disparities on low-income populations. Specialty food (farmers markets, butcher shops) were also included due to their availability of fresh goods. However, with significantly fewer locations than many of the other variables and limited spatial distribution, they should be viewed separately as opposed to direct comparisons to more extensive variables.

For nonprofit food resources, no locations appear above the White River. All locations are on the southwest side of the city. Immediately it can be determined that the accessibility from north of the White River will be miniscule, if any accessibility there exists at all. After running the service areas, only 16% of the total population is within the existing service area networks, with 22% of those with income

Figures 6A through 6D show the coverage changes for nonprofit food resources
less than 20% AMI being within the existing networks. The existing walking network is shown in Figure 6A. In the existing scenario, elderly populations show a 14% coverage, whereas that number drops to just 9% in the reduced speed scenario. Reduced speed for low-income populations drops to 15%, and the reduced speed map can be seen in Figure 6B. For comparison, the ideal walking service area is shown in Figure 6C. If an ideal scenario with the current locations would only reach 19% of the total population and just 26% of the low-income population studied here, it is clear that increasing these locations might be beneficial to the food security of some of the more vulnerable members of the community. Bicycling coverage for existing networks would double the coverage, increasing it to 31%, which can be seen in Figure 6D. The major difference is a larger southern extension onto the network, which potentially indicates a good location for another site to extend the walking scenarios. Additionally, increasing the connectivity of the existing sites would be a valuable improvement. Many of the locations, as seen in the maps, do not drastically reduce from ideal to the existing scenario, except for the location near the intersection of Hoyt and Memorial. Sidewalk connectivity improvements and pedestrian infrastructure would benefit this site and the existing coverage potential.

Figure 6E shows a density map of nonprofit food resources. Variables with fewer locations may not be represented as well by density maps as network analysis maps.
This is another variable where density studies are not as immediately beneficial to this type of direct analysis. The density map can be seen in Figure 6E. This type of study, however, could be beneficial for setting up broader indices that used statistics to compare a lot of variables.

The other food variable included, specialty food, includes venues like Minnetrista and Lahody Meats. It is important to keep in mind that these venues provide access to fresh, quality food and produce, but often come with seasonal restrictions in the case of farmers markets. Similar to nonprofit food resources, there were a very limited number of specialty food locations. Specialty food resources resulted in 14% coverage of the total population in existing network scenarios, shown in Figure 7A. The coverage for low-income populations was higher at 22%, with the coverage for elderly people being the

Figures 7A through 7D show the changes in network coverage for specialty food.
lowest at just 10%. The ADA and elderly-minded network coverage drops even more, as visible in Figure 7B. In ideal scenarios, the highest any variable covered was still just 27% for low-income, as shown in Figure 7C. Part of this again can be attributed to the small number of actual sites from the beginning, but multiple sites are located along major thoroughfares like Wheeling Avenue and do not have extensive sidewalk coverage on all approaching sides. That particular road does not have a shoulder and may not be perceived as safe for extensive pedestrian travel. Proximity to larger and more heavily traveled roads resulted in very low existing biking network coverage as well, ranging from a low of 8% in both age brackets to 14% in low-income. This network is shown in Figure 7D. Density maps for this variable were excluded as they follow the same pattern of many of the previous, in that they are not as beneficial to analysis with so few of locations.

With the biking networks also returning very low values, it can be assumed that infrastructure is a major current impediment to travel to these locations. Improvement to the surrounding infrastructure for this category would be beneficial to more than just the food environment. Though this category is small in number of venues, Minnetrista is a variable that plays multiple roles in this analysis. It is also a location where users can stroll through parks and gardens, and is a source of learning for healthy food habits and lifestyles. It is a cultural asset to the community, and a lack of alternative infrastructure around the site almost runs counter to the atmosphere and goals of the uses within the site.

*Parks and Trails*

Physical activity variables included parks by size, trails, and sidewalks. Parks were broken down into large and small parks, with the division being at 10 acres. This took into account large parks like Heekin, which has a variety of trails and activity areas, which could be better at reducing the risk for obesity than smaller ones with less to offer. The overall coverage from parks of all sizes in Muncie is well-developed. However, if that category is broken down and larger parks are separated, there is a clear gap in the northern parts of the city for large parks. Most parks in general are south of Centennial Avenue, with all of the large parks being south of that road. Size of parks can play an important role if
larger parks come with more facilities, activity areas, walking trails, and similar. Small, neighborhood parks are a great asset to communities but may not have as much space for jogging or cycling, for example.

The coverage for all parks versus large parks differs substantially. In the existing networks, the service areas around all parks resulted in 57% coverage for the total population, and a higher 67% coverage for minority populations. This network map can be seen in Figure 8A. However, when large parks are singled out, the coverage for existing networks drops sharply to 22% for the total population, and is just slightly highest for low-income populations at 28% coverage. This network map can be seen in Figure 8B. As noted above, there is a distinct lack of service for northern portions of the city when it comes to larger parks. Further analysis into the facilities offered by each park would be beneficial, but to some extent we can assume that smaller parks would lack facilities that require a lot of space.

*Figures 8A and 8B show the difference in existing walking coverage between all parks and just large parks.*
With the Cardinal Greenway being a prized project of the city, a northern park along the trail would not only increase the coverage of large parks, but could also enhance the connectivity of the parks system and promote added movement along the greenway. This could potentially create an activity corridor for cyclists and pedestrians. If activity on the trail increased substantially, the current caution signal on McGalliard could be replaced with a stop signal that could be activated by pedestrians and cyclists looking to cross the road. Increased pedestrian and cyclist activity could also promote increased pedestrian and cyclist infrastructure around the site, which could benefit other variables as well. To improve the study of parks, an inventory of facilities offered could be created. This would allow for a network coverage area to be ran from parks based on those that had no extra facilities versus those that

Figures 9A through 9D show the changes in coverage between the different networks.
had trails or basketball courts or similar. As noted in the literature review, what a park contains may be just as important as if the park is there in the first place.

As for the Cardinal Greenway and other trails in Muncie, existing coverage falls between that of all parks and large parks. Trails networks resulted in 30% coverage in the existing scenario for the entire population, with that percentage being the lowest and accounting for three variables (total population, elderly, and youth). The existing networks can be seen in Figure 9A. The highest coverage was 45% of minority populations. Minority population coverage was consistently higher for all physical activity variables. Ideally, as much as 60% of the minority population should be within 15 minutes of a trail, as shown in the ideal network coverage map in Figure 9B.

The ideal scenario would result in all categories being close to or above 50% coverage for the city, and can be seen in Figure 9C. This, partnered with even the existing coverage of all parks but preferably the ideal, is a highlight of the city. The biking connectivity can be seen in Figure 9D. Greenspace and activity areas already have a few anchors in the Cardinal Greenway and Minnetrista, which bring Muncie recognition and are prized components of the city. By increasing connectivity within

Figure 9E shows the density coverage of trails.
the parks and trail system, this would spillover as increasing coverage to other variables as well. This could be a great priority project for the city, as it is already further along than other variables such as grocery stores. Again, Minnetrista is centrally located and combines many healthy resources into one, which is an added bonus to increased connectivity to the site.

The density map for trails can be seen in Figure 9E above and it somewhat overestimates the portion of population that can actually reach the trails within fifteen minutes or less. This could be somewhat skewed, however, as some of the trails may have more access points than what are accounted for in this study. This could make the density map somewhat more accurate in the midrange and further out boundary. However, what we still see with the density map is that from a walking perspective, there still is not a considerable amount of coverage throughout the city. It is very limited. However, if this was combined with some of the park coverage in an overall recreation study, we would get much greater coverage. The connectivity between recreation features could be a beneficial aspect in developing more programs and events that get people coming to the sites. For instance, 5K runs or active events that are very popular currently could move between parks along and near the trail system.

*MITS*

MITS as a facility resource that can take people to healthy or unhealthy resources shows the most extensive coverage on the surface of any variable. However, if this were broken down by lines to see which had access to some of the healthy facilities like grocery stores, it may paint a significantly different picture. One issue is that there is not a circular MITS route that intersects the lines, which would allow for transfers and faster arrival than going all the way back to the downtown to get on a different line. This means that someone not living near the downtown or on a line that goes to a grocery store may have to get on a bus to the downtown, then transfer to another bus to go pick up groceries. This could potentially be time consuming, and may make easier options like grabbing quick food at a restaurant or smaller store with few fresh options a more attractive idea. The buses stop at many of the major grocery stores and are
a great resource for everyone in the community. Also worth noting is that MITS will pick up riders at any
intersection of the city, which could not be accounted for in this study but is important to keep in mind.

With that in mind, the coverage of MITS in its entirety is one of the highest of all the variables, with 76%
of the population covered in the fifteen minute walk buffer (Figure 10A). However, this would be increased
to an outstanding 92% in the ideal scenario, as shown in Figure 10B. For existing networks, minority
populations are even higher than the total population, with 83% being currently covered by a fifteen
minute walk to MITS stop. The lowest coverage for existing networks was elderly populations at 69%.
Elderly populations with the reduced speed network dropped even further to 56% (Figure 10C). The
existing biking networks resulted in somewhat less varied coverage, ranging from a low of 79%
coverage in elderly population to a high of 89% coverage in minority populations (Figure 10D).

Figures 10A through 10D show the changes in coverage for MITS bus stops by network.
With the fairly high coverage of MITS, it may be less critical to focus on the infrastructure to get to the stops, but perhaps more important to ensure that the routes can get people to important resources in a reasonable time. As mentioned before, a circulator route could be a valuable improvement to the system to connect the current lines and allow people to get to places within the city faster. This would merit more research and evaluation to determine its feasibility and potential contribution to the city in the form of time reductions or increased accessibility. The density map in Figure 10E shows that there are not many places where a lot of stops cluster, which could make getting between lines difficult outside of the downtown. Some crossing of routes or a circulator may be even more beneficial for this reason.

![Density map of MITS bus stop locations with major clusters in downtown and on McGalliard Road](image)

*Figure 10E shows the density of MITS bus stop locations with major clusters in the downtown and on McGalliard Road.*

**Schools**

Schools were included in this research as well, as many children may walk to school, and some schools may allow for the utilization of tracks or playgrounds for the public. Similarly, classes such as swim classes or others may be held at schools, or other workout facilities may be available such as Ball State University’s Rec Center. Also, Safe Routes to School programs encourage youth walking to school, and therefore it is pertinent to see what portions of the population presumably have the ability to do so.
The existing networks around all school facilities returned 55% coverage in a fifteen minute or less walking service area for the total population. Youth under the age of 16 were 52% covered within the walking buffer. The existing coverage map can be seen in Figure 11A and the ideal map in Figure 11B. The ideal coverage for the total population would be 70%, whereas an ideal scenario for youth with the current facilities would result in 67% coverage, and is shown in Figure 11C. Biking networks resulted in 78% coverage for youth and 79% coverage for the total population (Figure 11D).

With the potential need for the city to close schools, it becomes more important that the ones that are operational have well-developed sidewalk networks around them. Walking should not only be encouraged, but should also be safe. Improvements to this variable would likely be only infrastructure-related, as creating a new school is not necessary for the city. The results also indicate that a more in-
depth analysis may be required to determine if some schools have more access than others, which would help to determine where the most attention should be focused.

Summary

For this analysis, network analysis proved more effective and important than density analysis by providing realistic and more detailed networks. However, density was an interesting component of different variables in determining where clusters of variables exist. For variables with numerous facilities, the density component was better developed than those that had a small number of locations. Revealed in this analysis is the shortage of infrastructure for alternative transportation for many of the healthy resources especially, shown in the sometimes drastic reductions from ideal service areas to existing areas. The main advantage of network analysis is it allows for infrastructure comparison, which is not taken into account in density studies. This essentially predetermines that the majority of people will drive, and those that do not have the resources to do so will be limited by what is around them or what they can reach via MITS, which could be costly in time. Major thoroughfares throughout the city present a perceived and objective danger to pedestrians and cyclists, but there are ways to redesign roads to be safer for alternative forms of travel. Small improvements that build around a certain feature, like the Cardinal Greenway, and expand outward could be a potential way to phase projects while promoting and improving already popular features of the city. Also, analyzing the spatial distribution of locations will help to realize visual gaps in things such as large parks throughout the city.

For the existing pedestrian infrastructure, none of the highest three percentages were in directly healthy resources. MITS, non-fast food restaurants, and convenience stores had the highest existing coverage for total population, with fast food being fourth. The only directly healthy variable that would have made the top five is all parks, with just 57% coverage. This may indicate that it is important to prioritize projects and focus resources on increasing connections to, and in some cases the number of facilities, healthy resources such as grocery stores and parks. Recommendations for improvements and future studies, as well as general conclusions, will be discussed in the following chapter.
CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

RECOMMENDATIONS

It is in the best interest of a city to take a moment from time to time and analyze their infrastructure. By comparing ideal network coverage areas to existing network coverage areas, this research was able to determine that they vary widely and may be drastically reduced for some of the most critical variables to improved health and lifestyles. Not only can this help determine where coverage lacks for healthy and unhealthy resources, but it can also be an indication of where a city stands compared to its goals. If a city wants to move toward being a more bikeable place to live, but has little bicycle lane coverage and limited answers to major thoroughfares, research of this nature can show where work needs to be done.

General Recommendations

My recommendation for the city would be to utilize a study like this to identify areas of priority for future funding and projects. Prioritization of projects could be given to those that increase walkability near healthy resources such as parks, grocery stores, farmers markets, and similar. It does not mean that a sidewalk near a fast food venue would not get funded, as all increases in sidewalk connectivity are important to the overall walkability and health of the community. It would, however, encourage projects more that connect people with fresh goods and activity areas. When roads need to undergo construction, it makes sense to go ahead and add pedestrian and bicycle infrastructure at the same time. By increasing the connectivity of sidewalks and bike lanes, resulting coverage increases could bring the numbers much closer to the ideal. Also, many cities face restricted budgets and increasingly competitive grant applications, meaning that prioritizing projects is paramount to successful intervention and improvement.

Specific Recommendations: New Park Facility

Specific recommendations would include facility and infrastructure improvements. One major facility addition that should be a top priority would be the addition of a large park in some part of the
northern area of the city, with preference being given to close proximity locations to the Cardinal Greenway. To extend on this, a potentially beneficial phasing of projects could start with the Cardinal Greenway and expand outward to increase sidewalk connectivity around the trail. This would likely be simpler in neighborhood and residential areas, whereas it would be far more complex in the case of McGalliard. However, traffic studies could determine if a pedestrian signal that stopped traffic would be feasible for the site, with other options being medians with pedestrian refuge spots in the middle to reduce the number of lanes and variables a pedestrian or cyclist must account for in transit. It is important to look at all alternatives, as a great feature that is underutilized due to safety concerns represents missed opportunities for everyone and the city. Figure 12 shows a hypothetical park added to the network in the northern portion of the city along the Cardinal Greenway, which is shown in the trails marked by the dotted

**Figure 12** shows updated coverage areas for large parks, with a hypothetical north site added.
green line. The network of trails would make almost all large parks connected, and large park coverage would extend to the north of the city from just one addition to the network. This park would be close to one of the smaller parks, and could potentially be moved further north toward the airport. These network buffers were generated from the existing sidewalk network, meaning that extensive infrastructure improvements would not be taken into account. Sidewalk improvements would increase the network coverage even more.

Though roads like McGalliard would take extensive rehabilitation, it is not impossible to think that with proper planning and redesign, even those roads could be safe for pedestrian and cyclist movements. Bicyclists all over the world travel in much more heavily congested cities, and really just need the proper infrastructure to get going. Steps could be taken to improve this in the form of pedestrian infrastructure such as crosswalks with refuge medians and pedestrian/delayed signals. Refuge spots within medians allow pedestrians to cross major thoroughfares a few lanes at a time, reducing the risk of injury (FHWA, n.d.). Future development with access management, such as limiting the curb cuts and in turn the number of places a pedestrian has to acknowledge before crossing could add to the previously mentioned improvements as well. Infrastructure improvements would likely be the most realistic option for improvement for this scenario. Of course, as a major economic corridor this means that accessibility would also be increased to fast food venues and convenience stores on the street. The goal should not be to limit any one specific variable, but should be to provide a variety of options where people have the potential to make healthy decisions.

**Specific Recommendations: Major Grocery Options**

The most reasonable option for improving accessibility to grocery locations is increasing the sidewalk and safe bike route connectivity and safety. This has the potential to benefit other resources and improves quality of life in general by making the city as a whole more walkable. It is not, however, the only option. Courting and reaching an agreement with another grocery retailer to add new locations in the city could be another solution, but may be difficult if the demographics or site does not match what a
business is seeking. A downtown major grocery location seems reasonable at first glance due to a clear lack of coverage, but a look into the distribution of demographic density would reveal that it would not necessarily increase accessibility to many of the studied demographic categories. There is a small portion of people who live in the downtown, but the proximity of a downtown location to a MITS stop would increase the appeal and accessibility to others outside the downtown. In fact, the benefit to a grocery location in the downtown would be that all MITS lines come in to the downtown to transfer at the station. If a facility was available and interest could be sparked with a retailer, a location such as an abandoned school facility or similar would be beneficial to those utilizing the bus system, living, or working in and near the downtown, as shown in Figure 13. However, it still leaves considerable room for improvement with the existing grocery locations, and therefore infrastructure improvements are more important.

Figure 13 shows the updated grocery coverage areas with a hypothetical downtown location added.
Implementation

Some projects could potentially be funded within the current budget and with partnership with INDOT for road overhauls, for example. Roads with higher functional classification may be able to be worked in to projects that follow current state and federal initiatives to receive funding. Roads, alleys, sidewalks, and similar have some funding allocation already built in to the municipal budget, and having a system that prioritizes these systems allows for wiser and more targeted project spending that could benefit multiple initiatives. Resources are often tight in many communities, so prioritizing projects that would serve multiple end-goals is an imperative transition. A hypothetical example may be that Project A improves a road in a certain neighborhood but does not link to any other features, whereas Project B is in a different neighborhood and would increase access between Ball State and Minnetrista. Project B may be prioritized in the budget and schedule because it improves the road and connects major anchors of the city, as well as connects the neighborhood to a valuable healthy and cultural resource.

As mentioned before, as roads undergo construction in their natural life cycle it is possible to go ahead and add pedestrian infrastructure. Other counties in Indiana, however, have also had success creating mini-grant programs from larger grants won. Clinton County, as an example, received an ACHIEVE grant from the State of Indiana that allowed them to look into projects like Safe Routes to School and others that would improve the walkability of their community. Also, by using outreach programs to their local businesses, they encouraged many of their convenience stores and others to carry fresh produce. This started a series of initiatives that allowed Clinton County to move from 51st of 92 Indiana Counties for health outcomes to 34th in under 5 years (Dick, 2011). A similar scenario happened in Bloomington, Indiana.

Though the ACHIEVE grant is not still active, others like it may be available. With the right partnership with a college and professor, the research in this thesis could be used as support for a Robert Wood Johnson Foundation grant application, which could result in up to $100,000 for mini-grants or
other programs. The benefit to mini-grants is that they increase involvement by pulling in partners from schools and the community to get multiple projects going at once. One potential way to structure the program could be 25% of the final funds being used for college-partnered projects, 50% for infrastructure improvements, and the remaining as a flex category for other projects or costs. This type of delineation could be used for any grant, and if money granted to mini-programs required matching funds it would substantially increase the amount of money that could be pumped into the city. Another valuable option for smaller projects or seed money to attract larger grants would be the Ball Brothers Foundation. This could potentially be used to secure funding for a project or pilot program (e.g. pilot mini-grant or improvement program with healthy initiatives as its goal) that would help secure a larger grant.

CONCLUSION

In conclusion, planners cannot make decisions for people on where they eat or their activity levels. What planners can do is make sure that people have accessible and attractive resources that promote community health. Every time a person chooses to walk or bike instead of take a car, it is fewer carbon emissions and an improvement to their livelihood. People out walking and biking increases the chances for interaction between them, which can help build a sense of community. To get resident’s walking and biking more, it requires a cognitive decision and effort on the planner’s part to make sure that people have places to go and safe ways to get there. Through the use of GIS software, as demonstrated in this research, gaps in service area coverage can be quickly calculated and identified, ready to be integrated into future plans and improvements. The City of Muncie does not come out well in health rankings, and it will require substantial effort and partnerships to correct.

To build on this analysis, future studies focusing on the parks and trail system would be beneficial to see who is using the parks and their perception of them. If parks are available, but deemed unsafe to get to or to be in, it would drastically alter the actual accessibility. This research serves as a faster method to determine what people can actually reach, but only a survey can show what they actually want or feel able to walk to. Also, understanding what people are using and how often would help
determine what types of facilities should be prioritized in the future. Being able to determine what residents feel is missing could greatly alter what is offered in a new park, for example. A survey component to this research would strengthen and help all future decisions and prioritization of projects.

In this analysis, GIS was used to generate a fast comparison between where people should be able to reach versus what they can actually, safely reach. Immediately upon creation of the networks, some variables resulted in obvious gaps in coverage, as was the case with large parks missing in the northern portion of the city. This is one way to use the power of GIS to determine what a city is missing and to start generating ideas on where new locations or improvements should be implemented. Phasing of projects is the most reasonable approach to solving the gaps between the existing and ideal networks. Arguably, the best way to begin this is by building out from major facets of the city like the Cardinal Greenway and Minnetrista. Strengthening this research with an in-depth survey is recommended for the most optimal prioritization.

This type of research can be important to planners everywhere. This research can build the groundwork for community health plans and assessments, as well as provide research and backing for grants and programming. The best results stem from cities developing strong partnerships and creating cultures that thrive around activity. By making areas more walkable and increasing walking and biking networks to critical physical activity features, Muncie can also develop that type of culture more and start to move up the health rankings from its current position of 82.
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