Exploring Food Accessibility and Social Vulnerability in Atlanta, Georgia

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Abstract

The current study offers an in-depth spatial analysis of food accessibility and social vulnerability in the City of Atlanta, GA. We used the Two-Step Floating Catchment (2SFCA) methodology to develop a food accessibility index (FAI) and combined that with CDC's social vulnerability index (SVI) to study the most vulnerable population with low food access. Using the 2020 Census data, we identified six main Census tracts where the socially vulnerable residents were affected the most because they had the least access to food within a 15-minute walk or 15-minute drive time in three distinctive regions in Atlanta. Our findings can be used by city officials to provide incentives for improving food access and by organizations looking for suitable regions to place new food-serving sites.

1. Introduction

Fresh and nutritious food is essential for a balanced diet and living a healthier life. However, the proliferation of large supermarket chains in the outskirts of inner cities and in more affluent areas has forced smaller, independent, neighborhood grocery stores out of business, thereby creating areas where affordable, varied food is easily obtainable to only those who have access to transportation (Guy et al., 2004). Furey et al. (2001) coined the term "food desert," describing an area where high competition from multiple large chain supermarkets has created a void in communities where stores are not economically feasible. There was a significant demographic change between 1970 and 1988 when many affluent households migrated to the suburbs, which is another reason why supermarkets also changed their locations (Bianchi et al., 1982). These trends signify an important shift in accessibility to fresh food, especially for the vulnerable population still living in inner cities. Prior work in different geographic regions has indicated that minorities and people of color are among those most strongly affected by lack of access to fresh food (Caspi et al., 2016), healthcare (Cubbin et al., 2001; Deaton & Lubotsky, 2003), and education (Luster-Edward & Martin, 2019).

The purpose of this study is to explore how social vulnerability and food deserts are connected by examining the current state of food accessibility in Atlanta, GA. Social vulnerability refers to the externalities that affect human health negatively (Agency for Toxic Substances and Disease Registry, 2018). Based on the usage of the Centers for Disease Control and Prevention (CDC), such externalities consist of 15 factors, including poverty, ethnicity makeup, and transportation availability (Agency for Toxic Substances and Disease Registry, 2018). By overlaying food access and social vulnerability measurements, we can locate regions where better food access is desperately needed.

We chose Atlanta because (1) it is a major metropolitan city in the US, being a capital and the most populous city in its state, Georgia, (2) it has a very diverse racial/ethnic composition, with a minority ethnicity as a majority. As the 38th populous city in the US, Atlanta is home to about 500,000 people, with Black being the dominant race/ethnicity (47.2%), followed by White (39.8%), Hispanic (6%), mixed race (5.8%), and Asian (4.5%) (The Columbus Dispatch, 2020). Since research on food deserts has been performed on a wide range of cities, we would like to add to the knowledge base regarding conditions surrounding food deserts of the city of Atlanta and examine whether Atlanta residents have been disproportionately affected by the lack of available healthy food options around them.

To understand the current state of food accessibility in Atlanta, we utilized geographic information systems (GIS) and employ a Floating Catchment Area (FCA) method (Plachkinova et al., 2018). By exploring the supply of food options and the demand for them from local residents, we created a food accessibility index, FAI, which highlights areas with little opportunity to get food within a 15-minute walk or 15-minute transportation time using a vehicle or public transport. We selected the above travel time

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threshold based on the current literature on preferences on time with regards to food access (Hamrick & Hopkins, 2012; Smith et al., 2010; Tenkanen et al., 2016; Yang & Diez-Roux, 2012). These findings can be used by decision makers to select sites for future supermarkets in food desert neighborhoods. This idea has gathered a lot of steam. Over the past decade, federal and local governments in the United States have spent hundreds of millions of dollars incentivizing and encouraging grocery stores to open locations in food desert areas (Devitt, 2019).

The results of this study can also help policy makers to propose zoning changes that would allow for more mixed development so that commercial and residential areas would be better integrated, which would reduce traffic and encourage more alternative transportation than driving a personal vehicle. Furthermore, inner cities have the advantage of strategic location and locals are more incentivized to own smaller grocery stores (Butler, 1997) [link], which stimulates the local economy by promoting entrepreneurship, which can lead to reduced poverty rates within the community.

2. Background

2.1. Food Deserts

Food deserts are usually characterized by poor access to healthy and affordable food. Some of the main consequences of this problem are social and spatial disparities in diet and diet-related health outcomes such as cardiovascular disease and obesity(Beaulac et al., 2009). The term "food desert" originated in Scotland in the early 1990s and was used to describe poor access to an affordable and healthy diet(Cummins & Macintyre, 2002). Although it can mean a literal absence of retail food in a defined area, studies of food deserts more commonly assess differential accessibility to healthy and affordable food between socioeconomically advantaged and disadvantaged areas (Cummins & Macintyre, 2002). Low-income elderly residents are among those most seriously affected by food deserts due to limited transportation options, strong attachments to local neighborhoods, fixed incomes, and physical limitations for food shopping (K. Fitzpatrick et al., 2016). Having a better understanding of the needs of these variable vulnerable populations is the first step in developing successful strategies to combat these issues.

Many researchers have looked into the various aspects of food deserts. For instance, a large body of literature has documented that low-income neighborhoods are more likely to have food deserts (Gordon et al., 2011; Powell et al., 2011; Zenk et al., 2017). Many public health researchers, policymakers, and advocates further argue that food deserts are an important cause of unhealthy eating (Bitler & Haider, 2011; Hilmers et al., 2012). Rates of obesity-associated diabetes are exceptionally high in this low-income adult population (Conway et al., 2018). The American Heart Association even made a clear statement that there is an obesity epidemic in the US at the moment (Powell-Wiley et al., 2021). Previous work on this topic has prompted more research to highlight areas that should have higher priority in terms of policy implementations and government subsidies.

2.2 Social Vulnerability

The concept of vulnerability is commonly found in human-environment research (Wu et al., 2002) and it can be defined as "the capacity to be wounded" (Dow, 1992; Kates, 1985) or the "potential for loss" (Cutter et al., 1996). The World Conference Report on Reducing Hazards described vulnerability as "the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (Assembly, 2006). Social vulnerability stems from limited access to resources and political power, lack of social capital, divergent beliefs and customs, physical limitations of the population, and characteristics of the environment (Cutter et al., 2012). Additionally, socially constructed vulnerability depends on institutional development, social relations as well as coping ability for hazards [30]. This type of social vulnerability has been assessed by others in the past. For example, Dow (Dow, 1992) showed that people who have no access to social services or political power are more vulnerable. Another study (Anderson & Woodrow, 1991) provided evidence that poor people are often vulnerable because they have fewer opportunities for education; therefore, employment and income, and they are less likely to have health and property insurance.

The recent COVID-19 pandemic exacerbated some existing social vulnerabilities. For instance, socially vulnerable, fearful, persons in poorer health, and those with higher levels of depressive and anxiety symptoms have higher food insecurity odds, so redesigning food systems in the US during health crises like the current one is necessary to increase food access during crises Fitzpatrick et al., 2021). Furthermore, poverty and food insecurity have also increased as a result of the pandemic (Pereira & Oliveira, 2020), exposing an even bigger portion of the

population to risks and increasing their social vulnerability. While in the current study we focus exclusively on access to food, this is only one of the many components of the social vulnerability index.

For the purposes of the current study, we determine the social vulnerability index using the approach suggested by the CDC,[1] because it (1) focuses on socioeconomic attributes, which can provide insights into the population's access to resources such as private transportation; (2) is supported and maintained by federal agencies, which helps to promote data transparency; (3) includes American Community Survey (ACS) data, which provides a good estimation of the American's population; and (4) utilizes Census tract data, which is a finer geographic granularity (Vo et al., 2020). For simplicity and brevity, we refer to the CDC's social vulnerability index as SVI moving forward in this paper. The index is a continuous normalized value between 0 and 100, the higher value indicating more social vulnerability. The index will help us get a more comprehensive and accurate description of the Atlanta population and its needs when we assess their current access to food.

2.3. GIS Approach to Measure Food Access

A popular approach to measure geospatial relationship between supply and demand is Floating Catchment Area (FCA) method (Plachkinova et al., 2018) that relies on the interrelationship between supply and demand to derive an accessibility index for each of the demand sites. There have been several enhancements to the first method since its inception, as detailed in (Chen & Jia, 2019; Vo et al., 2015). Originally created to measure healthcare access (Luo & Wang, 2003), the Floating Catchment Method has been employed in a wide variety of phenomena: job accessibility (Xiao et al., 2021), urban park accessibility (Dony et al., 2015), transit systems accessibility (Langford et al., 2012), and even COVID-19 vaccination coverage (Mohammadi et al., 2021). Food accessibility has also been one of the popular topics of interest.

Within the area of food accessibility, research spans across a plethora of topics such as nutrition assistance programs (Chen, 2019) and school meals (Jabbari et al., 2021). More generally, food access research in the same line of inquiry as food deserts has also received considerable interest. For instance, in the US, Liu et al. (Liu et al., 2022) assessed grocery accessibility in the city of Chicago and found that predominantly Hispanic Census tracts have lower grocery accessibility. Healthy food accessibility in Baton Rouge, Louisiana was also examined using FCA (Kuai & Zhao, 2017). Internationally, the Hangzhou metropolitan area in China was explored with respect to food accessibility and socioeconomic inequality (Qi et al., 2020). Food deserts in Tehran, Iran were also a subject of interest (Mohammadian Mosammam et al., 2017). Given the same line of inquiry for our current research, we create an FAI map using FCA and overlaying that on the needs of population in Atlanta, GA. We employ a GIS approach to address the issue of food deserts because there is sufficient high-quality publicly available data and overlaying various aspects of the problem and plotting them on a large metropolitan area such as Atlanta can help to more easily identify areas that need to be prioritized. Furthermore, a visual representation of the results, such as a map, can be an effective tool to communicate this problem to various policy makers who may not be necessarily knowledgeable on the statistical techniques utilized. Following is a description of how we conducted the study to demonstrate the rigor and novelty of our work.

3. Methodology

To create the food accessibility index, we utilized the Two-Step Floating Catchment (2SFCA) that was originally proposed by Luo and Wang (Luo & Wang, 2003) and confirmed mathematically by Luo (Wang, 2021). For this research, we opted for the original approach due to its longevity and brevity in capturing the essence of the accessibility landscape without compromising accuracy and interpretability. In the 2SFCA method, we had to select the study site, the supply, the demand, and the travel threshold.

We obtained population information from the Census data repository and used it as our demand for food. We segmented the supply of food into two categories: (1) grocery stores and (2) convenience stores and restaurants. The dissection highlighted the fact that food obtained from grocery stores tends to be fresh, cheaper, and healthier while convenience stores and restaurants food tends to be quicker, more expensive, and not as healthy. It should be noted that we make no distinction between fast food restaurants, counter service restaurants, or regular restaurants. Due to the pandemic, most, if not all, restaurants have embraced food takeout as part of their business models. As a result, we wanted to model that behavior as general access to food. As for the distance and mode of travel, we selected walk time and drive time with a threshold of 15 minutes. Past studies have shown that

[1] https://svi.cdc.gov/, accessed on May 26, 2022

15 minutes is a good travel time for an urban setting (Hamrick & Hopkins, 2012; Yang & Diez-Roux, 2012). Next, we devised four scenarios for the analyses: (1) Walk to Groceries, (2) Drive to Groceries, (3) Walk to Convenience Stores and Restaurants, (4) and Drive to Convenience Stores and Restaurants.

Calculating the accessibility index comprises of two formulas. First, we calculate the provider-to-population ratio at each supply provider location using the formula:

$$R_j = \frac{S_j}{\sum_{k \in \{Distance(k,j) \leq d_0\}} P_k}$$

Where R_j is the provider-to-population ratio, S_j is the capacity at each provider j, P_k is the population at site k, d_0 is the travel threshold, and $Distance(k,j)$ denotes the travel time between the centroid of tract k and supplier at j.

After creating the provider-to-population ratio for each provider, we calculate the accessibility index for each population site as

$$A_i^F = \sum_{j \in \{Distance(i,j) \leq d_0\}} R_j$$

Where A_i^F is the spatial food accessibility index of each population site i, and $Distance(i,j)$ is the travel time between the centroid of location i and the store in j.

After obtaining the accessibility indices for each scenario, we perform Min-Max normalization and set the score with a range from 0 to 100 for interpretation and comparison. We then display the FAI in choropleth maps using five equal intervals from 0 to 100, with darker color signifying lower score, thus lower access to food. The geoprocessing calculations and visualizations were done in ArcGIS Pro 2.9.2, developed by ESRI[2]. In addition, we overlayed the SVI provided from the CDC on those maps [2]. It should be noted that while the SVI scoring is in the same range, the scoring is reverse of our FAI. That is, the higher the score, the more socially vulnerable is the site. The next section details our analyses and results.

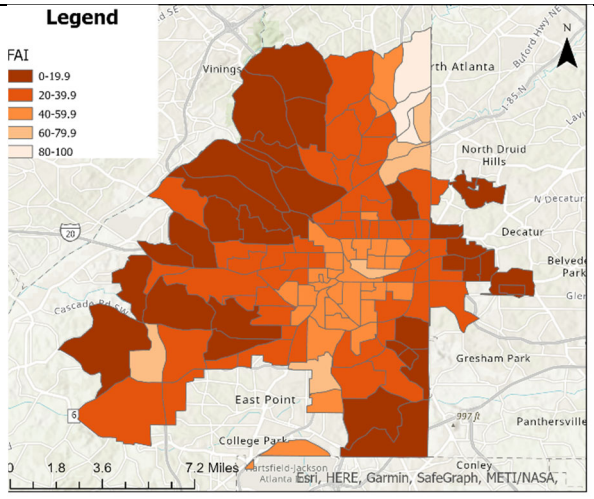

Figure 1: FAI – Drive to Groceries. Darker color means less food access.

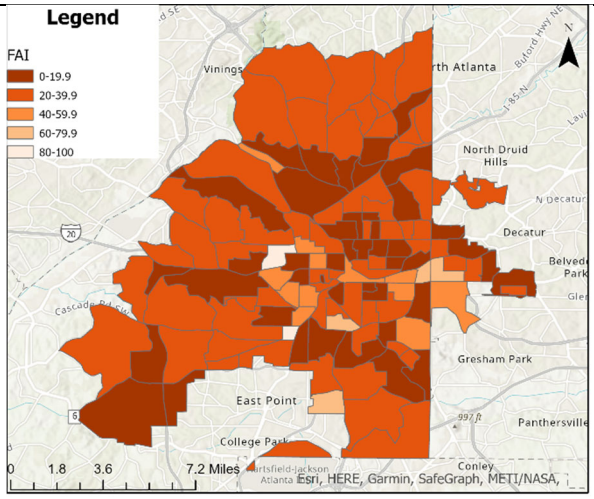

Figure 2: FAI – Walk to Groceries. Darker color means less food access.

[2] https://www.esri.com/, accessed on May 26, 2022

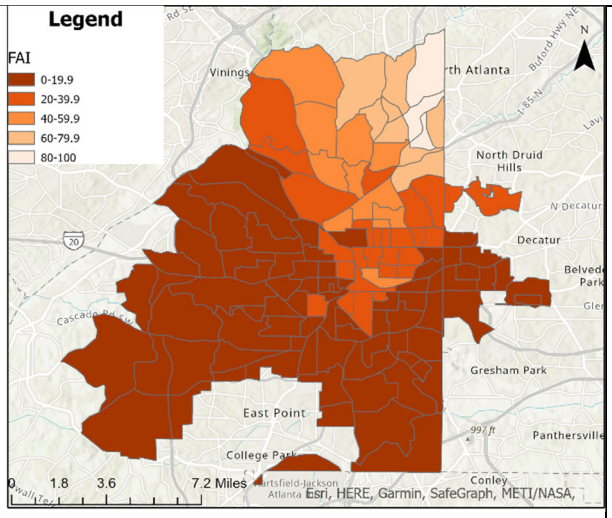

Figure 3: FAI – Drive to Convenience Stores and Restaurants. Darker color means less food access.

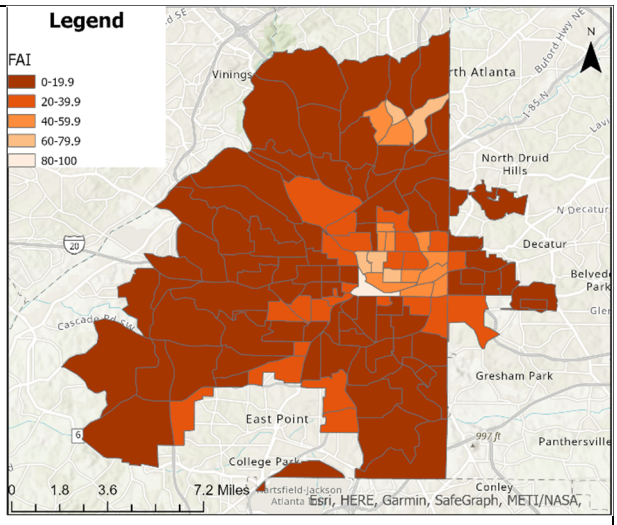

Figure 4: FAI – Walk to Convenience Stores and Restaurants. Darker color means less food access.

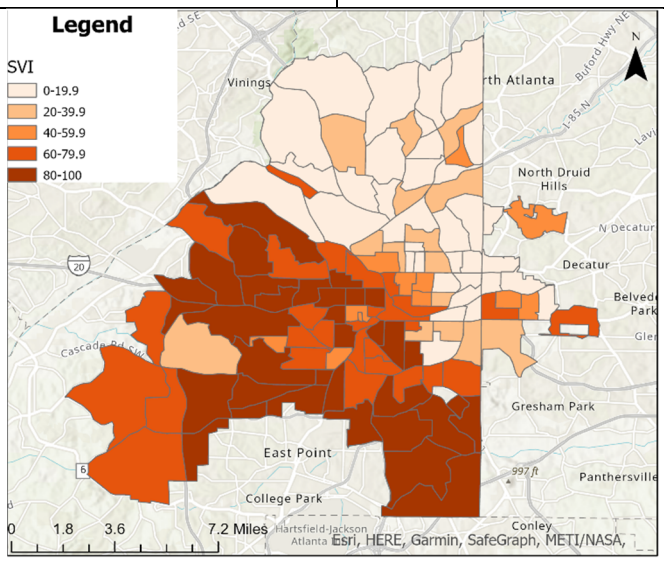

Figure 5: SVI for Atlanta, GA. Darker color means more socially vulnerable.

4. Data Analysis and Results

Figures 1 through 5 below are visualizations of the various types of FAI and SVI for the City of Atlanta based on the data summarized on Table 1 and Table 2. From figures 1-4, we can see that there is a disproportionate number of low FAI areas in Atlanta. Visually, the distribution of FAI scores across the access to convenience stores and restaurants maps tend to lean heavily on the lower end of the quintiles (represented by the predominant dark colors in all 4 maps) as opposed to the food access to groceries.

Table 1 provides the breakdown of the number of tracts in each quintile of FAI scores while Table 2 lists the number of tracts with the SVI scores for each quintile. As described earlier, for FAI, the lower the score, the lower the food access. For SVI, due to the scores being computed by the CDC, the scoring is reverse, where higher score means more socially vulnerable.

Table 1. Scoring distribution of FAI in Atlanta. Highlighted cells are the low food access tracts.

FAI Score Quantiles	Number of tracts – Walk to Groceries	Number of tracts – Drive to Groceries	Number of tracts – Drive to Convenience Stores and Restaurants	Number of tracts – Walk to Convenience Stores and Restaurants
0-19.9	***25***	***25***	***25***	***25***
20-39.9	26	26	26	26
40-59.9	26	37	26	26
60-79.9	26	15	26	26
80-100	25	25	25	25

Table 2. Scoring distribution of SVI in Atlanta. Highlighted cells are the highly socially vulnerable tracts.

SVI Score Quantiles	Number of tracts within the quintile
0-19.9	38
20-39.9	15
40-59.9	12
60-79.9	28
80-100	***35***

To understand more about the disadvantaged communities in the City of Atlanta, we created a map to unveil which tracts exhibit low FAI scores and are socially vulnerable. We identified a tract that has a low FAI score and a high SVI score via flags. Each flag represents a simple "Yes/No" when it comes to whether the tract is at the bottom quintile in any of the FAI access (walk to groceries, drive to groceries, walk to convenience stores and restaurants, drive to convenience store and restaurants) or at the top quintile in SVI. If a tract fits this classification, then a tract receives a flag. For example, if a tract has an FAI score in the lowest quintile in three of the FAI types in Table 2 (e.g., walk to groceries, drive to groceries, walk to convenience stores and restaurants, drive to convenience store and restaurants) and also an SVI value in the high SVI quintile, then the tract will get four flags. The higher the number of flags, the more indicative it is that the tract is exhibiting low access to food and it is highly socially vulnerable. Figure 6 depicts the tracts with their associated flags in Atlanta. In Figure 7, we only displayed the 2020 Census tracts that have the most flags. Fortunately, there is no tract in Atlanta containing all five flags. In other words, there are no tracts in Atlanta that exhibit extremely low access to food options in either with walking or driving options and are also socially vulnerable.

There are three distinctive geographical clusters from the six tracts that contain four flags, shown separately in Figures 8, 9 and 10. In Figure 8, there are two tracts located in the West Atlanta area, encompassing several neighborhoods such as Lincoln Homes, Scotts Crossing, and Collier Heights. Figure 9 depicts one single tract that takes up most of Adams Park and partially Cascade Heights and Venetian Hills. Finally, Figure 10 displays three tracts that overlay several neighborhoods such as Blair Villa, South River Garden, and Thomasville Heights.

5. Discussion and Implications

While the ideas of social vulnerability and food deserts are not new, our work takes a new approach by combining the two to explore their relationship through analysis of data for a relatively new site, the City of Atlanta, GA. Our findings indicate that within the city limits, there are several clusters where the population is simultaneously socially vulnerable and lacks sufficient access to fresh and nutritional food.

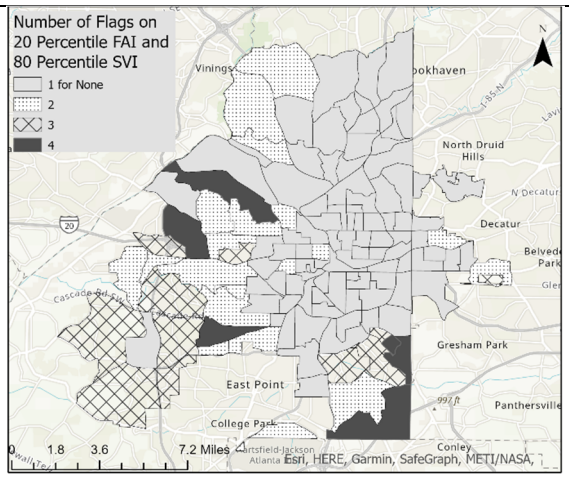

Figure 6: Flags for low access and socially vulnerable tracts in Atlanta.

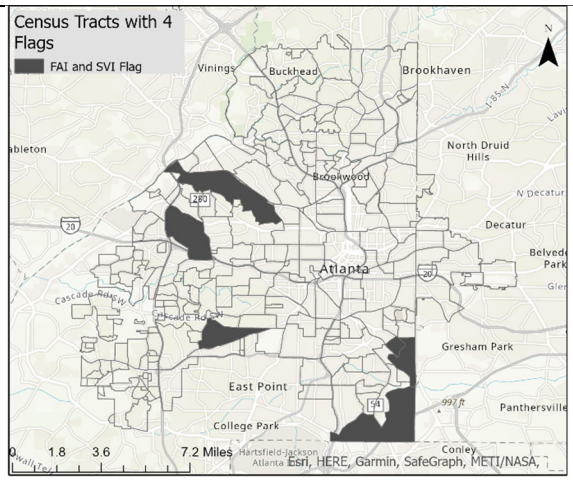

Figure 7: Census Tracts with low access and socially vulnerable tracts in Atlanta overlayed on neighborhood

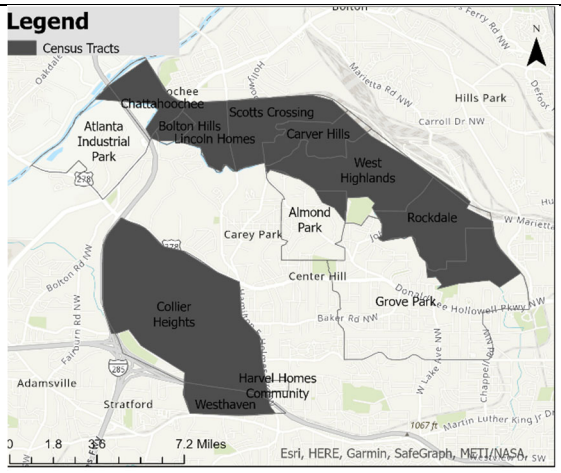

Figure 8: Neighborhood in West Atlanta containing low FAI and high SVI tracts

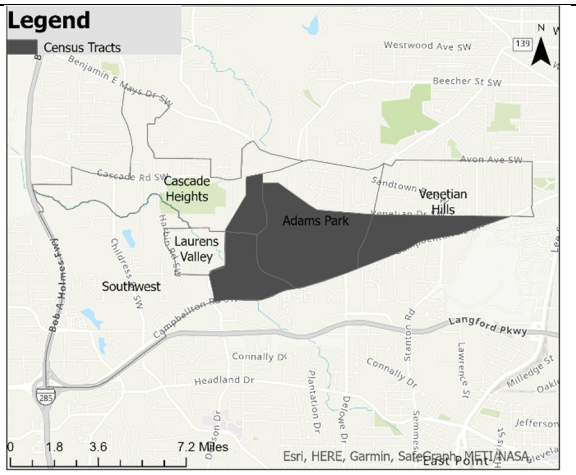

Figure 9: Neighborhood in Southwest Atlanta containing low FAI and high SVI tracts

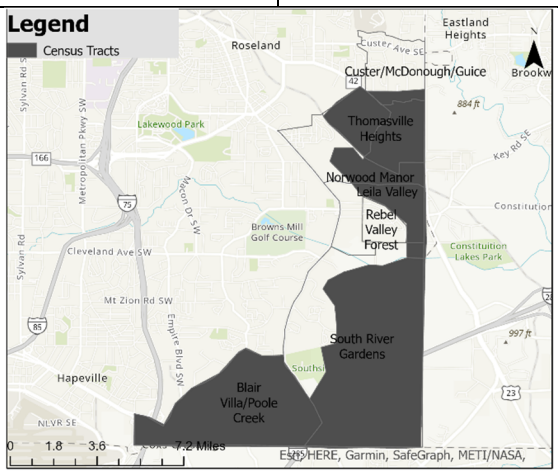

Figure 10: Neighborhood in the Southeast Atlanta containing low FAI and high SVI tracts

We utilize the latest 2020 Census data to indicate a problem of growing concern – population growth in cities that do not have the necessary resources to support residents of low socioeconomic status. From 2010 to 2020, Georgia's population increased by almost 80,000 people[3]. With increase in work from home accommodations that many companies are offering, Atlanta is becoming an attractive destination for those coming from expensive metropolitan areas such as New York or San Francisco, which would put even more strain on the local residents. However, the city needs to do better and ensure that the most vulnerable residents have access to fresh food, healthcare, education, and public transportation.

Our findings can be used by city officials who may want to provide incentives for adding another food supply location within the socially vulnerable areas or having targeted community initiative to help reducing food insecurity. For organizations, they can leverage the findings to secure regions with new and underserved customers. Another implication of our work is related to the future site selection for not only large chain supermarkets, but also small local grocery stores. We have established that in several tracts there is a significant demand and not sufficient supply of fresh food, so those areas could be considered with high priority for future development.

Prior work has demonstrated that engaging diverse community stakeholders can help co-create more sustainable solutions for food deserts (Fernhaber et al., 2019), so one approach to stimulate the economy and incentivize local entrepreneurs is by offering support to those who want to start their own business. Our work highlights potential areas that can be more lucrative for small businesses by showcasing the high demand and low supply for healthy food options.

In terms of the theoretical implications of our work and establishing the contributions of the current study, we utilize Leidner's definitions (Leidner, 2020). More specifically, we focus on developing new highly rigorous and innovative method to analyze a pressing social issue. We rely on the latest available Census data to develop our methodological approach and to create the food accessibility index. Furthermore, we combine different data points in a new manner, which allowed us to highlight disadvantages areas that are both socially vulnerable and lack access to food. Our work serves as further validation to the value of the 2SFCA method to compute novel datapoints and solve new problems.

[3] https://www.census.gov/quickfacts/atlantacitygeorgia, accessed on August 26, 2022

6. Limitations and Future Work

Though this study offers a deep dive into the food access in Atlanta, GA, there are several limitations to our approach. First of all, we have neglected an important aspect of how the City of Atlanta is organized: it crosses two counties: Fulton and DeKalb. In addition, to most residents of Atlanta, the unofficial city limits are within the interstate freeway I-285 perimeter. With that special make up, we would like to state that even though the research has accounted for the administrative boundary of Atlanta, it may be worthwhile extending the study into the larger area, which local residents commonly refer to as "Atlanta proper." Especially with the increasing population density in the city, we are expecting to see even more residents who move within those boundaries to be close to various downtown amenities.

Secondly, we did not discern greatly between types of restaurants and convenience stores. Treating all restaurants the same is a limitation of our project, because even though virtually all restaurants provide takeout as a food option, there are many restaurants that are out of the price range for households earning a median income. Thus, potentially the number of households without access to food within 15 minutes could be even greater. Further research that focuses on such distinction is worthy of investigation.

7. Conclusion

Our goal was to explore the current state of food accessibility in Atlanta, GA. To answer this question, we created a food accessibility index and overlayed it with existing social vulnerability index that helped us identify certain census tracts that comprise predominantly of minorities of low socioeconomic status who are deprived of healthy food options within a 15-minute walk or drive time. We demonstrated that taking a GIS approach can be useful to examine such societal issues and showed how our study can help the city of Atlanta creating more mixed-zoning areas so that residents can have better access to food. Furthermore, our findings have the potential to promote increased sustainability, since having available food nearby would reduce traffic and emissions, and support more small local grocery stores in areas of high demand as indicated in our spatial analysis.

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