Exploring Food Bank Deserts and Child Hunger in the Socioeconomic Contexts of K-12 Schools

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EXPLORING FOOD BANK DESERTS AND CHILD HUNGER IN THE
SOCIOECONOMIC CONTEXTS OF K-12 SCHOOLS

by

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Abstract

Food insecurity is of great concern in this country as more and more children, seniors, and families experience inadequate nutritious food to live healthy, productive lives. A case study of Mid-South Food Bank examines the concept of food bank deserts and looks at how children and families in low-income neighborhoods might have access to food. Previous definitions of food bank deserts have neglected to include two criteria present in food deserts, that is low-income and low accessibility to food resources.

Utilizing Geographic Information Systems (GIS), this paper will define, create, and analyze spatial connections between bus stops, food bank partner agencies, and Title I schools, my construct for low-income families. Specifically, I use the Proximity toolset in ArcGIS Pro 3.0 to operationalize the low-access and low-income standards across neighborhood schools in the contexts of food bank deserts.

Understanding the phenomenon of food bank deserts can be seen in terms of Robert Sampson’s (2012) focus on ecological differentiation, defined in terms of urban inequalities and clustering by social characteristics. His book Great American City demonstrates the powerful effects of ecologically concentrated disadvantage on a wide range of outcomes and social behavior in what became known as social area analysis. Sampson’s key dimensions of neighborhood difference include poverty, family structure and life cycle (female-headed households, child density), residential stability (home ownership and tenure), and racial/ethnic composition.

Assessing the work of Midsouth Food Bank and its partner agencies in three midsouth counties; Shelby County, TN; DeSoto County, MS; and Crittenden, AR; and using the criteria for a food bank desert: 1) high SNI index (low income) 2) no transportation, no accessibility to a
bus stop 3) outside 1.5-mile radius of Title I school; not within walking distance to a food bank partner agency, we find that, although, not all food bank partner agencies are located in high SNI, have accessibility to bus stops for students, and are within 1.5 mile walking distance from school to pantry, most pantries are strategically located to serve those in need. It is urgent to expand our children’s access to food in high-poverty areas, as we become more aware that children in some of our neighborhoods go without meals.
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Chapter 1
Introduction

Food insecurity, as defined by the United States Department of Agriculture (USDA), is a lack of consistent access to enough food for every person in a household to live an active, healthy life. This is due to the family’s economic situation and can be temporary or can last a long time. Currently, more than 34 million people in this country, including 9 million children experience food insecurity. Every community in the U.S. is home to families who face hunger (Feeding America, 2023).

There are some areas in the country where low-income families do not have access to nutritious food and USDA defines these areas as food deserts (USDA, 2023). Taking this concept one step further, some families do not have access to food through a food bank. There are 200 food banks in the U.S. that work through 61,000 partner agencies to provide food to families in need (Feeding America, 2023). If an individual lives in an area that is low-income, and has low access to food through a food bank partner agency, that person lives in a food bank desert, modeling this definition after USDA’s definition of food deserts.

Specifically, this study looks at the role food banks and food bank deserts play in high poverty neighborhoods. I measure food bank deserts in terms of Title I schools, which has never been studied before, and map them using GIS to analyze areas where access is needed in disadvantaged communities. It is vital to determine the role food banks play in the solution to food insecurity and a way to do that is examine where we find food bank deserts, in the context of high poverty schools, and assess how food banks might better serve those areas.

Of particular importance is food insecurity among children. While food insecurity in the country overall was 10.4% in 2021, for children it was 12.8%. The midsouth sees higher rates of food insecurity than some other parts of the country. For example, in 2021, Shelby County, TN
saw food insecurity for children under 18 at a rate of 21.7% and Crittenden County, AR at 26.8% (Feeding America, 2023). To this end, because Mid-South Food Bank, my study case, serves counties in Tennessee, Mississippi, and Arkansas, I have chosen Shelby County, TN, DeSoto County, MS, and Crittenden County, AR. These three counties are clustered together in the midsouth and have similar social and economic characteristic.

Children in school-age groups are more vulnerable to food insecurity because they are more prone to experience a variety of problems with their health and wellbeing. According to studies, children who lack access to food are more likely to experience poor health, iron deficiency, anxiety, depression, behavioral problems, psychological problems, and poor academic performance. Reducing or eliminating food insecurity is a pivotal predecessor to allowing children to reach their full academic and social potential (Snelling et al., 2014).

Children in high-poverty schools do not have consistent access to food based on where they live and where they go to school. There is a small but growing body of research on food bank deserts Waity (2016) and Walker et al. (2010), but none look at the empirical aspect of food bank deserts in relation to high-poverty schools. Defining food bank deserts in the contexts of schools, I examine areas that are high socioeconomic need index (SNI), using the 2020-2021 Common Core of Data, have no accessibility to bus stops, and are beyond a 1.5-mile distance (an acceptable walking distance) from a Title I school to a Mid-South Food Bank partner agency where children and their family could access food.

In schoolwide Title I schools, at least 40% of children are from low-income families; “Title I funds” support the demonstration of achievement levels through “schoolwide programs” that are designed to benefit “all students, particularly the lowest-achieving” (Virginia Department of Education, 2020). The majority of the Title I schools in the three target counties
in this study, Shelby County, TN; DeSoto County, MS; and Crittenden County, AR, are in high SNI census tracts.

I will define, create, and analyze spatial connections between bus stops, food bank partner agencies, and Title I schools utilizing Geographic Information Systems (GIS). Specifically, I use the Proximity toolset in ArcGIS Pro 3.0 to operationalize the low-access and low-income standards across neighborhood schools in the contexts of food bank deserts. It is urgent to expand our children’s access to food in high-poverty areas, as more people become aware that children in some of our neighborhoods go without meals.

There is a difference between food deserts and food bank deserts. USDA defines food deserts as low-income census tracts with a large number of residents with low levels of access to grocery stores and other retail outlets that sell healthy and affordable foods. Census tracts qualify as food deserts if they meet low-income and low-access thresholds: 1) Low-income: a poverty rate of 20% or greater, or a median family income at or below 80% of the statewide or metropolitan area median family income; 2) Low-access: at least 500 persons and/or at least 33% of the population lives more than 1 mile from a supermarket or large grocery store (10 miles for rural census tracts) (USDA, 2023).

Food bank desert, on the other hand, is a concept first developed by Waity (2016) using spatial analysis and food assistance. She noted areas where “the population center of a census block group is more than one mile from a food assistance agency” (Waity 2016: p 112), were food assistance deserts. I use the term “food bank deserts” to describe these regions, as food assistance agencies providing food assistance collaborate with local food banks. Food banks are 501(c)3s, nonprofit organizations that partner with Feeding America, the nation’s largest
domestic hunger-relief organization, and provide food to people facing hunger in the United States (Feeding America, 2023). Lastly, food banks and their partner agencies are a way for individuals and families to access food at no charge. A low-income family may live in an area that is not considered a food desert, by USDA standards, but if their family budget is stretched so much that they cannot purchase nutritious food, they depend on food banks and their agencies, at least for a portion of their meals.

Emergence of the issue of Food Insecurity among children

The first national assessment to measure food insecurity in the U.S. was completed in 1995 by the Census Bureau. In 1995, 17.4% of families with children were food insecure. Additionally, in 1999 that number decreased to 14.8% but rose to 16.1% in 2001. In 2007, 15.8% of households with children reported being food insecure (Kursmark & Weitzman, 2009). These percentages measure both the adults and children in the home and the combined food insecurity rate.

Food insecure children are those children living in food-insecure households, as measured by USDA. This reflects the household’s need to decide between paying for critical basic needs, including mortgage or rent, utilities, medical bills, or purchasing nutritious food for all in the household. Prior research confirms that children face higher food insecurity rates than adults (Amezquita & George, 2020). The chart below shows how our child hunger rates (measuring the food insecurity of the children in the household per USDA’s food security survey module) have increased and decreased over time (Coleman-Jensen et al., 2020):
Note the high child hunger rate right after the economic crash of 2008. Also, 2021 rates have gone down, most likely to the additional food USDA and other governmental agencies put into households during the COVID pandemic.

**Background of the study**

The American Institute of Nutrition refined the following definitions of food insecurity and hunger: Food insecurity is limited or uncertain availability of nutritious and safe food or the ability to acquire foods in socially acceptable ways. Hunger is the troubled or painful sensation caused by not having food (Cook & Frank, 2008). The United States Department of Agriculture (USDA) conducts an 18-question survey every year to collect data on food insecurity and hunger within our country’s population. Eight questions concern child food insecurity (Nord et al., 2007). Food insecurity and hunger specifically relate to limited household resources and poverty. The official poverty threshold for a family of four, two adults and two children, was $20,444 in 2006 (Cook & Frank, 2008). By 2019, the threshold had increased 26% to $25,750 (U.S. Department of Health & Human Services, n.d.). If a family’s combined income is less than the
family’s threshold, everyone in the household with income below this level would be considered living in poverty (Cook & Frank, 2008).

In 2005, 37 million people, or 12.6%, in the U.S. lived below the poverty threshold, with 35 million people food insecure, and 12.4 million of those were children under 18 years old (Cook & Frank, 2008). The highest level of food insufficiency in this country since 1998, when recording began, was in 2011, when the rate was 14.9%. Recent years have seen lower rates of food insecurity in the U.S. That is, in 2018, the food insecurity rate was 11.1%, and in 2019, the rate was 10.5% (Coleman-Jensen et al., 2020). As with poverty, those most at risk of food insecurity are African Americans, Latinos, households with children under six years old, and homes run by single mothers (Cook & Frank, 2008). Lastly, living in poverty is a substantial risk factor for food insecurity (Fernald & Gosliner, 2019), and children with minority status and low family income are more likely to suffer poor academic and development outcomes (Duncan et al., 2010; Finigan et al., 2015; Sektnan et al., 2010).

Poverty has a substantial relationship with child hunger yet affects children in other ways. Children living in poverty complete two fewer years of school, are less likely to be white, are less likely to have been born in an intact family, are more likely to live in the South, have mothers who are younger, and have more siblings in the household (Duncan et al., 2010). Additionally, children in poverty have limited access to adequate healthcare (Duncan et al., 2010; Finigan-Carr et al., 2015) and fewer educational opportunities (Duncan et al., 2010; Finigan-Carr et al., 2015; McIntyre et al., 2017; Sektnan et al., 2010).

However, many individuals and families struggle with food insecurity but are not labeled as living in poverty. They may have income just above the poverty threshold but struggle to buy food, pay for housing and utilities, as well as healthcare and medicine (Amezquita & George,
Other research confirms that growing up poor often means unmet financial needs and experiencing food insecurity (Proffitt et al., 2020).

Living in poverty is detrimental to children’s growth, health, and future development (Spies et al., 2014). Additional prior research shows that growing up in low-income families or neighborhoods increases the risk of disparities in behavioral, cognitive, social, physical health outcomes and school readiness for children of all ages (McConnel et al., 2012; Maggi et al., 2010; Sampson et al., 1995). In 2011, 15% of U.S. residents lived in poverty, and 22% of our children less than 18 were living in poverty (Spies et al., 2014). In 2017, more than 1 in 6 children, 17.5%, younger than 18 years old, lived in poverty, less than in 2011, but still high numbers. Again, African American children and Hispanics were at more significant risk of living in poverty at 29% and 25%, respectively (Fernald & Gosliner, 2019).

Statement of the Problem

Too many of our children are going without the adequate nutritious food they need to live healthy, productive lives, and poverty is the likely driving force behind hunger. One cannot discuss food insecurity for children without addressing poverty, as many of those food insecure are poor. Prior research shows that income poverty significantly correlates with food insecurity (Cook & Frank, 2008).

Children in high-poverty schools do not have consistent access to healthy food based on where they live and where they go to school. This study leverages ecological systems, food systems, and GIS mapping to examine the connections between low-income neighborhoods and schools, and children having access to consistent, nutritious food through food bank partner agencies. Additionally, this work explores food bank deserts, and where these areas are located to consider where food is needed to better serve students experiencing food insecurity.
There is very little research on the impact of food banks and food bank deserts, although food banks serve every county in the U.S. There are almost no studies on the impact food bank deserts have on the lack of access to food for our communities in these low income, low-access areas. This research will add knowledge to this field.

**Research Questions**

This study is guided by two primary research questions:

1. How should we conceptualize and measure food bank deserts?

2. Which sites in the Mid-South are potential locations of food bank deserts in relation to the socio-demographic characteristics of neighborhoods of Title I schools?

The aim is to observe the general pattern of neighborhood characteristics served by the Mid-South Food Bank and its partner agencies and determine the scope of the spatial proximity to high-poverty schools and food deserts and food bank deserts. The first question seeks to frame the characteristics of food bank deserts. The second question seeks to empirically measure the spatial relationship between high poverty schools and Mid-South Food Bank and its partner agencies and determine which sites are potential deserts. Together, these questions have implications for better allocation of resources to resolve hunger, food insecurity, and lack of access to healthy food for disadvantaged communities. An argument can be made that spatial proximity/clustering of food banks and their agencies to Title I schools will induce efficiency in their service areas and capture their target population more efficiently.

**Significance of the study**

Any efforts to address community food security access in these contexts must demonstrate that local food bank programs (nonprofits) are spatially close to ingrained pockets
of disadvantage because schools are frequently the primary food source for students in impoverished regions. My research focuses on a case study of regional food bank initiatives the Mid-South Food Bank operates in the Deep South. The Mid-South Food Bank is a desirable organization for various intervention activities due to significant philanthropic and governmental backing to assist in providing meals to impoverished communities. To decide if these organizations can be a part of long-term arrangements that aim to solve issues of food availability, it is crucial to understand where local food bank programs are located and how to foster the development of local responses. On the other hand, lack of strong spatial pattern between food bank providers that fight hunger and neighborhood disadvantage may ultimately compromise the effectiveness of nonprofits to navigate the food environments in areas deeply entrenched in poverty. To investigate the geographical relationships (or lack thereof) between differences in neighborhood socioeconomic features and the locations of the Mid-South Food Bank programs, I leverage the concept of food bank deserts.

Students who are healthy and prosperous contribute to the development of strong communities. Investing in the health of students helps strengthen the future health of communities. Providing students with access to proper nutrition significantly impacts their academic performance, as every child deserves the opportunity to live a healthy and productive life (Centers for Disease Control and Prevention, 2014).

Limitations and delimitations of the study

It is worth noting that this analysis contains areas of high poverty with little access to nutritious food within the Mid-South region. Although the geographic area covered includes urban, rural, and suburban areas, further information in different parts of the country is required
to fully understand the causes and effects of child hunger, food availability in high-poverty areas, and student education consequences.

Different food banks have various programs aimed at tackling child hunger. For example, All Faiths Food Bank in Sarasota, FL, where 1 in 4 children are food insecure, runs a robust child feeding program. When school is out and students lose access to free and reduced meals, this food bank steps in and provides food to more than 34,000 students and siblings yearly (All Faiths Food Bank, 2023). This study is not an exhaustive study of all child hunger programs around the country, and a survey of a larger geographic scale, including those efforts, would enhance this research.

Additionally, some of the data used in this research is from the 2020-2021 Common Core of Data (CCD) preliminary files. Because of COVID, these data might not be considered typical, and because this study will not produce results comparing pre-COVID, during COVID, and post-COVID data, there are limitations regarding changes in the food bank desert landscapes. However, further research will follow this project, conducting and completing a comparison analysis.

Finally, there are limitations of using Title I measures currently as they may not be a good representation of food insecurity at the school level. More research would be completed to look at child hunger at a school and zip code level.

Organization of this study

This study is organized to systematically address my research questions, and the chapters are sequenced and constructed to reflect the organization of this study. The study's structure will be developed over the course of five chapters. The introduction is found in the first chapter. The beginning of Chapter One presents food insecurity in general and describes the emergence of the
research problem along with the background of child food insecurity and how poverty plays a role. An understanding of the qualifications of child hunger and students’ access to nutritious food develops a discerning of general patterns in high poverty schools and neighborhoods that lack consistent access to food. A brief introduction regarding food deserts and food bank deserts is explained. The research challenge and earlier studies that are comparable to the study's research are also identified in chapter one. Along with the research questions that form the basis of this study, the goal and significance of the study are explained. Lastly, the study's boundaries, restrictions, and scope are specified.

Chapter Two is the literature review section of the study. Published literature related to food insecurity, along with food systems scholarship in general and food systems scholarship in the context of K-12 are discussed. Additionally, an overview of food deserts and food deserts in the socioeconomic context of K-12 are examined. Food bank deserts, their measurement of the ecology of food and their relationships to schools is reviewed. Next, a robust discussion of GIS spatial analysis and how this method is used to examine food deserts, food bank deserts, and food environments. The theoretical framework used includes ecological systems broadly and ecological differentiation, more specifically, as defined in terms of urban inequalities and clustering by social characteristics in Robert Sampson’s (2012) book, *Great American City*. Concluding the literature review and continuing to set the context and background of this research is the application to education.

The methods and criteria used to conduct this research are covered in Chapter Three. The problem and the research questions provided in Chapter One are thoroughly examined, and the theories used in the study are also described. This study utilizes data from the 2020-2021 Common Core of Data, Mid-South Food Bank’s partner agencies geocoded locations, Title I
public schools, transportation data from MATA route shapefiles, and social and economic data from the 2016-2020 American Community Survey. The instrument used for quantitative data analysis is geographic spatial analysis with GIS. This GIS framework is used to collect, organize, and analyze the data.

In Chapter Four of this study, my results and maps of food bank deserts in the Mid-South will be presented. This chapter will offer the solutions to my research queries and elaborate on the plan presented in Chapter Two. This chapter will also clarify my study's stated objectives, which were presented in Chapter one, and show why they are important. Finally, a summary of the findings will be presented and will connect to the literature review and conceptual framework.

The final chapter, Chapter Five, will discuss the conclusions of the research results. Lastly, recommendations for further research will conclude this study.
Chapter 2

Literature Review

There is substantial research on food insecurity, child hunger, food systems, and food deserts. The majority of published works include details of food insecurity for families and specifically children, poverty and its role in hunger, and food deserts. While these previous studies offer valuable insight into food insecurity, particularly concerning children, they provide only a partial snapshot of the problem.

This study presents a thematic literature review organized by topic, covering a wide spectrum of food insecurity, food systems, food deserts, and food bank deserts. The prior research on these topics will help establish why the issues covered are essential, place my research in the theoretical context of ecological systems and ecological differentiation, and identify the new problem of spatial proximity and spatial significance of high-poverty schools and students’ access to nutritious food from hunger relief agencies.

Purpose

This literature review aims to present an overview and the relevance of the existing literature to the research questions being asked in Chapter One of this study.

Food insecurity

Food insufficiency is defined as an inadequate amount of food intake due to a lack of money or resources. Those struggling with food insufficiency, or food insecurity, report that they sometimes or often do not have enough food to eat (Alaimo et al., 2001). Slopen et al. (2010) parallel this denotation that food insecurity is limited or uncertain availability of food due to inadequate resources and is one of the difficulties associated with poverty. Additionally, food
insecurity is twice as likely to be experienced by households with children compared to homes with adults only.

United States Department of Agriculture (USDA) utilizes a Core Food Security Module, consisting of 18 questions, to measure food insecurity in the household. USDA routinely conducts these surveys to determine how many households report being food insecure. They also utilize a child food security scale (Fram et al., 2011; Johnson & Markowitz, 2017; Kursmark & Weitzman, 2009). For example, in 1995, when the food security scale was first used, 17.4% of US households reported being food insecure, while in 2001, 16.1% reported food insecurity in their household (Kursmark & Weitzman, 2009).

Economic factors such as insufficient income, limited wealth, excessive debt, and high living expenses frequently contribute to a family's food insecurity. However, psychosocial factors, such as maternal mental and physical health, domestic violence, parental cooking and financial skills, parental education level, and familial social networks, contribute to food insecurity (Bauer et al., 2012). Food insecurity increases a family's likelihood of being food insecure when they lack access to food in their community. In 2009, 21.3 percent of US households with children experienced food insecurity in the preceding year on a national level (Bauer et al., 2012).

Food insecurity harms children's physical, social, and emotional health (Bauer et al., 2012; Ramirez, 2013; Barnidge et al., 2017). In comparison to food-secure children, children who experience food insecurity are less likely to consume a diet that meets recommended nutritional guidelines; they are also more likely to suffer from chronic illnesses, acute illness, psychosocial problems, and psychiatric distress, and have lower academic performance (Bauer et al., 2012).
Economic factors such as insufficient income, limited wealth, excessive debt, and high living expenses frequently contribute to a family's food insecurity. Psychosocial factors, however, such as maternal mental and physical health, domestic violence, parental cooking and financial skills, parental education level, and familial social networks, all contribute to food insecurity (Bauer et al., 2012).

Currently, 34 million people in the United States are food insecure, including 9 million children. In 2021, 53 million people turned to food programs, with the pandemic increasing food insecurity among families with children, as many of those do not qualify for federal nutrition programs (Feeding America, 2023).

**Food Systems scholarship**

The production, processing, distribution, preparation, and consumption of food, as well as the results of these activities, such as socioeconomic and environmental outcomes, are all included in the food system. Additionally, these elements include people, the environment, inputs, processes, infrastructures, and institutions (Hawkes & Ruel, 2011).

Two core constituent elements of food systems are the food supply chain and food environments. The production, storage, distribution, processing, packaging, retailing, and marketing processes that transfer food from production to consumption are all included in the food supply chain. Any level of this chain's many actors' decisions will have an effect on subsequent stages. They have an impact on the kinds of food that are accessible and available, as well as how they are produced and eaten (HLPE, 2017).

The physical, economic, political, and sociocultural framework in which consumers interact with the food system to purchase, prepare, and consume food is referred to as the "food environment." The "food entry points," or physical locations where food is purchased, the built
environment that enables consumers to access these locations, personal factors (such as income, education, values, and skills), as well as the political, social, and cultural norms that underlie these interactions, all make up the food environment. Physical and financial access to food (proximity and cost); food promotion, advertising, and information; and food quality and safety are the main components of the food environment that affect food choices, food acceptability, and diets (HLPE, 2017, p. 11).

Social, economic, and environmental injustice are characteristics of the current global food systems problem. Present-day land appropriation and exploitation, greenhouse gas emissions, ecological degradation (such as loss of topsoil and forest cover), and species extinction are all significant factors in the dominant capitalist food system. These factors, in turn, contribute to the climate crisis and the enlargement of power disparities on a global scale (Holt-Giménez, 2017).

More than 821 million people worldwide lack access to enough food to eat, and many more suffer from diseases linked to diet. Food systems that generate enough food to feed the world yet see a rise in the number of hungry people are also a reflection of the rising rates of inequality in the world. Farmers, fishermen, and employees throughout the food chain are among those who are most likely to experience hunger today. The COVID-19 pandemic in 2020 has made these problems more evident and severe (Hammelman et al., 2020).

As food banks seek equitable distributions of food through their partner agencies, that distribution begins with equitable access to food through food systems. To envision social futures, radical geography studies seek to explore relationships of power, exploitation, and oppression. Geographers have been looking more closely at the scalar, sociopolitical, and ecological dynamics of food systems in tandem with these changes. Hammelman et al. (2020)
suggest a radical food geography praxis that synthesizes critical components to improve the equity and sustainability of food systems in theory and practice. Praxis describes the dynamic relationships between theory and practice, critical reflection, and behaviors from such relationships. Along with radical geographies and food systems scholarship, a radical food geography praxis blends a notion of teaching informed by radical pedagogical techniques and exposing structural inequalities (Hammelman et al., 2020).

Three interrelated components comprise the radical food geography praxis that these researchers propose: (1) Theoretical engagement with oppressive power and structures inside and outside of the academy. By highlighting unequal power relations in daily-experienced place-based food projects, networks, and global food systems, it builds on the foundations of radical geographies and food systems study. (2) Action through partnerships between academia, social movements, and civil society. Through a focus on space and spatiality, engagements with social movements and social change, and a value placed on various ways of knowing and being in the world, it connects with radical geographies. (3) Examination of food systems through a broadly construed geographic lens. This format highlights the function of place and place-based networks in creating food systems and interactions with food as well as in fighting against inequalities in those systems (Hammelman et al., 2020).

**Food Systems scholarship in K-12**

Government organizations, civil society organizations, and significant agri-food firms concerned with what and how children are fed have affected the political debate surrounding school lunch (Gaddis & Coplen, 2018). Social aspects of school lunches impact social justice, economic growth, and ecological sustainability (Robert & Weaver-Hightower, 2011).
Food insecurity is limited or uncertain availability of food due to inadequate resources and is one of the difficulties associated with poverty. Food insecurity is twice as likely for households with children compared to homes without (Slopen et al., 2010). By providing free or significantly subsidized school lunches, the government and civil society organizations have intervened to mediate this situation (Gaddis & Coplen, 2018).

In the United States, we have the National School Lunch Program (NSLP), which was created by Congress and continues to be amended to improve child nutrition and health and support the agricultural economy (Billings & Aussenberg, 2019). The NSLP originated from the National School Lunch Act of 1946 (Hinman, 2011; Hirschman & Chriqui, 2012; Gurley, 2016), now known as the Richard B. Russell National School Lunch Act, (Billings & Aussenberg, 2017; Tonti, 2017), and is one of the most comprehensive food and nutrition assistance programs for children ages 5 to 18 in the country. It operates in public schools, nonprofit private schools, as well as child care organizations. Additionally, these programs utilize commodities from the United States Department of Agriculture (USDA) (Hinman, 2011).

NSLP costs about $11.6 billion annually and provides free or reduced-price meals to more than 31 million students. The federal government reimburses sponsors for each meal served, and this reimbursement rate is reviewed, and adjusted, if needed, every year on July 1 (Ghosh & Senauer, 2009). Sponsors can also utilize federal commodity products as a portion of their funding (Peterson, 2009). Prior research shows that NSLP participation is related to greater access to adequate food among children who are school-age, and this program reduces food insecurity by almost 14% (Huang & Barnidge, 2015). Additionally, this program is critical to child health and well-being (Au et al., 2020).
Students who live in households that receive Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance to Needy Families (TANF), or Food Distribution Program on Indian Reservations (FDPIR) benefits are categorically eligible for free lunches. Given the critical role of nutrition in students' healthy development, particularly those from low-income households, access to and participation in the school lunch program are crucial policy and research considerations (Kim & Joo, 2020).

Most students who receive free or reduced-price school meals are Black or Latino students from lower socioeconomic classes. Given the vast scope of school-meal programs that serve such a large number of dependent students, the food served to them must be of the highest quality and nutritional value (Tonti, 2017). Additionally, participation in the NSLP is associated with a six-point reduction in low food security and significant improvements in overall health and weight (Huang & Barnidge, 2015).

**Food deserts**

The American Institute of Nutrition refined the following definitions of food insecurity and hunger: Food insecurity is the inability to obtain food in socially acceptable ways or the limited or uncertain supply of nutritional and safe meals (Cook & Frank, 2008). Swafford et al. (2021) noted, too, that food insecurity means a lack of food quantity and not having access to nutritious food. Hunger is the troubled or painful sensation caused by not having food (Cook & Frank, 2008). The United States Department of Agriculture (USDA) conducts an 18-question survey every year, beginning in 1995, to collect data on food insecurity and hunger within our country’s population. Eight questions concern child food insecurity (Nord et al., 2007). Additionally, to determine if a person has access to enough food to lead a healthy life, the USDA
measures food insecurity. Many factors influence food security numbers in our communities. These include lack of money and transportation, as well as poor health (Lloyd, 2019).

Food insecurity and hunger specifically relate to limited household resources and poverty. In 2006, a family of four with two adults and two children was considered below the official poverty line at $20,444. (Cook & Frank, 2008). By 2019, the threshold had increased 26% to $25,750 (US Department of Health & Human Services, n.d.). If a family’s combined income is less than the family’s threshold, everyone in the household with income below this level would be considered living in poverty (Cook & Frank, 2008).

To fully understand food insecurity, one must first examine the concept of food deserts. The phrase "food desert" was initially used in Scotland in the early 1990s to characterize communities where citizens lacked consistent access to wholesome, affordable food (Cummins & Macintyre, 2002; Wright et al., 2016). Additionally, it first appeared in a government paper from a policy working group of the Conservative administration’s Low-Income Project Team of the Nutrition Task Force in 1995 (Cummins & Macintyre, 2002). These areas tend to be low-income or minority neighborhoods, and access to food is limited to gas stations and fast-food restaurants, which have fewer healthy options (Wright et al., 2016).

The 2008 Farm Bill, the first of which was enacted in 1933 in response to the difficulties farmers encountered during the Great Depression and depressed commodity prices caused by a crop excess Blauser (2011), included language that defined a food desert as an “area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower-income neighborhoods and communities” (Waity, 2016, p. 108). Wider-Lewis et al. (2018) expand the concept of a food desert to include when grocery
stores, supermarkets, or farmer's markets are far away and there is a lack of fresh fruits and vegetables.

Bitler et al. (2010) investigated the economics of food deserts to better understand the empirical literature on the topic and determine whether any progress had been achieved in determining whether food deserts are a problem in this country. After defining what a food product is, what a food desert is, and accessing the availability of food products, this literature then examines the supply and demand of economic theory. Given that eating well is a normal good, the demand for this wholesome choice will rise as consumers' incomes rise,

The researchers conclude whether food deserts exist and why based on their analysis:

(1) Food desert detection requires various data that may not be available from current data sources. Researchers have advanced their understanding of data challenges by carefully evaluating the information that may be gleaned from various sources. The results also suggest that the publicly available national-level data contain serious faults because many of the sources and kinds of nutritious food that are actually consumed are missing. (Bitler & Haider, 2010).

(2) The absoluteness or relativity of the concept of interest in food deserts should be expressly considered. Many academics utilize relative measurements as their definitions of food deserts. These definitions might be sufficient for their research objectives, but policymakers will likely be most interested in an absolute understanding of a food desert. (Bitler & Haider, 2010).

(3) Geographical areas are frequently considered the relevant market in food desert studies. Therefore, it is improbable that any definition will be consistently correct for various individuals throughout regions or even within regions. The relevant geographic area might be less for those with limited mobility than for others. Researchers have assessed how different definitions of the
relevant geographic area affect outcomes, but have not yet found the most efficient metric. (Bitler & Haider, 2010).

(4) Depending on whether a source of nutritious food is a replacement or a supplement to other important sources, examining geographic variance in that source may or may not reveal real food deserts. Additionally, much research indicates that food sources are frequently interchangeable, suggesting that studies that only consider one food source (such as supermarkets) give an inaccurate picture of food deserts (Bitler & Haider, 2010).

(5) Price monitoring should be a regular practice in food desert studies. Based on the data, there is little evidence that people in poverty usually pay more for food (Bitler & Haider, 2010).

(6) Designing effective public policy requires understanding the causes of food deserts, particularly in terms of supply factors, demand factors, or potential market failures. More information and even more advanced econometric techniques may be needed to understand why food deserts develop (Bitler & Haider, 2010).

(7) Progress has yet to be achieved in researching the causes of food deserts in the literature (Bitler & Haider, 2010).

Understanding what a food desert is, Dahle (2021) argues that food deserts are a byproduct of racialized housing segregation, and they continue to worsen racial and health disparities. This researcher also looks at the influence of food and the effects of residing in food deserts around the nation. The Fair Housing Act started reform, but could not repair what had already happened, according to the literature, which also states that zoning and redlining are the causes of food deserts. The author concludes by discussing what has been done at the federal and
state levels as well as plans to address food deserts, stressing that eliminating them requires cooperation between the government and local communities. (Dahle, 2021).

Wright et al. (2016) examine the food desert theory and note that low-income individuals frequently consume unhealthy diets because fresh, clean food is difficult to find close to where they live. This literature examines data on critical components of this theory across various disciplines and finds it needs improvement.

There are numerous explanations for why food deserts started to appear in the US. One viewpoint holds that big-box supermarket chains have driven away independent neighborhood grocers. These mega-supermarkets, however, are only available to those with transportation. Another idea holds that during the 1960s to the 1980s, as more affluent individuals moved to the suburbs, inner-city districts saw a decline in median income, which contributed to the growth of food deserts. This flight resulted in half of the supermarkets closing in the urban areas. Additionally, according to various studies, there were five times as many food stores in census tracts with white residents as in black communities. (Wright et al., 2016).

Early research on food deserts included only urban areas. Wider-Lewis et al. (2018) examined the connection between food insecurity and food deserts in a Jacksonville, Florida, urban area. According to this study, long-term health issues with heart disease and diabetes are partly caused by food poverty. The researchers found that food deserts exist in low-income neighborhoods where there are limited grocery stores. They resulted from the country-wide trend of decline in urban areas and rise in populations of suburban areas, leading to a lack of grocery stores in leftover poor communities (Wider-Lewis et al., 2018).

Limited transportation and limited food budgets are challenges in these food deserts.
Finally, in this metropolitan Jacksonville community, the study revealed no link between food insecurity and food deserts; instead, food access was more closely associated with store type than with the number of stores in the area. (Wider-Lewis et al., 2018).

As noted earlier, food deserts were previously defined only as urban areas where individuals and families lack access to reasonably priced, nutritious food. More recently, however, this definition has expanded to include rural areas as well. Alviola et al. (2013) examined rural and urban food deserts in Arkansas, a state with the worst health outcomes, to identify the sociodemographic and economic determinants of food desert areas. Grocery store access is examined, including the density of gas stations and fast-food restaurants in these food deserts, as the latter usually have fewer healthy food options available (Alviola et al., 2013).

This study revealed no conclusive proof that access to grocery stores was lessened in metropolitan areas with higher minority populations or lower median earnings. Yet, there was evidence that, in metropolitan settings, communities with a higher percentage of minority residents faced higher densities of fast-food and convenience stores that typically offered fewer healthful food alternatives, which may harm those people's diet quality (Alviola et al., 2013).

Not having enough food to eat and deciding between buying food or paying utilities, insurance, rent, or medical bills is common for older adults in this country. Rural seniors are particularly vulnerable due to the unique health, social, and nutritional challenges due to lower incomes. Rural food deserts can influence an individual's and a community's capacity to obtain a sufficient diet. For rural older individuals who reside in locations with a higher concentration of convenience stores, fewer grocery stores, limited access to transportation, and functional impairments, this may also lead to food insecurity or a lack of access to sufficient food to maintain an active, healthy lifestyle (Lloyd, 2019).
A 2017 USDA study found a slightly higher food insecurity rate for older adults living in non-metro areas than those in metro areas. Finally, meeting the nutritional needs of older adults living in rural areas can be challenging in food deserts in these areas (Lloyd, 2019).

Lebel et al. (2016) noted that health problems are also of concern in rural areas. Food insecurity is a significant public health problem affecting 13% of Canadian households. It is linked to a need for easy access to various fresh, reasonably priced foods. Measuring the food environment is difficult in rural areas due to the uneven distribution of food supply sources’ closeness. These researchers aimed to create a system for locating food deserts in remote regions (Lebel et al., 2016).

Four rural counties in Quebec were examined, conducting evaluations of 25 food items in grocery stores in these communities. The researchers rated the quality of the food, including freshness, affordability, diversity, and availability. The outcomes were contrasted with the USDA's food desert standards and the perspectives of local stakeholders, which include the Health Region of Chaudiere-Appalaches (HR-CA), a rural administrative region in Quebec (Lebel et al., 2016).

According to the study's findings, food deserts proved to be more prevalent when the USDA definition was used when food quality was considered. The impressions and expertise of stakeholders were consistent with the food environment measures. Nonetheless, this study identified at-risk areas in this region with food deserts. (Lebel et al., 2016).

Adams et al. (2010) broadened the scope of studies on the effects of food insecurity on health. Food deserts and the lack of access to sufficient healthy food have sparked a substantial amount of scholarly research on the health issues that persons who live in food deserts face. In-
depth medical study has revealed that poor diets and inactivity contribute to the nation's various health issues, such as cardiovascular disease, diabetes, and obesity. However, over the last twenty to twenty-five years, additional research has explored how the access or lack of access to healthy food environments, like grocery stores, directly impacts food shopping and the nutritional habits of individuals.

Additionally, according to the research on food deserts, access to nutrient-dense foods depends on availability and is influenced by a number of factors, including one's ability to travel to the store, one's race or ethnicity, one's income, and one's age. Grocery stores that offer nutritious options that are reasonably priced are often inaccessible to those living in poor neighborhoods, thus creating a food desert (Adams et al., 2010).

In Washington, DC, Compton and Ku (2023) examined the prevalence of food insecurity and living in a food desert for people with serious mental illnesses who were connected to five community mental health services. This was one particular health-related issue they looked at. Their research notes in 2017, USDA identified about 10% of the 65,000 census tracts in the U.S. as food deserts. Public health issues are tied to food insecurity, living in a food desert, and other socioeconomic risk factors, including mental illness. The results concluded that the 300 participants in the study, on average, had a 58% food insecurity rate compared to the national rate of 13.7%. Last but not least, female patients were more likely than male patients to live in a food desert (Compton & Ku, 2023).

Because research has confirmed the health-related concerns for those living in food deserts, whether urban or rural, the natural flow from these results would support health policy. Cummins and Macintyre (2002) demonstrate how, in the correct social context, assumptions about social reality, particularly food deserts – poor urban areas where people do not have access
to healthy, affordable food - can serve as the foundation for health policy even in the lack of adequate data. However, the presence of food deserts is not sufficiently supported by empirical data. When health policies are made that happen to align with larger policy goals, they are based on the inadequate data that is available, and that may not be the best way to solve the food poverty problem (Cummins & Macintyre, 2002).

Walker et al. (2010) summarized the studies that focus on the impact of local food environments on residents' access to reasonably priced, wholesome foods, noting that access to healthy food is constrained in areas without supermarkets or food deserts. The 31 studies that were reviewed in their analysis of the literature on food assessment and food desert research in the US. Nine measures were used in these studies to evaluate food access.

Four significant findings emerged from this literature that explains food deserts: (1) access to supermarkets – less access has a significant impact on a person’s diet, (2) racial and ethnic discrepancies in food deserts: compared to mostly White neighborhoods, predominantly Black communities have fewer stores and just 52% of chain supermarkets are available in Black neighborhoods, (3) income and socioeconomic status in food deserts – Food prices were found to be higher in places with the highest levels of poverty, and the majority of smaller stores in urban areas are situated in low-income neighborhoods, (4) the differences in chain versus non-chain stores, encompassing cost and availability of food items as well as store type – Finally, the cost of groceries is higher in metropolitan areas than in the suburbs, and larger supermarkets in suburban areas offset higher priced items by offering generic items (Walker et al., 2010).

In addition to food deserts, Curran and Armenia (2021) conducted a study that partnered with the food bank in Central Florida and utilized GIS analysis to examine the food bank’s responsiveness to the local community’s needs. Using Waity's (2016) technique of identifying
food assistance deserts, the researchers looked at predictors of geographically accessible food aid in six counties covered by the food bank. They also looked at census block groups designated as food assistance deserts.

This investigation discovered that, within a mile of their population center, more than half of the census block groups examined need access to food aid. However, the final results show that the partner agencies that work with the local food bank are generally responsible for the food insecurity needs of the community (Curran & Armenia, 2021).

Solutions to problems that stem from food deserts have also been presented in the food desert literature. Schupp (2019) looked at the issue of food deserts in the country, the presence of farmers markets in those underserved areas, and their impact on these communities. According to this study, those who live in food deserts have less nutrient-dense diets and suffer from worse health outcomes than those who do not. With the positive results from farmers’ markets located in food deserts, this study examines how often these markets are found in food deserts (Schupp, 2019).

The literature also views food deserts as a type of spatial inequality in society that disproportionately impacts low-income and populations of racial and ethnic minorities and that frequently takes the form of redlining. The study results reveal that food deserts and farmers markets overlap infrequently (Schupp, 2019).

Utama and Saraswati (2022) examined the design and implementation of food desert solutions while including how racial and class awareness integrate into those solutions. Additionally, this research evaluates how farmer’s markets and community kitchens might be effective, sustainable solutions to these underserved areas. Because minorities make up the bulk of those living in food deserts, these researchers believe that racism in this country is closely
related to food deserts and looking at the systemic racism rooted in the slavery system adds to this lack of service in food deserts. Lastly, this literature examines the role of local communities and partnerships in the continuity of the food system in South Memphis (Utama & Saraswati, 2022).

A final potential solution to food deserts, particularly for children, is presented by Swafford et al. (2021). Food insecurity means a lack of food quantity and a need for access to nutritious food. Food deserts are places without access to fresh, wholesome, and reasonably priced food. Due to the COVID-19 pandemic and the implications that resulted from school closures, food insecurity in the US increased from 11% in 2018 to 35% in 2020. Compared to children from higher-income households, children who live in food deserts may have a double the risk of being obese. This research shares the results of a pilot program that educated children living in food deserts on container and or community gardens. The results of this pilot were positive, as the participants felt they had learned the basics of container/community gardens. Lastly, the program has the potential to be implemented through 4-H programs (Swafford et al., 2021).

**Food deserts in the Socioeconomic context of K-12**

The relationship between children's nutrition and academic ability has received much attention in existing studies, but living in nutrient-poor areas, such as food deserts, has received less attention. However, Dutko et al. (2012) found that compared to other census tracts, food desert tracts had smaller populations, a higher percentage of unoccupied or abandoned dwellings, and residents who have lower levels of education, make less money, and are more likely to be unemployed. Furthermore, compared to comparable low-income census tracts with equal poverty rates, those with higher poverty rates are more likely to constitute food deserts.
Specifically, using the 2000 census data, Dutko et al. (2012) found that the percentage of the population with less than a high school degree in food deserts was 30%, while the percentage of the population with less than a high school degree in non-food deserts was only 20%. Ultimately, however, this study confirms poverty’s primary role in the evolution of food deserts (Dutko et al., 2012), and poverty negatively impacts students within K-12 education regarding health issues stemming from a low-nutrient diet, homelessness, lack of food, fewer resources at home for studying, parents working long hours, and the school itself being underfunded (National Association of Secondary School Principals, 2023).

For 20 years, Alexander et al. (2014) followed 790 first graders in a longitudinal study known as the Long Shadow Study, with 35% of the students living in food deserts. They wanted to demonstrate how little social mobility low-income Baltimore residents exhibit. Since none of these variables alone adequately represents SES (socioeconomic status), these researchers define SES as a mix of income, education, and occupation. Out of all the factors influencing school outcomes for children in this study, the socioeconomics of neighborhoods and school do more to determine school quality than anything else. Low SES puts families in low-SES neighborhoods and schools, which in turn contribute to the likelihood that students will end up with low SES. Only 4% of participants among kids whose parents had low socioeconomic positions went on to earn their bachelor's degrees, and 10% of individuals with low socioeconomic levels moved into higher socioeconomic statuses, taking social mobility into account.

Parents in food deserts more frequently visit fast-food and take-out establishments their counterparts. According to research, children who eat more fast food often perform academically worse than those who consistently consume a healthful diet (Colón-Ramos et al., 2018).
It is best if children are taught early on the value of eating various healthful foods. According to the Long Shadow Study by Alexander et al. (2014), consuming more processed meals can negatively impact on a child's IQ. These patterns suggest that a healthy diet can promote success in the classroom, and beyond.

Lastly, according to research by Frndak (2014), linking eating habits and cognitive development, children living in food deserts may perform worse academically. This study examined whether there is evidence for an ecological link between the occurrence of food deserts and student success at the school district level. According to the findings, a high frequency of food deserts may be linked to low academic achievement at the school district level. Food deserts account for a significant portion of the variation in academic success across urban and suburban school districts, beyond other potential determinants.

**Food bank deserts**

A food bank is a non-profit organization that gathers and distributes food to community organizations including food pantries, soup kitchens, and shelters and charities that fight hunger. To collect extra food that might otherwise go to waste, they collaborate with nearby supermarkets, eateries, and other food providers. Additionally, food banks warehouse millions of pounds of food and other products that go out to the community through food pantries, or partner agencies. These food pantries distribute food directly to people in need (Feeding America, 2023).

With an increase in pantry locations around the country in recent decades, food pantries have grown in importance for many Americans who are food insecure (Lohnes & Wilson, 2018). Some families rely on food pantries to meet their household needs, while many families use food banks as a complement to their grocery purchases. Additionally, although food pantries are
meant to be a short-term resource, some households will rely on them permanently (Robaina & Martin, 2013).

When previously defining and discussing food deserts, what was excluded was the presence of other food sources such as food bank programs and food pantries. Waity (2016) introduces the concept of "food assistance deserts," or regions with more than a mile between them and a population center and no access to food assistance services (such as food banks or pantries). Despite the fact that food deserts are frequently targeted for food aid, many food deserts are also food bank deserts (Bradley & Vitous, 2021). Food bank deserts increase a household's susceptibility to food insecurity, particularly for those who lack the means to purchase food in their communities, however, very little research covers this topic.

Lastly, Curran & Armenia (2021) looked at geographic service gaps in food assistance using GIS analysis to measure food bank deserts in Central Florida. These researchers identified characteristics and predictors of food bank deserts. They found that larger, rural block groups seem more likely to be food bank deserts than smaller, urban block groups. These researchers also found that the presence of a food bank desert is responsive to poverty, area, and race. Additionally, they found that distance to a food pantry location is significantly affected by population demographics and geographic characteristics.

Measurement of ecology of food

Following previous literature, studies on food deserts must meet both a low-income standard and a low-accessibility standard. The measurement of the ecology of food, extending the measurement of food deserts to the concepts and constructs of food bank deserts, I comprise measuring low-income standard, which includes census tracts in high-need schools (Title I schools) with no food banks or pantries near those in need, and the measurement of low-
accessibility standard, which encompasses census tracts in high-need schools (Title I schools) with no bus stops. The later expands to specifically examine walk accessibility. Much literature has examined walkability and reasonable distances. Table 1 summarizes these findings for each article. Articles are listed alphabetically using the author’s last name.

While there is no agreement about how to best influence the travel patterns of students and parents as a means of integrating into the fabric of the neighborhood, a common consensus is that walking distance to public transport is a key element of providing access to participation in life opportunities and to reach activities and services such as local food bank programs (Daniels & Mulley, 2013). Understanding the characteristics and variability of the local geography and public transport supply is important to add to an evidence base that has been plagued by a lack of empirical data and analysis related to improving food access in underserved communities.

Assumptions about transit walk accessibility imply proximity. A case in point, Zhao et al. (2003) observed 196 samples in their transit study in southeast Florida in which residences were located between 300 and 600 ft of a transit stop. For this reason, this study considers more than 600 feet from a bus-stop as a reasonable measure of food desert. Since poor households living in poverty lack vehicle access, walking and transit are the backbone of the larger spatial and interlocking context of key neighborhood characteristics (Corazza & Favaretto, 2019).

Giles-Corti et al. (2011) used a school-specific "walkability" rating to assess the effects of neighborhood walkability (based on street connectivity and traffic exposure) within 1 mile of public primary schools on kids who routinely walk to school. Using a Geographic Information System (GIS) that incorporates measurements of street connectivity and traffic exposure within one mile of all government primary schools, the Travel Environment and Kids research (TREK) created this index.
Table 1. Walkability

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<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Study</th>
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<tr>
<td>Redland, H., Schofield, G., &amp; Garrett, N. (2008)</td>
<td>Travel behavior and objectively measured urban design variables: Associations for adults traveling to work.</td>
<td>This study objectively measures urban design variables and transport-related physical activity behaviors for adults who commuted to work. They note that the World Health Organization advocates distance up to 3.1 miles as being acceptable and realistic for transport-related physical activity. These researchers found that 73% of adults in their sample traveled between 1.3 miles and 3.1 miles to walk to work.</td>
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<td>Corazza &amp; Favaretto (2019)</td>
<td>A methodology to evaluate accessibility to bus stops as a contribution to improve sustainability in urban mobility.</td>
<td>Transportation and walking are the cornerstones of sustainable mobility. Not only do bus stations symbolize the link between the two, but they also play a major role in determining how appealing the latter are. Making bus stops accessible is essential to boosting the allure and sustainability of public transportation. The article outlines a multi-step process for assessing the accessibility of bus stops, beginning with a group of seven indicators that represent both objective and subjective characteristics influencing travelers' decisions to stop at a particular bus stop.</td>
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<tr>
<td>Daniels &amp; Mulley (2013)</td>
<td>Explaining walking distance to public transport. The dominance of public transport supply.</td>
<td>Transportation and walking are the cornerstones of sustainable mobility. In addition to symbolizing the link between the two, bus stations play a major role in determining how appealing the latter are. Therefore, bus stop accessibility becomes essential to raising the allure and sustainability of public transportation. The study outlines a multi-step process for assessing the accessibility of bus stops, beginning with a group of seven indicators that represent both objective and subjective characteristics impacting travelers' decisions to use a particular bus stop. Results show the relevance of the urban network and environment in evaluating the accessibility and in promoting more sustainable mobility patterns.</td>
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<td>Giles-Corti et al. (2011)</td>
<td>School site and the potential to walk to school: The impact of street connectivity and traffic exposure in school neighborhoods.</td>
<td>Within 1.5 miles of public primary schools, the effect of neighborhood walkability (measured by street connectivity and traffic exposure) on children who routinely walk to school was investigated. Using a school-specific “walkability” measure and a cross-sectional research of students in Years 5, 6, and 7 as well as their consenting parents, the most and least walkable schools were determined. Following adjustment, children attending schools in high walkable communities—that is, neighborhoods with high street connection and low traffic volume—were more likely to walk to school on a regular basis, whereas children attending schools in high traffic volume neighborhoods were less likely to do so. More than 90% of students in elementary through high school resided within a &quot;safe and reasonable&quot; walking distance, which is defined as being no more than one mile from the school.</td>
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<td>Inacono, M., Krizek, K., &amp; El-Geneidy, A. (2009)</td>
<td>Access to Destinations: How Close is Close Enough? Estimating Accurate Distance Decay Functions for Multiple Modes and Different Purposes</td>
<td>Used travel survey data from the Twin Cities region in Minnesota to examine relationships between actual travel behavior and mean distance to various services. These researchers found that most walking trips cover roughly 1.36 miles, including all purposes, and longer for recreation trips.</td>
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<td>Larzen, J., El-Geneidy, A., &amp; Yassine, F. (2010)</td>
<td>Beyond the Quarter Mile: Re-examining Travel Distances by Active Transportation</td>
<td>This study focuses on how far people are willing to walk or cycle for different trip purposes in Montreal, Canada. They found that walking trips extend up to approximately 2.2 miles with an average of 1.2 miles for both work and leisure activities.</td>
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<td>Li et al. (2005)</td>
<td>The six-minute walk test in healthy children: reliability and validity</td>
<td>The aim of this study was to assess the reliability and validity of the 6-min walk test (6MWT) in healthy children. In healthy children, the 6-min walk test is a reliable and valid functional test for assessing exercise tolerance and endurance. The aim of this study was to quantify the amount of traffic exposure that children receive (the number of streets they cross) and to ascertain how much exposure contributes to pedestrian injuries. When analyzed by police district, injury and exposure rates were positively correlated. Crossings were similar by sex but increased with age and were inversely related to socioeconomic status.</td>
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<td>Macpherson et al. (1998)</td>
<td>Children’s exposure to traffic and pedestrian injuries</td>
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Table I (continued)

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<th>Author</th>
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<tr>
<td>Schlossberg, M., Greene, J., Phillips, P., Johnson, B., &amp; Parker, B. (2006)</td>
<td>School trips: Effects of urban form and distance on travel mode</td>
<td>This study examines the relationship between urban form, distance, and middle school students walking and biking to and from four schools in Oregon. Five primary results emerge: (1) urban form helps predict travel mode to and from school; (2) middle school students walk further than planners expect; (3) many students use a different mode when they travel to school and when they leave school; (4) urban form measures that predict walking behavior differ from those that predict biking behavior; and (5) urban form is only one factor in students’ transportation decisions.</td>
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<td>Timperio, A., Crawford, D., Telford, A., &amp; Salmon, J. (2003)</td>
<td>Perceptions about the local neighborhood and walking and cycling among children</td>
<td>This study examined association between perceptions of the local neighborhood in Australia and walking and cycling among children. These researchers found that the average walking distance to local destinations parents perceived as appropriate for their 5- to 6-year-old child was 2 (± or ±3 miles), while for 10- to 12-year-old children it was 1 (± or ±3 miles).</td>
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<td>Yang, Y., &amp; Diez-Roux, A. (2012).</td>
<td>Walking distance by trip purpose and population subgroups.</td>
<td>Background: Walking distance is an important concept in the fields of transportation and public health. A distance of 0.25 miles is often used as an acceptable walking distance in U.S. research studies. Overall, research on the distance and duration of walking trips for different purposes and across different population groups remains limited. Results - trips longer than 0.25 miles are common. There is substantial variability in the distance and duration of walking trips by purpose and population subgroups. In the U.S., over the past 2 decades, 40m (0.25 miles or a 5-minute walk) has sometimes been assumed to be the distance that “the average American will walk rather than drive,” and has been used as the value of acceptable walking distance in studies. However, this study by Yang and Diez-Roux (2012), the distances of walking trips vary by purpose. For example, distances of walking for recreation were substantially longer than distances for other purposes, such as work, shopping, and social events. These researchers found that when all purposes for the walking trip were considered, the average distance per walker (including gender, age, race, and total household income) was 1.45 miles.</td>
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<td>Zhao et al. (2003)</td>
<td>Forecasting transit walk accessibility: Regression model alternative to buffer method</td>
<td>Given forecast population and employment data, transit route information, and the type of street configuration, a methodology is described for estimating transit walk accessibility at the home end of transit trips and for forecasting transit walk accessibility at the home end for a future year. The technique for calculating the accessibility of transit walks gets around issues with both natural and artificial obstacles, like community fences and bodies of water, as well as the issues of unequal population distribution. Both the network-based approach and the buffer method have a tendency to overstate transit walk accessibility, according to a comparison of the results with those from the conventional buffer method and with approaches that take into account the real walk distance along streets.</td>
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According to the study's findings, the network design of the neighborhood roadway influences whether traffic has a good or detrimental impact on children's walking behavior (Giles-Corti et al., 2011). The stronger connection of the pedestrian network was substantially responsible for the much lower walkability of the neighborhoods surrounding lower SES schools compared to higher SES schools. Additionally, Macpherson et al. (1998) found that children in lower income areas travel farther to school than their higher SES counterparts, again emphasizing the point that neighborhood matters and transit walk accessibility differs depending on census tract and high or low-need schools.

Larsen et al. (2010) focused on how far people are willing to walk or cycle for different trip purposes in Montreal, Canada. They found that walking trips extend up to approximately 2.2 miles with an average of 1.2 miles for both work and leisure activities. Schlossberg et al. (2006) examined the relationship between urban form, distance, and middle school students walking and biking to and from four schools in Oregon. They also found that those who live within one mile of school are by far the most likely to walk, followed by those living 1 to 1.5 miles.

A study by Yang and Diez-Roux (2012) examined the distances of walking trips and their variation by purpose. They found distances of walking for recreation were substantially longer than distances for other purposes, such as work, shopping, and social events. These researchers also found that when all purposes for the walking trip were considered, the average distance per walker (including gender, age, race, and total household income) was 1.45 miles. A study by Timperio et al. (2004) examined the association between perceptions of the local neighborhood in Australia and walking and cycling among children. These researchers found that the average walking distance to local destinations parents perceived as appropriate for their 5- to 6- year old child was .9 (+ or -.7 miles), while for 10- to 12- year old children it was 1 (+ or -.8 miles.)
Badland et al. (2008) objectively measured urban design variables and transport-related physical activity behaviors for adults who commuted to work. They note that the World Health Organization advocates distance up to 3.1 miles as being acceptable and realistic for transport-related physical activity. These researchers found that 73% of adults in their sample traveled between 1.3 miles and 3.1 miles to walk to work. Iacono et al. (2008) used travel survey data from the Twin Cities region in Minnesota to examine relationships between actual travel behavior and mean distance to various services. These researchers found that most walking trips cover roughly 1.86 miles, including all purposes, and longer for recreation trips.

Neighborhood walkability can also be examined on the granular level using Li et al. (2005) 6-minute walk test for measuring children’s endurance. The 6-minute walk test has been shown to be reliable and valid for measuring children’s ability to walk to neighborhood schools, if that is an option for them, and a useful measure of functional capacity. I have extended this literature to further examine the concept and constructs of food bank deserts using “within walking distance” measures.

Measuring low-income standards, which includes census tracts in high-need schools (Title I schools) with no food banks or pantries nearby, examines data that encompasses the 2020-2021 Common Core of Data (CCD) preliminary files, identifying Title I schools and the total number of students eligible for the National School Lunch Program (NSLP) via free or reduced-price lunch and direct certification. Also, point data for geocoded location of Mid-South Food Bank programs in the city area (starting with Memphis, the largest city in the Deep South, and the seat of Shelby County), are included. Memphis has a history of neglecting or underserving disadvantaged communities and also struggles to provide food security for working
families. These conditions combined represent a revealing case for evaluating the sites and situations of the food bank desert phenomena.

Because the service area included in populations served by Mid-South Food Bank include three states, Tennessee, Mississippi, and Arkansas, this study will also include DeSoto County, Mississippi, and Crittenden County, Arkansas. These three contiguous counties are in a cluster in the heart of the Mid-South, are all served by Mid-South Food Bank, and have similar social and economic characteristics of their populations compared to the United States. Although the number of residents in each county vary, the percent minority in the mid-south are substantially higher than the national average, as is the poverty rate.

<table>
<thead>
<tr>
<th>Region</th>
<th>Population</th>
<th>Percent minorities</th>
<th>Poverty rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>333,288,000</td>
<td>25%</td>
<td>11.6%</td>
</tr>
<tr>
<td>Shelby County, Tennessee</td>
<td>916,000</td>
<td>60%</td>
<td>18%</td>
</tr>
<tr>
<td>DeSoto County, Mississippi</td>
<td>192,000</td>
<td>38%</td>
<td>11%</td>
</tr>
<tr>
<td>Crittenden County, Arkansas</td>
<td>47,000</td>
<td>60%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Census.gov

However, they are different enough in size and child hunger rates to provide an extensive analysis of high poverty schools and neighborhood characteristics to determine if there is spatial proximity to the high-poverty schools. In 2021, Feeding America (2023) notes the child hunger rate in Shelby County, Tennessee, to be 21.7%, with 50,850 children less than 18 years old being food insecure, while 4,440 children or 9.5% of children in DeSoto County, Mississippi are food insecure, and, Crittenden County, Arkansas, sees a 26.8% hunger rate with its children under 18 years old, or a total of 3,530 children.

Route shapefiles containing the Memphis Area Transit Authority (MATA) bus stops from the Memphis city Data Hub will be used. However, there is no public transit in either
Desoto County, Mississippi or Crittenden County, Arkansas. Finally, the newly released 2016-2020 American Community Survey 5-year estimates, will further raise our understanding of the social and economic characteristics of the population, specifically using proxy variables used for economic context and the socioeconomic need index (SNI). The SNI estimates the degree of disadvantage in each census block group and is constructed from a select set of socio-economic indicators that are shown to be predictors of low-income concentration given existing literature on vulnerable people and places (Gulosino & Maxwell, 2018; Wheeler, Czarnota & Jones, 2017).

Lastly, I use Waldorf’s index of relative rurality (IRR) to measure how rural these counties are, on a scale of 0-1 (Waldorf, 2018). Using this scale, 0 is the least rural and 1 is the most rural. Shelby County has an IRR = .26; DeSoto County has a score of .43; and Crittenden County’s IRR score is .48, and because all counties are in the Memphis Metropolitan statistical area, they are treated as urban when presenting distances (Waldorf & Kim, 2018).

**Food bank deserts in relationship to schools**

There is a growing but limited literature regarding food bank deserts, but almost none examine the empirical side of food bank deserts as it relates to schools. As more individuals are realizing that children are going hungry in our communities, there is an urgency to increase access to food for our children in schools, particularly high-poverty schools.

The Feeding America network consist of 200 food banks in the county, where every county has a food bank that represents them. These food banks work through partner agencies to distribute food out to the local community, that is, neighborhoods close to each partner agency. Even though food bankers will tell you, “When you’ve seen one food bank, you’ve seen one food bank”, many food banks run Child Nutrition programs. As the needs of communities vary
from location to location, each food bank tries to feed as many individuals, families, and children in need that they possible can, through whatever means works best for them, and with whatever capacity they have.

In assessing their service area, food banks may see areas in high poverty schools (Title I) where children and families do not have consistent access to nutritious food through partner agencies, creating food bank deserts. In some cases, the only food a child may receive in a day is the food he gets at school, through the Breakfast program and the NSLP. In these areas, food banks address this need in a number of ways.

One way to see that children in food bank deserts have access to food is through the back-pack program, which began in Arkansas in 1994 (Fram & Frongillo, 2018). This program is privately funded and aims to lessen weekend hunger among school-aged children by providing participants with ready-to-eat meals in backpacks to take home. This helps to address child hunger when other programs are not accessible (Cotugna & Forbes, 2007).

Some food banks and other nonprofits run federally funded child feeding programs. The Child and Adult Care Food Program (CACFP) is a national food assistance program managed by USDA and provides nutritious meals and snacks to children and adults who qualify and are enrolled in care facilities, such as preschools, after school enrichment programs and homeless shelters (Korenman et al., 2012).

Another federal child feeding program that some food banks and other nonprofits may participate in to feed children in food bank deserts is the Summer Food Service Program (SFSP). This program is also administered by USDA, who has a large role in addressing food insecurity in this country Turner and Calvert (2019), and provides low-income children with nutritious meals and snacks during the summer months when kids do not have access to free or reduced-
price school lunches (Bruce et al., 2019). The feeding site may be at a school, but may also be at a more centrally located location in the neighborhood where more children can access the meals.

Lastly, food banks may use Kid-Friendly Mobile Pantry distributions to give access to nutritious food that a child can prepare on his own. This entails loading a truck with kid-friendly product, such as ready to eat mac and cheese, pop-top beef stew and soup, cereal and shelf stable milk, crackers, and yogurt. The food bank will advertise the location of the distribution ahead of time, in conjunction with the school and other partners in the neighborhood, and along with volunteers, the food bank will distribute meal packs for children in neighborhoods with high-poverty (Title I) schools and areas that are food bank deserts.

With nine million children in the United States not knowing where to get their next meal, and adults knowing that a child’s chance for a bright tomorrow starts with getting enough food to eat today (Feeding America, 2023), people continue to see the urgency in feeding our children. School meals provide a great source of nutrition for students, but in food bank deserts and neighborhoods with high poverty schools, back-pack programs, CACFP, SFSP, and kid-friendly mobiles are a great way to supplement nutritious food for food insecure children.

**GIS applications to mapping and analysis of food environments**

Various methodologies have been used to explore GIS spatial analysis regarding locations of food deserts, food bank deserts, and the overall food system environment. Additionally, literature reviews, mixed methods, and qualitative studies have also been conducted to answer a plethora of questions concerning access to food. Table 2 summarizes these findings for each article. Articles are listed alphabetically using the author’s last name.
Sweeney et al. (2015) conducted an extensive literature review providing an analysis of the nature of GIS mapping in scholarly research and web-based food mapping from 2008 to 2016. The review of 34 journal articles and 70 web-mapping projects covers the purpose, study area, methods, and applications of food mapping research and initiatives. The review is structured around five themes: (1) the discipline from which the papers originate; (2) the topics(s), resources, or food-related phenomena they attempt to map; (3) the methods applied; (4) the geographic location of each project; and (5) the applications of the research.

They found that food access and food security are the most commonly mapped topics regarding food environments. Census tracts are the most commonly utilized mapping tool as well as mapping at the neighborhood level. However, a gap exists between interdisciplinary academic work and stakeholders research.

Charreire et al. (2010) also conducted a literature review and examined the spatial measurements produced by the GIS techniques that are used to define the food environment. Out of 29 research articles, they found there to be two distinct spatial strategies, the density and proximity approach. The density methodology uses the kernel density estimate, spatial clustering, and the buffer method to quantify the availability of food outlets. The proximity approach measures the distances or travel times to determine how close food outlets are. For a specific transportation network and mode, GIS network analysis tools enable the modeling of trip times between home addresses and food outlets, as well as the assumption of travel routing behaviors.

Larson et al. (2009) used a snowball strategy to identify 54 relevant research studies relating to the existence, nature, and effects of neighborhood differences regarding food access.
According to previously conducted studies, people who live in neighborhoods with better access to grocery stores and less access to convenience stores generally eat healthier diets and have lower obesity rates. Additionally, the lack of access to healthier meals has a particularly negative impact on people living in low-income, minority, and rural areas. Finally, because they are associated with fewer nutrient-rich diets and greater obesity rates, neighborhood differences in access to food are a concern for residents.

The last literature review I examined provides rich information regarding food banks and their role in the community in feeding people. Bazerghi et al. (2016) conducted a review, of 37 studies regarding food banks, food pantries, food insecurity to examine the role of food banks and pantries in addressing food insecurity and the nutritional needs of their clients. They concluded food banks are being used more as long-term solution to food insecurity and not just temporary. There is an increase in need and food banks are not able to eliminate food insecurity. More importantly, food banks cannot meet the nutritional needs of clients served.

More and more researchers are applying a GIS based methodology to measure spatial variation and proximity to determine access to food in all communities, including both rural and urban. Frank et al. (2006) examined proximity to food retailers in various urban and demographic settings and included a full audit of the food quality offered at 302 food enterprises in four towns in the Atlanta Region. The analyses compared the spatial linkages between schools, with an emphasis on a middle and elementary school in each municipality and sit-down and fast food restaurants as well as between grocery and convenience stores. Using GIS, the distances on the road network between each food shop and school locations were calculated.
The findings imply that while walkability does not affect food quality across areas, income does. Additionally, findings point to the possibility of food quality varying differently depending on proximity to schools in higher-income communities versus lower-income communities.

Bacon and Baker (2017) utilized GIS to map private food assistance and potential need for food at the census-tract scale. They sought to answer: Do people with the greatest need have food distributions sites in close proximity? Is there adequate geographic coverage to meet the need?

First, they conducted a comparative analysis by using poverty and a food insecurity index. Next, they mapped locations of food pantries using U.S. Census maps to identify rural and urban areas. For urban areas, they used GIS to draw 1-mile buffer zones around each pantry to indicate the area that is within close proximity. Rural used a 10-mile buffer zone. Third, they developed a poverty-based assessment of food insecurity to identify areas of high poverty and low access to food distributions. This research resulted in revealing that food assistance distribution locations matched the areas of potential need in more than 80% of urban census tracts. Additionally, 38% of the low-income census tracts had low access to food assistance (Bacon & Baker, 2017).

Aun (2020) looked at the intersection of food deserts and food assistance deserts in El Paso county, Texas with the aim of determining if racial/ethnic minorities and other socially disadvantaged people are more likely to reside in neighborhoods associated with food deserts, food assistance deserts, or areas where these two might overlap. He used census tracts for the unit of analysis and added demographic and socioeconomic data as well as data from the 2019 Food Research Atlas to identify food desert boundaries. Lastly, food pantries in the county were also utilized and identified by street addresses.
Using a GIS spatial analytic approach, Aun (2020) found that these socially
disadvantaged individuals are more likely to live in neighborhoods classified as food insecure,
and are overrepresented by Hispanics, individuals with less that a high school diploma, have
limited English, are foreign born, and rent their residence.

McEntee and Agyeman (2010) conducted a study that contributes to the development of a
method to identify rural food deserts using the location of grocery stores and residential
neighborhoods. Using GIS approach to the rural state of Vermont, these researchers identified
areas of inadequate geographic food access with some overlapping with high poverty locations.
McEntee and Agyeman (2010) sought to answer the following research question: Can we make a
meaningful contribution to rural food desert identification strategies using the location of grocery
stores and residential units? They concluded the food desert criteria resulted in 12 census tracts
to be food deserts with a mean distance from residential neighborhoods to grocery stores greater
than or equal to 10 miles. The mean distance to grocery stores within these rural food desert
tracts was 13.5 miles.

Another study examined the concentration of fast-food restaurants in areas proximal to
schools to characterize school neighborhood food environments. Austin et al (2005) used
geocoded addresses of restaurants and schools, in addition to the bivariate K function. This
research resulted in calculating the median distance from any school in Chicago to the nearest
fast-food restaurant was 0.52 km, a distance that an adult can walk in little more than 5 minutes,
and 78% of schools had at least one fast-food restaurant within 800 m. Fast-food restaurants
were statistically significantly clustered in areas within a short walking distance from schools,
with an estimated 3 to 4 times as many fast-food restaurants within 1.5 km from schools than
would be expected if the restaurants were distributed throughout the city in a way unrelated to school locations.

Schuette and Laninga (2016) conducted a study in rural Idaho at the zip code level to examine the complexity of food insecurity in those regions. They created a food insecurity index based on census data, food accessibility data from grocery stores and SNAP information. With that food insecurity index, these researchers used GIS mapping to test for spatial clustering. Their research had three goals: 1) quantify the state of food insecurity in a rural region of the US, 2) identify areas that are more or less food secure within the region at the zip code level, and 3) illustrate any spatial patterns in the distribution of food insecurity levels across the region.

This resulted in the discovery of two zip codes in the region (83843 & 83871) that were found to be the most food secure according to the food insecurity index. There was also a clustering of areas moderately food secure in NW section of the region, and a clustering of most to moderately food insecure in the eastern side of region. These finding support the call for more place-based research and multidimensional indicators to identify food insecure areas (Schuette & Laninga, 2016).

Yagoub et al. (2022) demonstrated how remote sensing and geographic information system (GIS) could be used to address social and environmental problems such as those faced by food banks. Remote sensing was found as an effective tool and proxy to extract socioeconomic indicators such as size of building, distance between houses, streets width, and scarcity of trees/greenness (vegetative indicator). The indicators together with GIS multi-criteria and weighted overlay were used to find suitable food bank locations.

As noted earlier in this paper, Waity (2016) developed the concept of food assistance deserts and she looked at the geographic disparity in access to food assistance organizations
between rural and urban areas. She used GIS analysis to map the locations of these organizations. She also calculated the distance between the population center and the closest food assistance organization using the population center of the census block group. The census block group was regarded as being in a food aid desert if the closest agency was more than a mile away. Waity (2016) concluded that rural high-poverty counties in the sample of Indiana counties are most likely to be in census block groups that are food assistance deserts, and urban high-poverty counties are least likely to be food assistance deserts.

A few researchers used the mixed-methods approach to GIS and food deserts. One study examined the reliability of current techniques for identifying food deserts and identified some flaws in those approaches. LeClair and Aksan (2014) used GIS mapping and on-the-ground-observations of food available in Bridgeport, CT. They used the analysis to evaluate and improve the means of how food deserts are detected, as well as to introduce the concept of the price–distance cost of food.

They mapped locations of food retailers in Bridgeport using GIS, by zip code, created a market basket (bread, carrots, apples, hamburger, milk, cheese and eggs) and priced these out for comparison to major grocery stores. When public transit is the only way for residents to access a major food shop, the inclusion of price-distance cost is meant to more accurately account for the implicit costs of obtaining food. Residents will continue to rely on neighborhood small grocery stores that provide minimally nutrient-dense food if the implied costs are high enough. They concluded that the opportunity cost to urban consumers of obtaining far away food remains too high (LeClair & Aksan, 2014).

Meenar (2017) created an evaluation tool and index with a conceptual foundation in community food security, which is defined as having access to reasonably priced and nutrient-
dense food. This study lends credence to the current food environment literature and demonstrates the need for assessments at the urban neighborhood scale to address issues like hunger, eating patterns, and vulnerable populations in addition to an analysis of food access.

Additionally, this study evaluated the food ecosystems using participative and mixed-methods approaches in GIS. The Place-Based Food Insecurity and Vulnerability Index (PFIVI) was created using participatory GIS (PGIS) in a standard GIS-based raster overlay analysis, examining the differences between the "geographic-access" based food environment and the more thorough community food security-influenced assessments that consider economic access, public health and food habits, and vulnerable populations and places.

Meenar (2017) built six independent models (based off of existing literature) using ESRI ModelBuilder™ 10.2 and raster overlay analysis techniques. The six indicators used were: 1) Hunger, areas where residents face hunger and food hardship; 2) Low access, areas where residents have lower access to healthy food; 3) Habit, areas where residents generally have poor food habit, 4) Health, areas with poor public health conditions; 5) Engage, areas with lower community engagement; and 6) Risk, areas with at-risk population and vulnerable places. This model was then applied to the city of Philadelphia, and utilizing the raster-based Euclidean Distance tool in ArcGIS, this study found that expanding the variables that are grounded by community-based nonprofits, it resulted in a higher number of census tracts that may have food insecure or vulnerable populations. Lastly, the mixed-methods of adding interviews with residents, added value to this study (Meenar, 2017).

Using GIS mapping and a multinomial logistic regression model, Villa et al. (2022) identified how different demographic groups engage with PRM’s (Phoenix Rescue Mission, in
Arizona) brick-and-mortar or mobile pantries. To include qualitative data, questionnaires were used with clients of pantry.

These researchers identified how different demographic groups engage with brick-and-mortar or mobile pantries. The research questions: Do mobile food pantries serve a distinct set of clients relative to brick-and-mortar food pantries? And are some clients using both? If so, how do the (1) demographic and (2) economic characteristics of clients differ across service distribution types (Villa et al., 2022)?

The results they found included that immigrants, people of color, and women are more likely to utilize mobile pantries than other populations in Maricopa County. In addition, seniors, married and common-law married people, and Black, Indigenous, and People of Color are more likely to use both a brick-and-mortar pantry and mobile pantries (Villa et al., 2022).

Although most analysis involving location includes a GIS component, some research regarding food insecurity and food deserts has been qualitative. The purpose of the next study was to determine any association between socioeconomic indicators of structural racism at the state level and the extent of food insecurity among White and Black households in the U. S. These researchers note that income differences between White individuals and Black individuals are rooted in structural racism by restricting intergenerational wealth accumulation and transfer, and educational and employment opportunities for Blacks Americans (Chaparro et al., 2022). Chaparro, et al., (2022) used secondary pooled, cross-sectional data to find a prevalence of food insecurity for the entire sample of 158,551 households was 10.7%. The Black to White ratio of food insecurity prevalence averaged 1.5. On average, White adults have better socioeconomic outcomes than Black adults at the state level. For Black households, racial inequity domains were associated with higher odds of food insecurity.
Table 2. GIS applications to mapping and analysis of food environments academic

<table>
<thead>
<tr>
<th>Author</th>
<th>Data</th>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>Type of Study</th>
<th>Research Design/Purpose</th>
<th>Analysis</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 American Community Survey, UI Department of Agriculture's 2010 Food Research Atlas, Sun City Hunger Relief Coalition’s 2010 Food Assistance Calendar</td>
<td>1) food desert tracts vs. non-food desert tracts, 2) food assistance desert tracts vs. non-food assistance desert tracts, 3) food desert and food assistance desert overlapping tracts vs. not, 4) neither food desert nor food assistance desert tracts vs. not</td>
<td>GIS spatial analytic approach</td>
<td>Determine if racial/ethnic minorities and other socially disadvantaged individuals are more likely to live in neighborhoods associated with food deserts, food assistance deserts, and where these two areas overlap.</td>
<td>Statistical analysis based on bivariate Z tests of proportions that compare the sociodemographic characteristics of different food access categories to those outside these areas.</td>
<td>Bivariate comparisons show that racial/ethnic minorities and socially disadvantaged groups are more likely to reside in neighborhoods classified as food deserts and food assistance deserts, groups that are significantly overrepresented are Hispanic, less than a high school education, limited English proficiency, foreign born, and renters.</td>
<td>Data used does not reflect the impact of COVID-19. Next, this study treated all supermarkets and food assistance sites equally and did not distinguish between them in terms of the hours they were open, food prices, food quality, and products available. While a neighborhood may be identified as having adequate access to either a supermarket or food assistance site, these attributes could present additional barriers that may not make them attractive to local residents. Last, the study site only included geographic limitations.</td>
<td></td>
</tr>
<tr>
<td>Austin et al., 2009</td>
<td>schools locations, fast food locations, distance from school to restaurants</td>
<td>geocoded addresses of restaurants and schools, bivariate K function</td>
<td>Examine the concentration of fast-food restaurants in areas proximal to schools to characterize school neighborhood food environments.</td>
<td>Calculate the mean and median distance from schools to the nearest fast-food restaurant. Used GIS to map buffer around each school and then calculated the number of fast-food restaurants in buffer. Next, use the bivariate K function to quantify the degree of clustering of fast-food restaurants around schools.</td>
<td>The median distance from any school in Chicago to the nearest fast-food restaurant was 0.65 km, a distance that an adult can walk in little more than 5 min. Walks of 1 fast-food restaurant within 800 m. Fast-food restaurants were statistically significantly clustered in areas with a short walking distance from schools, with an estimated 2 to 4 times as many fast-food restaurants within 1.5 km from schools than would be expected if the restaurants were distributed throughout the city in a way unrelated to school locations.</td>
<td>1995 data re: land use was all that was available and update data might allow for more accurate classifications. Student nutritional patterns were not included in this study.</td>
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Table 2. (continued)

<table>
<thead>
<tr>
<th>Author</th>
<th>Data</th>
<th>Dependent Variable</th>
<th>Independent Variables</th>
<th>Type of Study</th>
<th>Research Design/Purpose</th>
<th>Analysis</th>
<th>Results</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacon &amp; Baker, 2017</td>
<td>US Census ACS 5-year estimates of poverty and demographic data, 2010-2014</td>
<td>access to food based on distance</td>
<td>poverty, unemployment, % of households that rent, food insecurity index</td>
<td>GIS analysis</td>
<td>Utilize GIS to map private food assistance and potential need at the census tract scale; Do people with the greatest need have food distribution sites in close proximity-is there adequate geographic coverage to meet the need?</td>
<td>Identify the role of food banks in promoting food security and nutritional choices of those in need. Are they providing sufficient food to clients to reduce food insecurity? Are their programs meeting the nutritional needs? Are food banks meeting client needs to maximize food security outcomes?</td>
<td>Food banks are being used more as a long-term solution to food insecurity and not just temporary. There is an increase in need and food banks are not able to eliminate food insecurity. Food banks cannot meet the nutritional needs of clients served.</td>
<td>Information on population characteristics and food availability was incomplete and subject to change. Use of US census data, although regarded as high quality, it is not perfect. Large immigrant population is most likely undercounted. Homeless population also undercounted. Some important factors are omitted: federal and state assistance, and access to transportation. Only one county is used—most include a diverse set of counties to be generalizable.</td>
</tr>
<tr>
<td>Bazargi, 2016</td>
<td>37 articles were accepted for review - regarding food banks, food pantries, food insecurity</td>
<td>role of food banks, food pantries, food insecurity</td>
<td>food security; nutritional need of clients served</td>
<td>Literature review</td>
<td>Identify articles as cross-sectional, longitudinal, randomized controlled trial, mixed methods, qualitative, and quantitative studies.</td>
<td>Missing and unreported data in some studies, poor response rates.</td>
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<tr>
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<th>Results</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Bradley &amp; Vitous, 2021</td>
<td>Ethnographic data, using GIS mapping, provided by semi-structured interviews</td>
<td>4 barriers to accessing food assistance: transportation, health constraints, distribution frequency, and support from government assistance programs</td>
<td>Food access for participants; location of pantries</td>
<td>Ethnographic, through interviews, and GIS mapping</td>
<td>Explore barriers to free food access through ethnographic data provided by semi-structured interviews with food bank partner agency clients, GIS mapping to map food distribution locations in Tampa.</td>
<td>Ethnographic analysis (n=29; data collected from mobile pantry clients—demographics, individual experiences of food insecurity, barriers to food access, health, and spatial analysis) how the physical makeup of Tampa, Fl, can affect the lived experiences of residents; mapping locations of food distribution points</td>
<td>Hour primary barriers to accessing food assistance: 1) transportation, 2) health constraints, 3) distribution frequency, 4) Insufficient support from government assistance programs. GIS analysis: few food distribution sites were located in food deserts. Major highways separated distribution sites from food deserts. Most food deserts are also food bank interview participants only recruited from 2 of 66 food distribution sites. Both in food deserts and distributed once a month. Also, distributions locations changed from the time verified and the time the observations were conducted. Follow up study should be conducted a year later.</td>
<td></td>
</tr>
<tr>
<td>Chaparro et al., 2022</td>
<td>Current Population Survey (CPS) and ACS, 2015-2019 data</td>
<td>Household food insecurity</td>
<td>Racial inequities in socioeconomic outcomes: Income, earnings, education, unemployment, and home ownership</td>
<td>Secondary analysis of pooled, cross-sectional data</td>
<td>Purpose - determine the association between socioeconomic indicators of structural racism at the state level and food insecurity among White and Black households in the U.S.</td>
<td>Statistical analysis - the weighted prevalence of food insecurity by household race/ethnicity at state level calculated using sample weights. Ratio of Black to White food insecurity prevalence analyzed. Multivariable analysis conducted.</td>
<td>Prevalence of food insecurity for the entire sample was 10.7%. The black to white ratio of food insecurity prevalence averaged 1.5. On average, White adults have better socioeconomic outcomes than Black adults at the state level. For Black households, racial inequity domains were associated with higher odds of food insecurity. The structural racism indicators included have not been previously validated. Mixed race and other racialized households are not represented specifically Native Americans.</td>
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</tr>
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<tbody>
<tr>
<td>Chernev et al., 2010</td>
<td>29 sources: health science databases - Medline/Pubmed, PsycINFO, Francis and GeoBase.</td>
<td>n/a</td>
<td>n/a</td>
<td>Literature Review</td>
<td>Investigate the geographic information systems (GIS) methods used to define the food environment and the types of spatial measurements they generate.</td>
<td>The selected studies fall into two categories: (i) studies that explore the relationships between characteristics of the food environment and measurements of individual food behaviours; and (ii) studies that compare accessibility of food outlets in different types of neighbourhoods.</td>
<td>There were found to be two distinct spatial strategies. The density methodology uses the kernel density estimate, spatial clustering, and the buffer method to quantify the availability of food outlets. The proximity approach measures the distances or travel times to determine how close food outlets are for a specific transportation network and mode. GIS network analysis tools enable the modelling of trip time between relevant addresses (home) and food outlets, as well as the assumption of travel routing behaviors.</td>
<td>Reflecting on geographic access, cultural, social, and economic factors are not considered.</td>
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<tr>
<td>Frank et al., 2006</td>
<td>29 sources: health science databases - Medline/Pubmed, PsycINFO, Francis and GeoBase.</td>
<td>school locations (in 4 neighborhoods), sit-down and fast food restaurant locations, and low grocery stores and convenience stores</td>
<td>spatial relationship between schools, restaurants, and grocery stores and convenience stores</td>
<td>Literature Review</td>
<td>Spatial relationships using GIS</td>
<td>There were found to be two distinct spatial strategies. The density methodology uses the kernel density estimate, spatial clustering, and the buffer method to quantify the availability of food outlets. The proximity approach measures the distances or travel times to determine how close food outlets are for a specific transportation network and mode. GIS network analysis tools enable the modelling of trip time between relevant addresses (home) and food outlets, as well as the assumption of travel routing behaviors.</td>
<td>Food quality varies across neighborhoods by income, but not by walkability. The potential for food quality varies differentially with distance from schools in higher vs. lower income communities.</td>
<td>There was no explanation of systematic associations by community design, income, and food access quality. No assessment of which factors are most influential in explaining access to food environments, including distances and variations in income and walkability.</td>
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<tr>
<td>Lerson, Story &amp; Niskanen, 2009</td>
<td>29 sources: health science databases - Medline/Pubmed, PsycINFO, Francis and GeoBase.</td>
<td>physical availability of grocery stores, restaurants, and health food access</td>
<td>neighborhood differences in accessing food. Searches in PubMed and MEDLINE using key words.</td>
<td>Literature Review</td>
<td>Snowball strategy to identify relevant research studies relating to neighborhood differences in accessing food.</td>
<td>Describe and evaluate existing research relating to neighborhood differences in the availability of healthy food access.</td>
<td>Compare neighborhood access to grocery stores and restaurants to healthy dietary intake, risk for obesity.</td>
<td>Neighborhood residents with better access to supermarkets and limited access to convenience stores have healthier diets and lower obesity rates.</td>
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<tr>
<td>Leclaire &amp; Alsens,</td>
<td>US Census Bureau, addresses of retail food outlets,</td>
<td>access to major</td>
<td>transportation options</td>
<td>GIS</td>
<td>examines the reliability of current techniques for identifying food deserts, and identifies some of the flaws in these approaches</td>
<td>Map location of food retailers in Bridgeport using GIS, by zip code, market basket (bread, carrots, apples, hamburger, milk, cheese and eggs) established and priced out for comparison to major grocery stores</td>
<td>opportunity cost to urban consumers of obtaining far away food remains too high</td>
<td>Due to the opening and closing of food retailers, the maps presented do not completely measure food access. No information is provided on foods available at smaller stores.</td>
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<td>2014</td>
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<td>grocery stores for</td>
<td>income</td>
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<td>McEntee &amp; Agersn,</td>
<td>locations of grocery stores (including smaller general stores and independent food retailers). In Vermont, mean distance to grocery stores within census tract.</td>
<td>rural food desert identification</td>
<td></td>
<td>GIS approach - geographic access to healthy food</td>
<td>Contribute to the development of a method to identify rural food deserts</td>
<td>Investigate geographic access to food and develop a method to identify rural food deserts</td>
<td>Food desert criteria =12 census tracts are food deserts with mean distance from residential units to grocery stores greater than or equal to 10 miles. Mean distance to grocery stores within food desert tracts was 13.5 miles.</td>
<td>Used diverse range of variables, grounded in community, food access goes beyond geographic mapping, and includes wuality, variety, availability and affordability of food. Not all census tracts 122 tracts have high PFIV, indicating a high level of food insecurity, 138 tracts medium to low.</td>
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<td>2016</td>
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<td>&amp; Meiners, 2017</td>
<td>assessment tool and index PFIV index</td>
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<td>participatory and mixed-methods approaches in GIS (participatory GIS, interviews, content analysis, and spatial analysis)</td>
<td>Fill theoretical and methodological gaps in food environment analysis; develop a Place-based food insecurity and vulnerability index (PFIV); use 8 indicators; map them. Use case study of Philadelphia.</td>
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<tr>
<td>Schuette &amp; Lasleins, 2016</td>
<td>American Community Survey 2012 census data, food accessibility data from food resource retail outlets, SNAP approved retail outlets</td>
<td>food insecurity index at the zip code level</td>
<td>population totals, racial distributions, age, household dynamics and income, poverty, unemployment, health insurance coverage, food stamp participation.</td>
<td>Exploratory study using GIS</td>
<td>GIS spatial analysis: Aim: 1) quantify the state of food insecurity in a rural region of the US, 2) identify areas that are more or less food secure within the region at the zip code level, 3) illustrate any spatial patterns in the distribution of food insecurity levels across the region. Spatial analysis to test for spatial clustering in food security indices, identifying areas within the region that are most vulnerable to food insecurity.</td>
<td>Two zip codes in the region (85345 &amp; 85573) were the most food secure according to the food insecurity index. There is a clustering of areas moderately food secure in NW section of the region; also a clustering of most to moderately food insecure in eastern side of region.</td>
<td>The study shows areas with the highest food insecurity based on the food security index, but does not explain what the key factors are. Also including focus groups and key participant surveys would supplement these findings. Nutrition and quality were not assessed.</td>
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<td>Sweeney et al., 2016</td>
<td>34 journal articles and 70 web-mapping projects covering the purpose, study areas, topics, methods, and application of food mapping research</td>
<td>n/a</td>
<td>n/a</td>
<td>Literature Review</td>
<td>Article and web review of GIS mapping in scholarly research to inform community stakeholders and food mapping policy initiatives</td>
<td>Analysis of the nature of GIS mapping in scholarly research and web-based food mapping since 2008.</td>
<td>Review was structured around 5 themes: 1) the discipline the paper originated, 2) food-related phenomena mapped, 3) methods applied, 4) geographic location of each project, 5) applications of the research. GIS mapping is best used as a suite of tools to advance informed community planning. A gap still exists between interdisciplinary academic work and practitioner.</td>
<td>Due to the number of food-mapping literature, this article is limited to projects published after 2008, a year when the economy crashed. It would be beneficial to include time periods before the crash of 2008. Maps used are not always current and maintained so data may be out-of-date.</td>
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<td>Villa et al., 2022</td>
<td>Census data: American Communities Survey (5-year estimates, 2004-2013); data from food pantry</td>
<td>categorical indicator of reference group: brick-and-mortar client, mobile-only client, or brick-and-mortar and mobile client; using age, household size, monthly gross income, gender, marital status, and race/ethnicity</td>
<td>visits to brick-and-mortar pantry and/or visits to mobile pantry distributions</td>
<td>Using GIS mapping and a multinomial logistic regression model, this research identifies how different demographic groups engage with brick-and-mortar or mobile pantries. Answer: Do mobile food pantries serve a distinct set of clients relative to brick-and-mortar food pantries? And are some clients using both? If so, how do the (1) demographic and (2) economic characteristics of clients differ across service distribution types?</td>
<td>Identify how different demographic groups utilize brick-and-mortar pantry or mobile pantry in Maricopa Co., Arizona</td>
<td>Immigrants, people of color, and women are more likely to utilize mobile pantries than other populations in Maricopa County. In addition, seniors, married, and common law married people, and Black, Indigenous, and People of Color are more likely to use both a brick-and-mortar pantry and the mobile pantry.</td>
<td>Used data collected by only one organization. More data needed to see effects of COVID. Driving time to food access was not considered.</td>
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<td>Wally, 2016</td>
<td>Geocoded locations of food pantries; distance from pantry to population center of census block group; counties in Indiana; poverty data from Small Area Income and Poverty Estimates</td>
<td>Food assistance deserts</td>
<td>1) distance b/w pantry and the population center of the census block group; 2) counties in Indiana; 3) food pantries; geocoded locations 4) socioeconomic variables</td>
<td>GIS spatial analysis - analysis of the spatial inequality between rural and urban areas in access to food assistance agencies</td>
<td>Examine how counties with rural areas and poverty impact geographic proximity to food assistance agencies. Map the location of food pantries and soup kitchens that provide food assistance. Considered both variation in the average distance between census block group population centers and food assistance agencies, and variation in the average distance between low-income census block groups and food assistance agencies. Introduced a new concept, the “food assistance desert,” to draw attention to the locations where those who are food insecure have to travel far to secure assistance.</td>
<td>84% of rural high-poverty census block groups in sample are food assistance deserts. Urban high-poverty census block groups are more likely to have a food pantry less than a mile away than both urban and rural low-poverty census block groups. Urban high-poverty counties - 50% of census block groups are food assistance deserts. Urban low-poverty counties - 70% are food assistance deserts. Rural low-poverty counties - 76% are food assistance deserts.</td>
<td>People with higher incomes, not just poverty level, face food insecurity, the study should expand to include counties as a whole, not just low-income block groups.</td>
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<td>Will &amp; Milligan, 2015</td>
<td>Survey responses from partner agencies and also clients served. Demographic and household characteristics; food security core module; 1,600 individuals and 577 surveys; 28 pantries</td>
<td>Characteristics of clients served at pantries</td>
<td>Online surveys (focused on services provided and those they serve) of the agencies and organizations that Second Harvest of North Florida provides food. Also, face-to-face interviews of food recipients at partner agencies</td>
<td>Find out who is hungry in North Florida and characteristics of these recipients using qualitative survey method</td>
<td>Analysis includes examining survey responses, categorize results; include demographics</td>
<td>Whites represent the largest group of recipients; minorities are overrepresented as pantry clients; many cited difficulties paying bills, 40% had children under 18, most clients were women; 20% had a veteran in the household; majority fell significantly below the poverty line; 14% had a job; 4% worked full-time. Clients served face significant problems re: food insecurity and there is little hope for the future.</td>
<td>Response rate of agencies was only 58% and the USDA food insecurity module of 18 questions was too long. It could be shortened.</td>
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<tr>
<td>Zaglouh et al., 2022</td>
<td>Vector data including population, districts boundaries, locations of food sources (hotels, cooperative shops, malls), and roads. The vector data was obtained from Al Ain Municipality. ArcGIS software was used for image processing and spatial analysis</td>
<td>new food bank location</td>
<td>population, districts boundaries, locations of food sources, roads; poverty unemployment, homeownership, income</td>
<td>Remote sensing and GIS analysis</td>
<td>demonstrate how remote sensing and geographic information system (GIS) could be used to address social and environmental problems such as food banks. Remote sensing was found as an effective tool and proxy to extract socioeconomic indicators such as size of building, distance between houses, streets width, and scarcity of tree/ greenness (vegetative indicators). The indicators together with GIS multi-criteria and weighted overlay were used to find suitable food bank locations.</td>
<td>location analysis using remote sensing and GIS mapping</td>
<td>six districts were chosen as best locations for a food bank.</td>
<td>Data used was pre-COVID. Updated and high-resolution satellite images could be better utilized.</td>
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Theories applied

Ecological Systems

In its broadest sense, ecological theory aims to explain and forecast observable phenomena, including temporal and spatial diversity patterns (Costello et al., 2012). The two most significant paradigms in the broad discipline of ecology include ecosystem ecology (concerning materials and energy) and organismal or population ecology (concerning individuals and behavior). Specifically, the ecosystem paradigm is the study of the structure and function of nature. In contrast, the population paradigm includes the study of natural environments and the interrelationships between individuals and their setting. Additionally, the distribution and reasons of change in individual abundance and profusion in area, place, and time are examined by the population ecology paradigm. (Pickett et al., 2007).

Additionally, Bronfenbrenner’s Ecological Systems Theory can help us understand how students connect to their community in the K-12 setting. Bronfenbrenner (1977) proposed that the child's environment is made up of a series of interconnected concentric circles. He arranged them according to the impact they have on children. The five systems, named microsystem, mesosystem, exosystem, macrosystem, and chronosystem, are interrelated and the influence of one system on a child’s development depends on their relationship with others, including parents, siblings, teachers, friends, and community neighbors.
The microsystem is the most influential level of the ecological systems theory. This is the most immediate environmental setting containing the development children and includes family, school, and friends. The interactions between the child's microsystems, such as those between parents and teachers or between classmates and siblings, are included in the mesosystem. The growth of the child should be positively impacted if the parents and teachers get along and have a good relationship, as opposed to negatively impacted if the two parties do not get along (Bronfenbrenner, 1977; Leonard 2011).

The exosystem incorporates other formal and informal social structures, which do not contain the child but will indirectly influence them. Their neighborhood, parents’ workplaces, friends of parents, for example, will affect a child. A parent’s behavior after coming home from work will positively or negatively affect the development of the child. The macrosystem focuses on how cultural elements affect a child’s development, such as socioeconomic status, poverty, and race. The culture a child is immersed in will influence their beliefs and perceptions. A child living in poverty will experience a different experience and development than a child from a wealthy family. Last is the chronosystem. This level includes all of the environmental changes
that influence development of a child over his lifetime, including starting school, parents getting divorced, or moving to a new neighborhood (Bronfenbrenner, 1977; Leonard, 2011).

Over the years, as more and more people understand the problem of child hunger in this country, community partners, businesses, philanthropy donors, religious organizations, and nonprofits have increasingly assumed responsibility for feeding children who do not have consistent access to food. Bronfenbrenner’s ecological systems theory can help us better understand school-community partnering that promotes access to food for children living in food deserts and food bank deserts.

In the school setting, the inner most circle, microsystem, includes a students’ friends, their home, school, and church. The mesosystem level includes the network relationships among that inner most circle. The exosystem includes state and local school systems, school committees, and community/business leaders, while the macrosystem in the school setting includes racism, poverty, and school culture.

A student’s family will have the most impact on his having access to nutritious food, but if the parents are unable to provide enough food for the family and must seek assistance in the community, that is where the exosystem, school partners, will indirectly connect to the student and provide access to food for the family. Later, I will discuss how school partners in this circle work to increase food in Title I schools and low-income neighborhoods where these children live, and how food banks play a part in providing food to students outside of school hours.

The school setting is often immersed in an entrenched culture with strong historical roots, which explains the macrosystem that will influence a child’s ability to have adequate, nutritious food. Ethnic neighborhoods, segregated schools, and poverty all play a part in food accessibility.
Feeding America notes that the Black community consistently faces hunger at higher rates than Whites due to social, economic, and environmental challenges. In 2021, nearly 20% of Black individuals experienced food insecurity – almost three times the rate of white households. Additionally, Latino communities experience unique challenges and are more likely to face hunger than non-Hispanic White communities. In 2021, 17% of all Latinos in the U.S. were food insecure. (Feeding America, 2023).

Bronfenbrenner’s last level in his theory is the chronosystem. In the K-12 school setting, we see how settings, relationships, and their importance changes over time. I noted earlier that child hunger in the U.S. has gone from 19.7% in 1998, to 23.2% in 2009, down to 14.6% in 2019, and up to 16.1% on 2020. However, in 2021, that rate went down to 12.8%, in large part because of the community partners and institutions that worked together to more aggressively meet the food needs of students during COVID (Feeding America, 2023). As more and more groups are understanding the food needs of students, both inside and outside of the school setting, understand the lack of access in food deserts and food bank deserts, hopefully we see more effort on everyone’s part to feed our children, consistent and nutrition food.

**Space, place, and time**

In order to comprehend social injustices and the insufficiency of policy concerning communities and neighborhoods, social studies academics have used space, place, and time (Gulson & Symes, 2007). In fact, Jackson and Marsden (1966) placed the community of Huddersfield in the United Kingdom at the center of their work when tasked with understanding the impact of education on that city.
Tuck and McKenzie (2015) noted the significance of place in social science research. Critical research needs to focus on place since doing so makes it easier to pay attention to the ways that social and environmental issues intersect with land and the environment. An example of that intersection includes urban environments' unequal spatial distribution of various social services due to racialization, gender, economic inequities, access to nutritious food, fair and equitable education, or other issues.

Additionally, Tuck and McKenzie (2015) beseech social science scholars to consider place as more than just the physical and spatial characteristics of a region but also to acknowledge how locations and our orientations to them influence history, empire, and culture. Lastly, these scholars promote careful deliberation of complex issues and the use of methodological strategies that influence the embeddedness of social life in and with places (Tuck & McKenzie, 2015).

In the 1990s, space and place were significant issues for cultural scholars who used humanities and social science approaches in their research. Horley et al. (2010) utilized geographic information systems (GIS) to enhance place and space methodologies for a cultural research project in a remote city in Australia. This research revealed essential sites and linkages between people and places.

Finally, Butler and Kinclair (2020) note that by expanding understanding of the nature of injustices and offering potential remedies, spatial techniques can increase the possibility for social research to challenge oppressive power structures and economic inequalities, like food deserts and child hunger.
Because Sampson’s theory of ecological differentiation and neighborhood effects can be traced back to ecological theory, I will now dissect this theory.

**Ecological differentiation**

A food desert as an “area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower-income neighborhoods and communities” (Waity, 2016, p. 108). Wider-Lewis et al. (2018) expand the concept of a food desert to include when grocery stores, supermarkets, or farmer's markets are far away, and there is a lack of availability to fresh fruits and vegetables.

In this study, understanding the phenomenon of food bank deserts can be seen in terms of Robert Sampson’s (2012) focus on ecological differentiation, defined in terms of urban inequalities and clustering by social characteristics. His book *Great American City* demonstrates the powerful effects of ecologically concentrated disadvantage on a wide range of outcomes and social behavior in what became known as social area analysis. Sampson’s key dimensions of neighborhood difference include poverty, family structure and life cycle (female-headed households, child density), residential stability (home ownership and tenure), and racial/ethnic composition.

Additionally, Sampson (2012) focuses on the effective group processes that occur in contexts when there is a common notion of what a neighborhood or community is. These areas have a significant role in determining the type and amount of human behavior.

Sampson (2012) proposes ten elements as a broad theoretical strategy to the probing of ecological differentiation and neighborhood effects:

1) Relentlessly concentrate on the social background in the first place, mainly as it is reflected in urban inequality and neighborhood distinction.
2) Investigate contextual or neighborhood-level changes separately, using an eclectic approach to data collection that draws on various techniques but is always connected to some empirical evaluation of social-ecological properties, supported by a set of standardized criteria for validation—ecometrics.

3) Focus on social-interactional, social-psychological, organizational, and cultural aspects of city life instead of just individual traits or traditional compositional features such as racial makeup and poverty across ecological contexts, led by ecometric concepts.

4) Incorporate a life-course perspective on the temporal dynamics of neighborhood change, and justify neighborhood trajectories within this framework.

5) Express a simultaneous interest in the causes and processes that underpin stability while highlighting different facets of local social reproduction.

6) Include individual selection decisions that impact community outcomes in studies of neighborhood dynamics; instead of viewing selection as a statistical inconvenience, consider it as a social process.

7) Go past the neighborhood to produce greater geographical (dis)advantages and analyze neighborhood effects and processes that cross or affect local boundaries.

8) Think about combining differences between the constituent neighborhoods with the higher-order, or non-spatial, networks that connect them as you construct a concern with the social organization of the city or metropolitan area as a whole. Go even further and include larger-scale processes that go beyond the effects of proximity to other objects.
9) Provide recommendations for community-level interventions as a to the individual disease model of medicine that is based on science, keeping in mind human concerns with public affairs improving city and community life.

10) Lastly, while maintaining a multicultural perspective on the nature of evidence and causation, highlight the interdisciplinary approach taken by theoretically interpretive empirical research (Sampson, 2012).

Sampson’s line of inquiry is similar to over a century of neighborhood ecological research (Dauter & Fuller, 2016; Odgers et al., 2012), suggesting interlocking neighborhood conditions such as concentrated poverty and disadvantage often make neighborhood differences such as food deserts highly visible. A large body of research on neighborhood effects has examined if and how a person's neighborhood influences various aspects of their lives, including their health and social mobility (Sampson et al., 2002). Specifically, Odgers et. (2012) confirm that compared to wealthy communities, disadvantaged neighborhoods have a higher rate of early death and incarceration among children.

This research base, for instance, frequently uses sociodemographic data to examine how settings affect individual and intergenerational outcomes, such as the racial and socioeconomic composition of census tracts or block groups (Butler & Kinclair, 2020; Sharkey, 2013; Sharkey & Elwert, 2011). In response to the appeal made by Sampson et al. (2002), an increasing number of academics looking at neighborhood effects have started to consider spatial aspects of inequality. By applying spatial techniques, these studies and others like them uncover and show the unequal allocation of resources throughout a certain area. They go beyond just describing the location of opportunity to demonstrate the underlying connections between racial and
socioeconomic isolation and the availability—or lack thereof—of educational opportunities in communities.

Sampson et al. (2002) summed the empirical research on the social-ecological differentiation of neighborhoods with five facts concerning children and youth:

1) In terms of socioeconomic inequality and racial segregation, there is a significant difference between communities. There is compelling evidence linking African Americans' spatial isolation and concentrated disadvantage.

2) At the neighborhood level, a range of social issues—including, but not limited to, crime, teenage delinquency, social and physical dysfunction, low birth weight, infant mortality, school dropout, and child abuse—tend to be grouped.

3) The above two sets of clusters are related to one another. Neighborhood predictors include concentrations of poverty, racist segregation, female lead households, and tenure in one's current residence.

4) The operational unit of analysis has not significantly affected the empirical findings. Place stratification of local communities in American society according to criteria like socioeconomic class, race, and family status is a significant phenomenon, whether at the census tracts or other neighborhood units at the level of the local community.

5) The concentration of affluence at the upper end of the income scale and the ecological concentration of poverty appear to have grown dramatically over the past few decades.

Because ecology is social and Sampson (2012) examines the powerful effects of ecologically concentrated disadvantaged populations, I will examine what is present in the
environment and neighborhoods that blocks access to fresh, nutritious food for marginalized populations, and how we might measure levels of access for those in low-income neighborhoods and/or living in poverty. These variables include family structure, household income, unemployment, education level, racial/ethnic composition, and receiving some form of public assistance, which includes SNAP, TANF, FDPIR, and NSLP.

Concentrating on social aspects of neighborhoods and neighborhood schools, the traditional compositions of neighborhoods and neighborhood schools, such as racial makeup, poverty, and inequality, the theory of ecological differentiation and neighborhood effects is best suited for this study to lead us to an understanding of concentrated disadvantaged ecological systems.

**Application to education**

The path for health is formed in the early childhood years. Prediction of a healthy state in adulthood involves early life experiences of social, cognitive, and physical elements (Hearst, 2016). Maggi et al. (2010) add to the research of the significance of early childhood development by stating that the family economic circumstances affect early child development, including poverty. Additionally, social determinants influence development and health outcomes throughout a person’s lifespan. These social determinants are living conditions, interpersonal relationships, family economic status including, having the basic needs met, learning environments, and living in a safe neighborhood.

Jackson (2014) completed a study in which he examined how children’s early WIC, a federal nutrition program for Women, Infants and Children and aims to protect children against negative effects of food insecurity at an early age, participation correlates in the short-term with
cognitive development and in the long-term with reading and math achievement. Utilizing the Early Childhood Longitudinal Study Birth Cohort (ECLS-B) and Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID), this researcher found results consistent with WIC providing nutritional and education resources to balance the disadvantages experienced by low-income families.

Children receiving early WIC nutrition in utero performed significantly better on academic assessments compared to siblings who did not receive WIC in utero. This data supports the benefits of WIC participation with benefits extending past years of participation in the program into school years (Jackson, 2014).

Food insecurity affects the academics of children. Johnson et al. (2017) found evidence of an association between early food insecurity in children and social-emotional outcomes and approaches to learning. These researchers also discovered associations between early food insecurity and reading and math outcomes.

Citing studies from Pennsylvania, Massachusetts, Illinois, and Canada, Johnson and Markowitz (2017) found that food insecurity during the first five years of life (those that lay the foundation for the skills needed to master kindergarten) is damaging to children by (1) indirect effects due to the influence on parental well-being; parental stress and depression; parent being less sensitive to the child’s needs; child engages in fewer activities that stimulate development; stress from a hungry child being irritable, thus negative parent responses (2) direct effects through brain growth disruption of children and physical development, limited nutrition in diet, impede memory, behavior and attention span. Less advanced motor skills and increased isolation are also noted.
Additionally, using the early Childhood Longitudinal Study-Birth Cohort, this research found that at nine months, food insecurity was associated with increased hyperactivity, problems with conduct, and reduced reading and math scores in kindergarten. At two years, food insecurity was associated with increased hyperactivity, problems with conduct, decreased approaches to learning math skills, and decreased reading performance in kindergarten. Finally, at preschool, food insecurity was significantly linked with decreased approaches to learning and reduced reading scores (Johnson & Markowitz, 2017).

Alaimo et al. (2001) note that food-insecure students are more than twice as likely to fail a grade and miss more days of school. Additionally, this researcher discovered that food insecure students age six to eleven had a negative association with academic ability in math (Alaimo et al., 2001). Perez et al. (2012) parallels this data and notes a correlation between high food insecurity among children and academic and emotional outcomes.

Spies et al. (2014) studied specifically the educational impact of poverty and hunger on students with disabilities. In 2011, 15% of US population lived in poverty, and 21.9% of our children younger than 18 years old were living in poverty, most prevalent in children with disabilities. One detrimental condition of poverty that directly affects students’ development and academic achievement is food insecurity. As hunger can present itself as a physical ailment, as poor concentration and lethargy, or through behavioral changes, it does impact the academic performance of children in the classroom, particularly with students with disabilities.

To help alleviate the effects of hunger on students with disabilities, Spies et al. (2014) note that teachers can play a pivotal role in recognizing the signs of hunger by building a supportive classroom environment where students feel open to share information, be informed about resources to help families who are food insecure, observe student behavior in the cafeteria,
have healthy snacks available in each classroom and identify food banks and pantries in the neighborhood and communicate that information to families.

Perez-Escamilla and Vianna (2012) echo the effects of poverty on families noting that household food insecurity is caused by poverty of the mother, members in the household have less that average health, and less than optimal living conditions. Additionally, household food insecurity affects children’s mental, physical, social, and emotional advancement, along with poorer academic success and intellectual preferment later in life. Solutions offered by these researchers include improved access to mental healthcare, child development and enrichment programs, and increased access to programs that offer healthy food options (Perez-Escamilla & Vianna, 2012).

McIntyre et al. (2017) used the National Longitudinal Survey of Children and Youth study to examine the effects of child hunger on educational attainment, and noting that adaptive behaviors are shaped by one’s environment and socioeconomic status, children in low-income households attain lower tests scores, repeat grades more often, and achieve lower levels of education compared to higher-income households.

Finigan et al. (2015) conclude with a simple statement; child hunger impacts the education and health of our students. Lastly, children struggling with poverty and or food insecurity experience lower academic performance and lower health outcomes (Slopen et al., 2010).
Chapter 3
Methodology

After a restatement of the research questions, the present chapter begins with an explanation of the general methodology employed in this study—specifically, a geospatial analysis of data, done with the help of state-of-the-art GIS software that support with real-world applications. In the next section, the conditions under which the data were collected are outlined and a description of geospatial analytic methods is provided. The study’s primary research questions are provided below:

1. How should we conceptualize and measure food bank deserts?

2. Which sites in the Mid-South are potential locations of food deserts in relation to the socio-demographic characteristics of neighborhoods of Title I schools?

Data

Rather than decontextualizing data, as with traditional statistical methods, geospatial tools situate food bank partner agency locations within contextual maps of broader data. This data includes:

(1) The 2020-21 Common Core of Data (CCD) preliminary files, identifying Title I schools.
(2) Point data for geocoded locations of Mid-South Food Bank programs and agencies in the mid-south area, Shelby County, Tennessee; Crittenden County, Arkansas; and DeSoto County, Mississippi.
(3) Bus routes and stops shapefiles containing the Memphis Area Transit Authority (MATA) bus stops from the Memphis City Data Hub.¹
(4) The newly released 2016–2020 American Community Survey 5-year estimates, raising our understanding of the social and economic characteristics of the population.

¹For more information, see https://data.memphistn.gov/dataset/MATA-Bus-Stops/hx3j-4s9r and https://data.memphistn.gov/stories/s/About-Us/c992-uc3g/.
Following Chapter 2, this study extends the literature on food deserts study by offering suitable constructs of food bank deserts based on two key measures:

- **Low-income standard** – census tracts that represent high-need areas, as measured by the socioeconomic need (SNI) index.
- **Low-accessibility standard** – census tracts that do not have bus stops and are not within walking distance to food bank partner agencies.

As proxy for low-income standard, this study utilizes a breakdown of the six socioeconomic need variables that make up the socioeconomic need index. The need index (SNI) is a normalized socioeconomic status measure for all census tracts developed from six measures understood to represent disadvantage: percent of adults older than age 25 with less than a high school education; percent unemployment; percent of households with income below the poverty line; percent of households receiving public assistance; percent of female-headed households with children; and median household income. The SNI is scaled such that the higher number indicates more tract disadvantage than a tract with a lower number. The SNI index is created using Geographic Information Systems to measure acute disadvantage census tracts. Specifically, the color scales of tones (colors from yellow to brown) represent areas of low need to high need. The light color [yellow] expresses small values, while dark color [brown] expresses large values.

As proxy for low-accessibility standard, census tracts that contain bus stops are selected as layer features, which are shown in grey color polygons. These polygons are distinguished from different tones of color of census tracts (areas of low need to high need) that do not have bus stops. The idea is that food banks that fall within the grey color polygons (census tracts) represent areas that can be accessed by bus public transportation. In addition, Title 1 schools that contain bus stop census tracts (grey color polygons) are juxtaposed with Title 1 schools but no bus stop census tracts. The last step in the process is to identify Title 1 schools with no bus stops and not within walking distance to a food bank. According to the previous literature, walking
distance is measured at 1.5 miles. Thus, food bank deserts are captured in terms of high need tracts, tracts with no bus stops and more than 1.5 miles walking distance to a food bank.

Due to data constraints, only the Shelby County (Tennessee) context contains the full set of variables to identify suitable locations of food bank deserts, while the two other research contexts of this study, namely DeSoto County (Mississippi) and Crittenden County (Arkansas), do not account for transit availability (public transport facilities such as bus). The table below describes the full set of geographic variables contained in this study.

<table>
<thead>
<tr>
<th>SNI at census tract (visualize community demographics) 2016–2020 American Community Survey 5-year estimates – Census data</th>
<th>The need index (SNI) is a normalized socioeconomic status measure for all census tracts developed from six measures understood to represent disadvantage: percent of adults older than age 25 with less than a high school education; percent unemployment; percent of households with income below the poverty line; percent of households receiving public assistance; percent of female-headed households with children; and median household income. The SNI is scaled such that the higher number indicates more tract disadvantage than a tract with a lower number. Census data are provided in the form of boundaries (polygons).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title I school locations</td>
<td>The 2020-21 Common Core of Data (CCD) preliminary files, identifying Title I schools (In schoolwide Title I schools, at least 40% of children are from low-income families). This data produced geocoded address points, which in turn generated point features. Using ArcGIS, a new layer from a selection of features was created to identify Title 1 schools.</td>
</tr>
<tr>
<td>Food bank partner agency locations</td>
<td>Mid-South Food Bank programs and agencies in the Mid-South area, Shelby County, Tennessee; Crittenden County, Arkansas; and DeSoto County, Mississippi. The geocoded point features from addresses produced point layers.</td>
</tr>
<tr>
<td>Bus routes and bus stops (Point shapefile)</td>
<td>Point shapefiles containing the Memphis Area Transit Authority (MATA) bus stops from the Memphis City Data Hub. Bus routes and stops were constructed from point data.</td>
</tr>
</tbody>
</table>

Variables

The data obtained from American Community Survey (ACS) served as proxy variables for determining the economic context and the socioeconomic need index (SNI) in census tracts.
1. Percent of adults older than age 25 with less than a high school education
2. Percent unemployment
3. Percent of households with income below the poverty line
4. Percent of households receiving public assistance
5. Percent of female-headed households with children
6. Median household income

Variable definitions and sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Income</td>
<td>Median income in the past 12 months</td>
<td>American Community Survey</td>
</tr>
<tr>
<td>Percent unemployment</td>
<td>Percent unemployment (population 16 years and over)</td>
<td>American Community Survey</td>
</tr>
<tr>
<td>FOOD STAMPS/Supplemental Nutrition Assistance program (SNAP)</td>
<td>Percent of households receiving public assistance</td>
<td>American Community Survey</td>
</tr>
<tr>
<td>Households and families-percent of female-headed households with children</td>
<td>Percent of female-headed households with children</td>
<td>American Community Survey</td>
</tr>
<tr>
<td>Educational attainment-less than high school</td>
<td>Percent of adults older than age 25 with less than a high school education</td>
<td>American Community Survey</td>
</tr>
<tr>
<td>Poverty status</td>
<td>Percent of households with income below the poverty level</td>
<td>American Community Survey</td>
</tr>
</tbody>
</table>
Method of Analysis

The instrument used for quantitative data analysis is GIS mapping. The GIS framework is used to collect, organize, and analyze data. It has roots in geography as a science. Geospatial data can be created, managed, visualized, analyzed, and interpreted using GIS. Through its unique capabilities, GIS can uncover rich information from data, such as relationships, patterns, and situations, enabling one to make smarter decisions (ESRI 2011, n.d.). ArcMap, an ESRI ArcGIS software product, was initially released in 1999. However, the first mass-market, dual-core processor meant for desktop computers was not released until 2005; thus, there was no parallel computing. Utilizing ArcGIS, we can produce maps to visualize our data and make it easy to understand. Understanding what has happened, what is happening, and what will happen in a specific geographic area requires the use of GIS. To assist us make better judgments regarding the difficulties we confront on a local scale, it uses geographic understanding to help solve spatial problems. This program offers the features and resources needed to save, examine, and
present geographic data. Additionally, it provides the tools needed to input, manipulate, and query geographic data (ESRI 2011, n.d.).

ArcGIS has been used in many research programs to capture the complex relationships between transportation, land use and coastal storm surge. Higgins et al. (2022) utilized ArcGIS, along with other software tools, to calculate geographic accessibility in Toronto, Canada, by walking and use of public transit. These researchers found significant differences in computation time and calculated accessibility. Balstrom and Kirby (2022) used ArcGIS to provide an overview of storm surge-induced inundation impacts along coastlines in Copenhagen and where to consider mitigative action. Additionally, to better understand the biogeography, population, and economic activity connected to mountains in Canada, McDowell and Guo (2021) conducted geospatial analysis using ArcGIS Pro. In terms of a variety of environmental and socioeconomic criteria, their findings demonstrated the significance of Canadian mountain systems on a national and international level. Lastly, a geography professor at a college in Southern California used GIS to create a community-based learning initiative that concentrated on food waste and food insecurity. The goal was to evaluate and promote the development of initiatives that would guarantee inhabitants of North County and San Diego had access to enough food and improve the equity, sustainability, and health of the current food system (Baumann, 2020).

Indeed, geographic information systems (GIS) provided the tools necessary to compare different geospatial datasets, and eventually derive an index that was representative of all the variables combined. This ability is critical to developing the SNI.

Spatial join techniques are useful for joining data from another layer based on spatial location. A case in point, the spatial location of Title 1 schools contained in census tracts with no bus stops were spatially joined to point location data of food banks to generate the distance to the
nearest food bank agency. This output attribute table that produced a column of mile distance between each Title 1 school and nearest food bank. The sorted distances identified those in walking distance (1.5 miles) and those exceeding walking distance (more than 1.5 miles).

Interactive feature selection highlights and chooses a subset of features on the map to use in subsequent exploration or analysis of geospatial data. In this study, the interactive select features enabled the identification of census tracts with no bus stops – a key measure of lack of access to food banks partner agencies.

The overlay operations contain tools to overlay multiple geospatial features to display the features of an additional polygon layer. A case in point, this study overlaid multiple data sets (representing school accessibility differences to food bank pantries) together for the purpose of identifying relationships between them.
Chapter 4
Results

Research on food deserts has brought new attention to questions of spatial accessibility to the food insecure. As an exploratory exercise, I carried out expanded criteria for Food Bank Deserts to examine accessibility to food bank partner agencies where food insecure students and families in low-income areas have access to food. My criteria expand Waity’s (2016: p 112) concept of food assistance deserts “where the population center of a census block group is more than one mile from a food assistance agency”. This definition excludes the two essential criteria for a food desert of low-income and low access.

My expanded criteria of a food bank desert include low-income and low access by public transit and walking distance. I examined the location of Title I schools in three target counties, Shelby County, TN; DeSoto County, MS; and Crittenden County, AR. Title I schools represent those families in neighborhoods who are more distressed compared to lower need SNI. Also, only Shelby County has public transportation, so that is the only county with mapped bus stops.

My focus on the following 12 maps is on SNI in all counties, the locations of Title I schools, locations of food bank partner agencies, and accessibility food at a pantry. To examine accessibility, I looked at accessibility to bus stops, if possible, and distance from the Title I schools to a food bank partner agency. If the distance was within the 1.5-mile acceptable walking distance from a Title I school, students and families had access to food from a food bank pantry. If a Title I school is in a high SNI, in a census tract with no bus stops, and more than 1.5 miles to a food bank partner agency, that school is food bank desert eligible.
Shelby County, Tennessee

Map 1 - Shelby County Census Tracts -SNI Index- Food Banks, Title 1 Schools

These data were mapped using a Geographic Information System (GIS). Maps 1 to 12 provide a cursory view of food bank deserts. Census tracts are shaded according to level of socioeconomic distress; darker shading represents higher scores on a composite index of socioeconomic distress. Map 1 shows all of Shelby County, TN, with locations of Mid-South Food Bank partner agencies denoted with blue circles, and Shelby County Title I school locations denoted with green triangles relative to the census tracts. All data are point data. Note the highest poverty areas in Shelby County are located around Memphis proper. The outer suburban areas in Shelby County are mostly the lower poverty areas, as depicted with the lighter shading. Additionally, most of
the Title I schools appear to be in high SNI areas, denoted by the dark brown color, and in Memphis. It shows a spatial clustering of local food bank programs to entrenched pockets of disadvantaged, as illustrated by brown gradient backgrounds. The SNI index in these neighborhoods is varied in the range between 22.7 and 61.15, with the greatest concern being those who live in SNI 30.14 and higher.

Map 2 – Shelby County Census Tracts – SNI Index – Bus Stops

As most of the MATA routes are found in the Memphis area census tracts, these tracts have access to bus stops and are shown in gray areas. Map 2 shows the context of Shelby County with bus stops and highways. The red dots represent bus stops. Most of the high SNI areas of Shelby County overall have access to the bus system.
This important map shows MATA bus system information in Shelby County. The gray area in Map 3 represents census tracts with bus stops, overlayed by food banks as points. This transportation file is point data and the points represent food bank partner agencies either accessible to bus stops, or not. If a census tract is outside of the gray area, there are no bus stops in that census tract. This visual pattern shows light blue circles that represent the food bank partner agency locations that are accessible to bus stops. The dark blue circles represent food bank partner agencies that are not accessible to bus stops. These agencies are mostly in low need areas, low SNIs. So, having poor food bank pantry agency access in these areas is of less concern. Note one food bank location in the top right corner of the map that is in a yellow
census tract. It is close to a higher need area and is located where it is because the agency that partners with the food bank agreed to open a pantry at that location to serve families in the neighboring census tract. That is the only one, as most pantries are located in medium to high need areas. The pantries, or food bank partner agencies, are also in middle income areas; and circle between high need and low need.

Map 4 – Shelby County Census Tracts - SNI Index – Title I Schools Accessibility to Bus Stops

This map shows all census tracts that have bus stops and no bus stops, overlayed by Title I schools as point features. If a census tract is outside of the gray area, there are no bus stops in that tract. Light colored triangles represent Title I schools that are accessible to bus stops, relative to the dark green triangles that represent Title I schools with no accessibility to bus stops.
stops. A map overlay of Title I schools not in bus stop census tracts represents visual information of high-to-low SNI and lack of accessibility to bus stops.

Map 5 – Shelby County Census Tracts – SNI - Title I School Accessibility Differences to Food Banks

Map 5 juxtaposes no bus stop census tracts and no walk to food bank pantries with no bus stop census tracts and walk to food bank partner agencies, rounding up this study’s core features of low-accessibility standard. Once again, the gray area shows where one has access to bus stops. The gradient colors are high-need to low-need areas, overlaid by no bus stop census tracts and no walk to food bank pantries versus contrasted with no bus stop census tracts and walk to food bank pantries. Note the medium green triangle with a black outline in areas that are not gray. Students and families can walk to food bank partners because it is less than 1.5 miles from a
Title I school. However, the dark green triangle shows no access to a bus stop and one cannot walk to a food bank pantry, as the distance is beyond that 1.5 miles from the school. The focus here is on schools that are food bank desert eligible.

Map 6 – Shelby County Census Tracts – SNI – Title I School No Accessibility to Food Banks by Bus or Walking

Now, Map 6 zeroes in on food bank desert eligible. Again, the three criteria include:

1) High SNI
2) No accessibility to a bus stop
3) Beyond the 1.5-mile radius from the Title I school to a food bank partner agency.

The green triangles in the yellow census tract are not food bank deserts, as they are not in high need areas. The green triangle in the upper middle census tract would be food bank desert
eligible. It is a Title I school, with no bus stop, one cannot walk to a food bank partner agency, and it is in a high need census tract. Note, the threshold for high census tract is 22.7 and above. Following these criteria, these are food bank desert eligible. In Title I schools that are in more affluent areas, the residents are more likely to have access to an automobile. Low-income residents, however, may not have access to transportation, cannot walk beyond 1.5 miles from a Title I school to food bank pantry, and are most eligible to be in food bank deserts. The table below shows the average walking distance to food banks— a mean of 1.77 miles. There are twenty-one food bank deserts eligible in Shelby County, with distances ranging from 1.72 miles to 4.68 miles.

Table 3: Descriptive Statistics: Average Walking Distance (Miles) to Food Banks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Food Banks</td>
<td>41</td>
<td>1.766</td>
<td>1.281</td>
<td>0</td>
<td>4.679</td>
</tr>
</tbody>
</table>
Map 7 shows SNI for the census tracts in DeSoto County, MS where residents do not have access to public transportation, so access to bus routes is not possible. Additionally, this map shows food bank partner agencies relative to the SNI index. Of the food bank partner agencies in DeSoto county, five are solidly in high need areas, while the others are close to high need areas.
Map 8 illustrates the food bank partners relative to the Title 1 schools in DeSoto County. Note the lower center of the map has two food bank partner agencies where there are no Title I schools in the immediate area. For the most part, partner agencies are located somewhat close to high need areas as noted by locations of Title I schools and in, or close to high SNI.
Map 9 shows the distance of food bank partner agencies relative to Title I schools. The light green triangles represent schools where one can walk to a food bank. The dark green triangles represent schools where you cannot walk to a food bank partner agency, as it is beyond the 1.5-mile distance, so per my criteria, that school is food bank desert eligible. We are not concerned with the school in far right because it is in low SNI census tract and does not meet the first criteria of low income. Dark green triangles in high SNI are eligible food bank deserts because they fall within my criteria. Note the two schools on the far-left side of the map, in deep brown, fall within the criteria of food bank deserts. The table below shows the average walking
distance to food banks—a mean of 1.998 miles. Accordingly, there are fourteen food bank deserts eligible in DeSoto County, with distances ranging from 2.44 miles to 4.37 miles.

Table 4: Descriptive Statistics: Average Walking Distance (Miles) to Food Banks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Food Banks</td>
<td>23</td>
<td>1.998</td>
<td>1.095</td>
<td>.481</td>
<td>4.375</td>
</tr>
</tbody>
</table>

Crittenden County, Arkansas

Map 10 – Crittenden County Census Tracts – SNI – Food Banks

Map 10 shows SNI for the census tracts in Crittenden County, AR where residents do not have access to public transportation, so like in DeSoto County, MS, access to bus routes is not possible. This map depicts SNI relative to food bank partner agencies. As previously seen from
the other two counties, most of the food bank pantries, all but one in the case of Crittenden County, are located in high SNI census tracts. It is worth noting that in this county because it is so rural, there are many areas that do not have access to food through a food bank partner agency. Though the average SNI in Crittenden County, AR, is 22.595, Map 10 indicates that food banks are in very high need areas as shown in deep brown color.

Table 5: Descriptive Statistics: Average SNI in Crittenden County, AR

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNI in Crittenden County</td>
<td>20</td>
<td>22.59</td>
<td>9.097</td>
<td>7.951</td>
<td>36.766</td>
</tr>
</tbody>
</table>

Map 11 – Crittenden County Census Tracts – SNI – Food Banks and Title I Schools
Map 11 illustrates locations of food bank partner agencies, depicted with a blue circle, and the locations of Title I schools, represented by green triangles. Most Title I schools have a food bank pantry in close proximity.

Map 12 – Crittenden County Census Tracts – SNI-Food Bank Distance to Title I Schools

Map 12 rounds out this analysis by a visual view of Crittenden County, AR. This map illustrates accessibility by walking distance from a Title I school to a food bank pantry. The light green triangles represent schools that are within walking distance to food bank locations. The dark green triangles depict schools beyond 1.5 miles from food bank partner agency and cannot be accessed by walking. Like Map 9, this map shows four Title I food bank desert eligible
schools. The table below shows the average walking distance to food banks— a mean of 2.653 miles. There are four food bank deserts eligible in Crittenden County, with distances ranging from 1.66 miles to 16.13 miles.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Food Banks</td>
<td>17</td>
<td>2.653</td>
<td>5.084</td>
<td>.185</td>
<td>16.128</td>
</tr>
</tbody>
</table>

**Summary**

The gradient color scheme in yellow, orange, and brown colors represent high-need to low-need areas, proxied by the SNI. The geospatial analysis shows that the Mid-South’s food bank pantries are in high-needs areas of Shelby County, DeSoto County, and Crittenden County. However, this study identified specific service areas that comprise the low-income standard and low-accessibility standard of food bank deserts. Specifically, there are twenty-one food bank deserts eligible in Shelby County, fourteen food bank deserts eligible in DeSoto County, and four food bank deserts eligible in Crittenden County. Such an analysis is of great value to local communities and stakeholders because it allows the Mid-South Food Bank and its networks to make great strides to enhance access in the food environment.
Chapter 5
Conclusions

Although there is plenty of food in this country and no one should go hungry, Feeding America reports over 33 million people were food insecure in the U.S. in 2021, and that includes 9.3 million children (Feeding America, 2023). Children in school-age groups are more likely to face a range of health and wellness issues, making them more susceptible to food insecurity. Before enabling kids to realize their full academic and social potential, food insecurity must be reduced or eradicated. (Snelling et al., 2014).

Children in high-poverty schools do not have consistent access to food based on where they live and where they go to school. With this in mind, the purpose of this study was to operationalize the concept of food bank deserts in K-12 schools. I examined to what extent the geographic concentration of local food bank programs is clustered in the larger interlocking context of neighborhood poverty.

The case study I used was Mid-South Food Bank, which serves 31 counties, in three states in the midsouth. The largest county, Shelby County, includes Memphis, Tennessee, which has a history of deep poverty and persistent disadvantage in education. Consistent with Robert Sampson’s focus on ecological differentiation, I examined high-poverty neighborhoods (high SNI census tracts) that do not have bus stops and in public schools with NSLP students (Title I schools) but are in areas with no food bank partner agencies, that is, food bank deserts. I used GIS mapping to examine the spatial connections (or lack thereof) between the food bank partner agencies, where people can access food, and disparities in neighborhood socioeconomic characteristics.
These geospatial tools situated food bank partner agency locations, in three counties in the midsouth, within contextual maps of broader data, including the 2020-2021 Common Core of Data, identifying Title I schools, 5-year estimated from the 2016-2020 American Community Survey, and route shapefiles identifying bus stops. Combining the results of mapping using the Proximity toolset in ArcGIS Pro to operationalize the low-access and low-income standards across neighborhood school contexts of food bank deserts, answers to the two primary research questions could be assembled.

The research questions being answered by this study:

1. How should we conceptualize and measure food bank deserts?
2. Which sites in the Mid-South are potential locations of food deserts in relation to the socio-demographic characteristics of neighborhoods of Title I schools?

The literature focuses on food deserts, and now, food bank deserts is a dominant theme when discussing food insecurity, especially among children. However, previous literature has not addressed food bank deserts and the part they might play in lack of access to consistent, nutritious food in low-income neighborhoods and high-poverty schools. This research addresses that void.

This study, understanding the phenomenon of food bank deserts, is seen in terms of Robert Sampson’s (2012) focus on ecological differentiation, defined in terms of urban inequalities and clustering by social characteristics. I have discussed his book *Great American City*, and how Sampson demonstrates the powerful effects of ecologically concentrated disadvantage on a wide range of outcomes and social behavior in what is known as social area analysis.
Sampson's major elements of neighborhood variation include racial/ethnic mix, residential stability (property ownership and tenure), kid density, family structure and life cycle (female-headed households), and poverty. His line of inquiry is similar to over a century of neighborhood ecological research (Dauter & Fuller, 2016; Odgers et al., 2012), which suggests that interlocking neighborhood conditions such as concentrated poverty and disadvantage often make neighborhood differences such as food deserts and food bank deserts highly visible.

Following this theoretical lens, this study examined the clustering of census tracts with no food bank partner agencies within walking distance to a Title I school, no access to a bus stop, and in high-poverty neighborhoods. With this, I am now able to identify Title I schools that are food bank desert eligible.

As scant research has been done on food bank deserts, the few previous studies omit the low-income and low-access criteria when identifying these phenomena. My research, however, corrects this shortfall. Additionally, this study empirically measured the spatial relationship between Title I schools and food bank pantries.

**Discussion and Analysis**

My findings support the continuing salience of the social context of food bank deserts, especially as manifested in urban inequalities and neighborhood differentiation. My maps reveal the importance of ecological differentiation, highlighting the extent of food bank deserts in distinct spatial communities. I highlight the interlocking context of food bank deserts with neighborhood poverty, transit walk accessibility, and educationally disadvantaged students in public schools (Title I schools).

Because schools are often the main source of food for children in underserved communities, any efforts to address community food security access in these contexts must show
that local food bank programs are spatially proximate to low-income neighborhoods to entrenched pockets of disadvantage. Using Title I schools to identify disadvantaged neighborhoods, this research has accomplished that.

Expanding on Sampson’s (2012) theory of ecological differentiation and its implications includes neighborhood effects. The neighborhood we grow up in matters and as this research examined neighborhoods from an SNI census tract and Title I school level, a more detailed study would include a unit of analysis called block groups. A block group is a small cluster of individual blocks in a neighborhood and would allow granular factors to be accounted for, including how many and specifically where food is most needed (marigallagher.com).

For the most part, Mid-South food Bank has strategically placed partner agencies in census tracts with high to medium SNI. One of the challenges the food bank faces is the willingness of partners to open and run a food pantry. Most managers of food pantries are volunteers, so where they are placed is in large part where the partner has access to a brick and mortar building and where the manager can work.

However, practical implications for this research and recommendations for Mid-South Food Bank to address the food bank deserts uncovered in this research is to closely examine the neighborhoods in the three target counties and prioritize need in these potential food bank deserts. The food bank should do a deep dive of food assistance needs in the 21 potential food bank deserts in Shelby County, TN; the 14 in DeSoto County, MS; and the 4 potential food bank deserts in Crittenden County, AR, and prioritize food pantries in these Title I schools, as well as conduct mobile pantry distributions in these neighborhoods. Mobile distributions would allow the food bank to provide consistent access to nutritious food in these neighborhoods without the need for a brick and mortar pantry, which is often a concern in ensuring equitable access to food.
Following previous literature, my study identifying food bank deserts meets the low-income and low accessibility standard. That is, a census tract in low socioeconomic neighborhoods with no Mid-South Food Bank partner agencies serves as a reasonable indicator of a food bank desert. If one of the concerns of the traditional conception of a food bank desert is a lack of ready access to fresh, healthy, then the analogous concern of food bank deserts in the socioeconomic contexts of K-12 schools would be that high-need schools (Title I schools) and high-need neighborhoods are not in spatial proximity to food banks that address food insecurity.

To fulfill the low-income standard, this study builds a “socio-economic need index” that has been used in prior studies (Gulosino & Lubienski, 2011; Lubienski, Gulosino, & Weitzel, 2009). The “socio-economic need index” estimates the degree of disadvantage in each census block group. The need index is constructed from a select set of socio-economic indicators that are shown to be predictors of low-income concentration given existing literature on vulnerable people and places (Gulosino & Maxwell, 2018; Wheeler, Czarnota & Jones, 2017).

While opinions differ on the best ways to affect students' and parents' travel habits in order to integrate them into the neighborhood, most people agree that having access to public transportation within walking distance is essential to giving people access to opportunities in life as well as to services and activities like neighborhood food banks (Daniels & Mulley, 2013). Comprehending the peculiarities and fluctuations of the regional terrain and public transportation system is crucial in augmenting an evidence foundation beset by an insufficiency of empirical data and analysis about enhancing food accessibility in marginalized groups.

Presumptions on the accessibility of transit walks presume proximity. By testing children's endurance with the 6-minute walk test developed by Li et al. (2005), neighborhood walkability can also be investigated at a more detailed level. It has been demonstrated that the 6-
minute walk test is a legitimate and reliable way to assess children's functional capacity as well as their ability to walk to local schools, if that is a viable option for them. Using "within walking distance" measurements to evaluate low accessibility, this study expands this literature to investigate the notion and concepts of food bank deserts in more detail.

Reviewing Maps 1, 5 and 6, we see that most Shelby County agencies are located in high SNI and have access to bus stops. Map 6, however, allows the isolation of Title I schools that are food bank desert eligible. Of the 21 possible food bank desert eligible schools, 11 are in high to medium SNI, with no bus stops, and not within walking distance to a pantry. Additionally, Mid-South Food Bank should analyze the neighborhood of the school in the deep brown SNI in the far south of Map 6. With no food bank partner agency nearby, it would be important to seek additional resources to serve families living in that high poverty neighborhood.

Map 9 is important in analyzing service to families and children in DeSoto County, MS. Because there is no public transportation in this county, access to food without a vehicle can be a challenge. Mid-South Food Bank, for the most part, strategically places pantries in medium to high SNI. However, a deeper dive into how students and families in the neighborhoods in the far west of the county access food is paramount.

Lastly, Crittenden County on Map 11 shows that pantries are located in medium to high SNI, and close to Title I schools. Of the four title I schools that are food bank eligible, of most concern is the school and low-income neighborhood in the far west of the county.

Overall, acknowledging the mission of Mid-South Food Bank is to change lives by eliminating hunger in the Mid-South (midsouthfoodbank.org), this research is an important step in examining high food insecurity rates among children in these three target counties, as well as
further research on the other 28 counties this food bank serves. Focusing on the neighborhoods where Title I schools are located, a construct for low-income families, and accessibility to food bank pantries would advance the mission of the food bank to eliminate hunger in these counties, particularly among children. Again, analysis at the block level would expand our knowledge of food insecurity in our low-income neighborhoods.

Limitations and Future Direction

As this research had its limitations, with no comparisons of time, my expanded research will include data from 2018-2022 to analyze pre-COVID, during COVID, and post-COVID. As we all know, COVID was a rare event, many people lost their jobs, and people who ordinarily would not rely on food bank pantries found themselves in need of food assistance for the first time in their lives. My future research will do a comparative analysis of pounds of food distributed by food bank pantry, the number of people served each year during that 5-year span, and what areas of high need are not currently being met in the 31 counties in Mid-South Food Bank’s service area. However, despite its limitations, this study is a good preliminary analysis to identify food bank deserts, and stands as an adequate subset of food deserts.

My findings serve as a template for further analysis of food bank deserts in urban and rural school contexts. At present, there is no systematic effort to track the localized contexts of hunger and food access that food providers and public schools face in alleviating food insecurity in the community. My ongoing research is useful for providing surveillance for areas that may be at risk of becoming food deserts and food bank deserts. As well, future directions in research may involve finding clusters of Title 1 schools near to Title 1 schools in food deserts to develop a networked approach to food access.
My current research of three midsouth counties as well as my expanded comparative research over time can be replicated to all counties in the U.S. Even though all 200 food banks in the country work a little different, they all have their own service area that they are responsible for, and comparing different parts of the country would add great value to the work all food banks do all over the country. Exploring more sophisticated quantitative analysis, using national data, GIS, and regression, a future master map of where food deserts and food bank deserts are for each food bank and each county the food bank serves would allow better decision making regarding who is not currently being served and how might those children and families be reached. Solving hunger issues at the school and neighborhood levels would go a long way in decreasing the number of children that do not know where their next meal is coming from.

My research can also aid local providers in formulating policies suited to the specific needs of these communities. There are three policy implications with this research: 1) provide more support for the presence of food bank pantries inside schools; 2) ensure adequate resources for expanding food bank pantries that are within walking distance to a Title I school; and 3) ensure accessibility of Title I schools to bus stops.

Finally, my future research on food bank deserts will include mixed methods design. Mixed methods design is research that involves the researcher combining elements of both qualitative and quantitative approaches for a particular study. It is a context-specific utilization of multiple approaches to research, interwoven into the inquiry process to address a research problem and build a cohesive narrative to solve it. This research method works to solve problems that involve multiple systems. The goal is to inform the work of leaders and stakeholders as they decide how to tackle the complex policy questions in their particular contexts (Creswell & Clark, 2017).
I will add qualitative practices to my research to include interviews, document reviews, and focus groups. This will allow great dialogue in neighborhoods with Title I schools, school administrators, parents, and food banks with their partner agencies. This mixed method approach will mitigate some of the limitations inherent in employing a singular method and help gain a comprehensive, deeper understanding of food bank deserts and how to eliminate them as well as eliminate child hunger in all our communities.
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Appendix A

Definition of terms

*ArcGIS Pro 3.0:* ArcGIS Pro 3.0 is a later version of the desktop GIS. In 1982, the original version of the ArcGIS system's core was made available. In order to avoid the high cost of a workstation, ArcGIS Desktop was released in 2001, and this version was transferred to the Windows operating system. ArcGIS Pro 3.0 was created to utilize GIS services easily and to exploit multicore 64-bit computers fully. It also introduced a new mechanism for managing tasks (Price, 2023).

*Common Core of Data (CCD):* The Common Core of Data (CCD) is the Department of Education’s primary database on public elementary and secondary education in the United States. It is an exhaustive annual database of all public elementary and secondary schools as well as educational districts around the country (National Center for Education Statistics, 2023).

*Ecological Differentiation:* Ecological Differentiation is defined as urban inequalities and clustering by social characteristics. In Robert Sampson’s (2012) book, *Great American City,* he demonstrates the powerful effects of ecologically concentrated disadvantage on various outcomes and social behavior in what became known as social area analysis. Sampson’s key dimensions of neighborhood difference include poverty, family structure and life cycle (female-headed households, child density), residential stability (home ownership and tenure), and racial/ethnic composition.

*Esri:* Esri is the Environmental Systems Research Institute, Inc. This company developed and sells the ArcGIS system (Price, 2023).
Food Distribution Program on Indian Reservations (FDPIR): Food Distribution Program on Indian Reservations is a federal program administered by USDA to provide food to income-eligible households living on Indian reservations and to Native American households residing in designated areas near reservations or in Oklahoma (U. S. Department of Agriculture; Food and Nutrition Service, 2023).

Food Banks: Food banks are 501(c)3s, nonprofit organizations that partner with Feeding America, the nation’s largest domestic hunger-relief organization, and provide food to people facing hunger in the United States. The food banks work with partner agencies in their communities to help distribute food locally, directly to individuals and families (Feeding America, 2023).

Food Bank/ Pantry deserts: Food Bank/pantry deserts, also called food assistance deserts, are areas where people lack access to food aid (Waity, 2016).

Food deserts: A food desert as an “area in the United States with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower-income neighborhoods and communities” (Waity, 2016, p. 108). Wider-Lewis et al. (2018) expand the concept of a food desert to include when grocery stores, supermarkets, or farmer's markets are far away and there is a lack of fresh fruits and vegetables.

Food insecurity (food insufficiency): Food insecurity is the inability to obtain food in socially acceptable ways or the limited or uncertain supply of nutritional and safe meals (Cook & Frank, 2008). Swafford et al. (2021) note that food insecurity means a lack of food quantity and not having access to nutritious food.

Food Systems: The actions involved in the production, processing, transportation, and consumption of food are all part of the food system. The governance, economics, sustainability,
amount of food wasted, and effects of food production on the environment are all aspects of the food system (Diaz, 2020).

**GIS:** GIS is a geographic information system. In real life, a GIS is a set of computer tools that enable users to interact with data associated with a specific geographic place. It is a database made specifically to handle map data. GIS offers data structures and functionalities for computer-based map data storage, analysis, management, and publication (Price, 2023).

**Hunger:** Hunger is the troubled or painful sensation caused by not having food (Cook & Frank, 2008).

**MATA:** The Memphis region's public transportation system is run by the Memphis Area Transit Authority (MATA). MATA, one of Tennessee’s largest public transportation providers, transports passengers on fixed-route buses, paratransit vehicles, and vintage rail trolleys throughout Shelby County and the City of Memphis (City of Memphis, 2023).

**NGOs:** NGOs are Non-governmental organizations. The United Nations defines NGOs as a non-profit, voluntary group of citizens organized at the local, state, or worldwide levels to address problems that promote the common good. NGOs carry out a range of services and humanitarian tasks (Symaco, 2016).

**NSLP:** The National School Lunch Program (NSLP), born from the National School Lunch Act of 1946 (Hinman, 2011), is one of the most extensive nutrition assistance programs for school-aged children in the United States and operates in public schools, non-profit private schools, as well as child care agencies (Hinman, 2011).

**Poverty:** Most people associate poverty with deprivation. It is the lack of money or the inability to obtain economic commodities that are seen as necessities, such as food, housing, or medical care. The 1960s saw the development of the current official definition of poverty, which
bases its calculation on pre-tax income. A family of four (two adults and two children) was considered poor in 2013 if its annual income was less than $23,624 (Falk & Spar, 2014).

**SNAP:** Supplemental Nutrition Assistance Program (SNAP) was previously known as the food stamp program. It is the country’s most extensive government-funded food assistance program and provides nutrition to low-income families (Hong & Henly, 2020).

**Spatial proximity:** The property of one feature being close to another feature in ArcGIS Pro 3.0. For example, it will test how close A features are to features in B (two class features). Using spatial operators to assess proximity, spatial queries extract features based on the criteria of how two layers are spatially connected (Price, 2023).

**TANF:** Temporary Assistance for Needy Families is a block grant created in the Personal Responsibility and Work Opportunity Reconciliation Act of 1996. This grant provides benefits and services to needy families with children (Falk, G. 2023).

**Title I schools:** In schoolwide Title I schools, at least 40% of children are from low-income families; “Title I funds” support the demonstration of achievement levels through “schoolwide programs” that are designed to benefit “all students, particularly the lowest-achieving” (Virginia Department of Education, 2020).

**Transit accessibility:** Transit accessibility refers to the ability of residents and workers to reach transit facilities, including bus stops and rail stations.

**USDA:** United States Department of Agriculture. This division of the federal government works to improve rural communities, protect and conserve our natural resources, and give the American people a reliable healthy food supply. It also supports the American agricultural economy. The Food and Nutrition Service (FNS) of USDA oversees the USDA nutrition
assistance programs, which give low-income individuals and children access to food, a nutritious diet, and nutrition education.
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PI Name: Charisse Gulosino
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Advisor and/or Co-PI:
Submission Type: Admin Withdrawal
Title: Exploring Food Bank Deserts and Child Hunger in the Socioeconomic Contexts of K-12 Schools
IRB ID: PRO-FY2024-89

From the information provided on your determination review request for “Exploring Food Bank Deserts and Child Hunger in the Socioeconomic Contexts of K-12 Schools”, the IRB has determined that your activity does not meet the Office of Human Subjects Research Protections definition of human subjects research and 45 CFR part 46 does not apply. This determination applies only to the activities described in the submission noted above and does not apply to any changes to this project. Please submit a new request to the IRB for a determination if any changes are made which lead to any questions about whether the activities are research involving human subjects.

This study does not require IRB approval nor review. Your determination will be administratively withdrawn from Cayuse IRB and you will receive an email similar to this correspondence from irb@memphis.edu. This submission will be archived in Cayuse IRB.

Thanks,

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