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Food access in Kalamazoo, Michigan: A spatial analysis

Natalie E. Call,[a] Elizabeth M. Silber,[b] and E. Binney Girdler[c]*
Kalamazoo College

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Abstract

Healthy and affordable food is a universal human need. In the U.S., food access is often limited in low-income areas as opposed to medium- and high-income areas. To address disparities in the availability of healthy foods, the dispersion of food access points needs to be quantified and documented. Nutritional quality and consistency of availability vary across different types of food access points, including permanent grocery stores, farmers markets, community gardens, food pantries, and convenience stores. Accessibility is also determined by the means of transportation available or required to get to food access points (public transit, driving, or walking). In this geographic information systems (GIS)-based analysis, we identify differences in accessibility to distinct types of food access points—reliable, seasonal, and lower quality—between low-income and higher-income tracts in the City of Kalamazoo, Michigan. We found that all full-service grocery stores are accessible via bus routes in the City of Kalamazoo; however, 11% of people reside in low-income areas with low access to these grocery stores—beyond the 0.25-mile walkable distance to bus routes. We then asked whether the addition of community gardens, food pantries, and farmers markets, on the "plus" side, or convenience and dollar stores, on the "minus" side, changes the food access landscape in this community. We found that the "positive" access points served areas that already had access to grocers, while "negative" access points filled the access gap in lower income areas. More than twice as many low-income residents had walkable access to convenience stores—which provide lower-quality and highly processed food—with 81% of them being located within low-income tracts. Geographical analysis of

[a] Natalie E. Call, Undergraduate, Environmental Studies Program, Kalamazoo College; natalie.call19@kzoo.edu

[b] Elizabeth M. Silber, Undergraduate, Environmental Studies Program, Kalamazoo College; elizabeth.silber19@kzoo.edu

[c] * *Corresponding author:* E. Binney Girdler, Professor of Biology and Environmental Studies, Kalamazoo College; 1200 Academy Street; Kalamazoo, Michigan 49006 USA; +1-269-337-5977; binney.girdler@kzoo.edu

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All authors contributed equally to the research.

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low food access and low-quality food access is important to identify structural patterns, but it needs to be paired with interview-based community assessments to ascertain how residents actually procure their food.

Keywords
Geographic Information Systems, GIS, Public Transit, Food Access, Grocery Stores, Farmers Market, Community Gardens, Convenience Stores, Income Data, American Community Survey (ACS), Food Environment

Introduction

Food access is a fundamental human right and should be prioritized on a national and local scale. Food insecurity is defined by the U.S. Department of Agriculture (USDA) as the inability of a household to acquire food that meets the nutritional needs of its members. This inability is present on a national scale, with 33.8 million people categorized as living in food-insecure households in 2022 (USDA, 2022a). Lack of access to food is proven to have detrimental health effects, including increased risk of obesity, heart disease, diabetes, mental disorders, and other chronic diseases (U.S. Department of Health and Human Services [HHS], 2023). Alongside these negative health impacts, food insecurity has been associated with an economic burden of over US$167.5 billion annually (Shepard et al., 2011). These long-term impacts of a lack of access to healthy food are not only detrimental to the health and well-being of individuals, but to society.

Food insecurity occurs for a variety of reasons, one of which is barriers to food access points. Areas with low access to affordable, healthy food are referred to as "food deserts" and are often associated with a higher percentage of residents experiencing poverty (HHS, 2023). Other authors have used the term "food apartheid" to reflect the systemic injustice, resulting from government policies and discrimination, that has led to inadequate access to social services (Brones, 2018). The formal definition of low grocery store access is defined as at least 33% of the population being greater than one-half mile from the nearest grocery store (USDA, 2022b). However, this definition does not adequately consider the amount of time needed to obtain groceries and cook a meal that meets the nutritional needs of a household. Previous studies have shown times of five minutes and distance of around a quarter of a mile to be a more reasonable threshold than that of the USDA-defined one-half mile (Kotval-K et al., 2021; Steuteville, 2017; Yang & Diez-Roux, 2012).

Government programs such as the Supplemental Nutrition Assistant Program (SNAP) have been implemented to relieve the economic burden of food access for low-income families. According to the USDA, in Michigan, 13% of the state population receives monthly benefits from SNAP, with the national average at 12% (Center on Budget and Policy Priorities [CBPP], 2023). Even though SNAP is widely used, not all food access points accept its benefits, as they do not stock required items (Ross et al., 2018).

Food access points vary in nutritional quality of food, reliability, and affordability. Grocery stores—defined as retail stores that carry healthy food options (such as fresh fruit, vegetables, fish, and poultry)—are seen to be a reliable permanent resource (U.S. Census Bureau, 2022). Food pantries, community gardens, and farmers markets provide additional locally sourced yet affordable resources while promoting a sense of community (Ferris et al., 2001; Kantor, 2001). However, community gardens and farmers markets are limited due to their seasonality, and food pantries can be unreliable, with food that is often close to expiration and lacking protein (Kordon et al., 2022; Long et al., 2023). Convenience stores are retail businesses with a wide range of common items, including frozen prepared foods; however, they typically provide unhealthy food options, like high-fat items and sugary drinks (Xin et al., 2021).

Public transit, vehicle ownership, and walkability (sidewalks, infrastructure, bike lanes, etc.) influence accessibility to these food access points. These factors vary throughout cities and are heavily influenced by the financial situation of households. Studies in cities such as Grand Rapids, Michigan and Portland, Oregon have shown that there are more food access points in wealthier census tracts, and that higher costs are associated with socioeconomically disadvantaged tracts

(Breyer & Voss-Andreae, 2013; Kotval-K et al., 2021). In particular, low-income areas tend to have more convenience stores that offer lower-quality food (Chenarides et al., 2021; Hilmers et al., 2012).

In addition to affecting socioeconomically disadvantaged populations, food insecurity has been shown to have disproportionate effects on persons from racial and ethnic minorities. An analysis examining trends in food insecurity from 2001 to 2016 found that food insecurity rates for both non-Hispanic black and Hispanic households were at least twice that of non-Hispanic white households (Odoms-Young & Bruce, 2018). These racial and ethnic disparities are associated with historical factors, including residential segregation, poverty, and neighborhood deprivation. The history of "white flight" during the periods of 1950s-1980 can be seen in many northern urban communities (Boustan, 2007). In Kalamazoo, Michigan, a mass movement of wealth and industry away from the city center led to a disinvestment in food access for urban areas in the city (Shultz-Purves, 2013).

We chose to explore the geography of food access in the City of Kalamazoo due to its size, historical background, variation in income among census tracts, and because we live in this city. We aimed to study food insecurity by examining the distribution of public access to different food purveyors (Leroy et al., 2015). By spatially examining accessibility of reliable nutritious foods (grocery stores), unreliable but healthy food sources (seasonal pop-ups), and lower quality food sources (convenience stores), we highlight areas in which food security in Kalamazoo can be improved.

Methods

All data used in our analysis were obtained from publicly available online sources. We used the open source software QGIS-LTR (3.22) to conduct all spatial analyses and create our maps.

Proportional Census Tract Calculation

Since some census tracts crossed the City of Kalamazoo boundary, we calculated the proportion of those tract areas that fell within the City of Kalamazoo, and, assuming that the populations were homogeneously distributed within the tracts, adjusted the population size within the city portion of the tract accordingly. We used similar proportional estimates of population for all areas in our study.

Classification of Income Data

American Community Survey (ACS) data from 2018 was joined with census tract data using the software QGIS-LTR (3.22). To quantify the income data, we grouped the ACS 2018 median incomes into seven categories: $15,000–$24,999, $25,000–$34,999, $35,000–$44,999, $45,000–$54,999, $55,000–$64,999, $65,000–$74,999, and $75,000–$84,999.[1] The ACS defines low income as any income falling below the median, and hence the census tracts that fell below the median income in Kalamazoo ($44,296) (U.S. Census Bureau, n.d.) were categorized as low income (Figure 1).

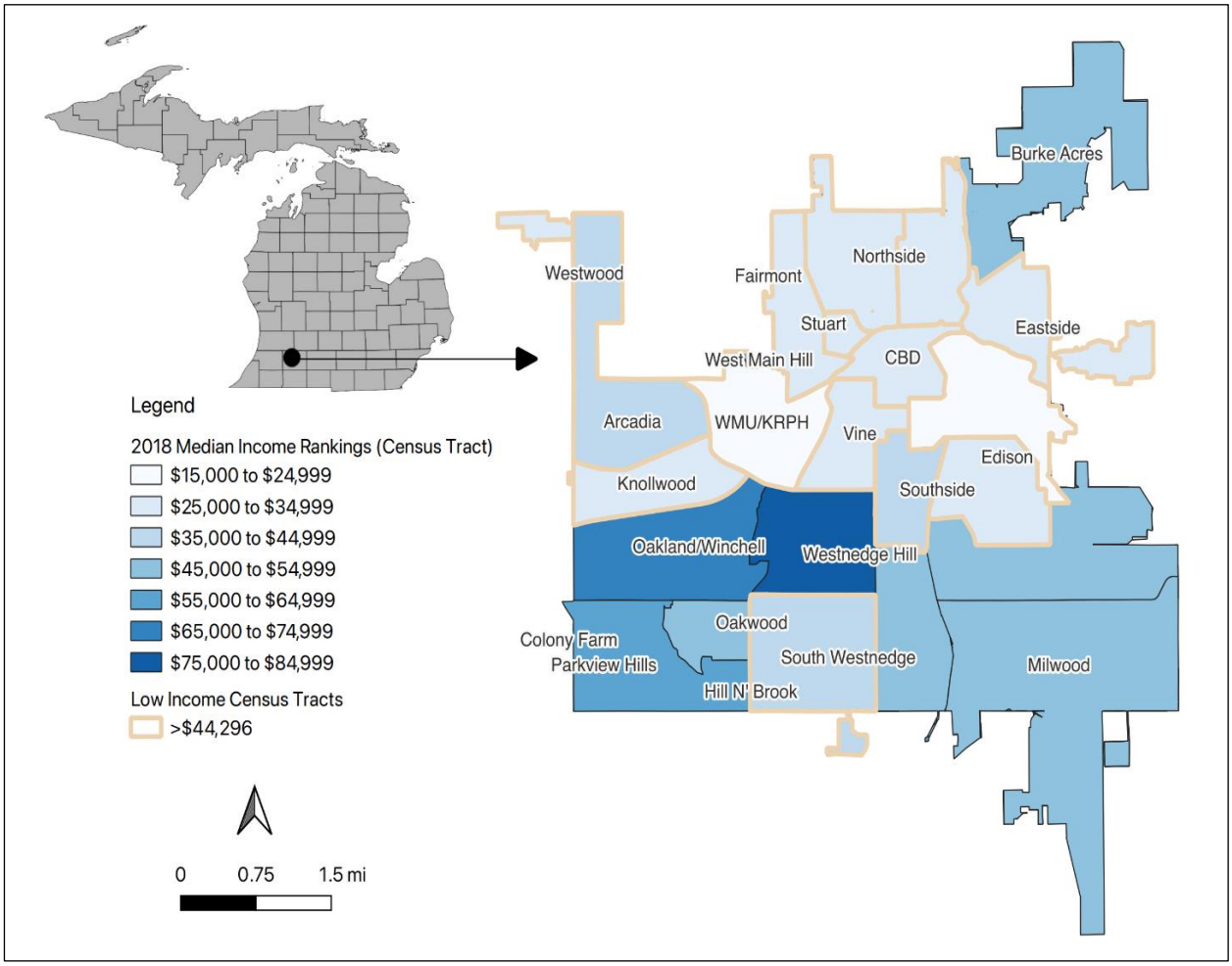
Classification of Grocery and Convenience Retailers

Grocery stores and convenience stores were classified using the North American Industry Classification System [NAICS] (U.S. Census Bureau, 2022). NAICS classifies supermarkets and other grocery retailers as serving canned and frozen foods, fresh fruits and vegetables, and fresh and prepared meats, fish, and poultry. Convenience stores are primarily engaged in retailing a limited line of groceries that usually includes milk, bread, soda, and snacks. We used the function My Maps in Google Maps to mark the location point for each retail store. Google Maps, reviews, descriptions, and photos were used to determine the food items sold at each store. We researched convenience and grocery stores located in Kalamazoo, Michigan and then further determined if each retailer fit the NAICS classification for either a convenience or grocery retailer. Other websites were also used to ensure all retailers fitting either the grocery or convenience NAICS classification were accounted for in the City of Kalamazoo. Eleven grocery stores are located within the City of Kalamazoo and 14 grocery stores were included that are outside the City of Kalamazoo, with a total of 25 grocery stores mapped in our study. Twenty-five

[1] All currencies in this article are in US$.

Figure 1. Map of the City of Kalamazoo Census Tracts Showing 2018 Median Income

Income rankings were divided into 7 categories: the darker the shade of blue, the higher the median income. Low-income tracts were categorized as any tract that fell below the 2018 median income of $44,296, and these low-income tracts are outlined in beige. Names refer to neighborhoods within the city. CBD = Central Business District (downtown).



convenience stores are located within the City of Kalamazoo and six convenience stores were included that are outside the City of Kalamazoo, with a total of 31 convenience stores mapped in our study. We included the 14 grocery and six convenience stores that were within 0.25 miles of the city limits to ensure all accessible points were included.

Acceptance of Supplemental Nutrition Assistance Program (SNAP) Benefits

SNAP provides nutrition benefits to supplement the food budget, and we wanted to ensure that we represented each convenience and grocery store with the correct benefits. To ensure each convenience and grocery retailer accepted SNAP, the USDA SNAP retailer locator was utilized (USDA, 2019) and cross checked with the list of retailers. All convenience and grocery stores included in our study accept SNAP.

Low-Income and Low-Access (LI-LA) Areas

We define "low-income and low-access" (LI-LA) areas as those within the City of Kalamazoo that were both low income, as defined above, and more than a 0.25-mile walk to a bus stop. There are 21 bus routes in the City of Kalamazoo, and each bus route was traced using the My Maps tool in Google Maps. The bus routes were then transferred to QGIS as a KML file. The USDA uses a definition

of 0.50 miles as "access," considering that residents living within 0.50 miles of a resource are willing and able to walk that distance to access it (USDA, 2022b). Other studies, however, show this definition as unrealistic, and show commute times of five minutes with a quarter mile to food access points as more common (Kotval-K et al., 2021). Therefore, we used a 0.25-mile buffer around bus routes to estimate access to a grocery store. The low income (less than the average 2018 median income of $44,296) census tract layer was clipped with a polygon representing a 0.25-mile buffer around all bus stop routes using the QGIS "Clip" tool. The resulting low-income areas that did not fall within a 0.25-mile buffer were then considered low-income and low-access areas. We estimated population sizes within the LI-LA areas based on proportional area, again assuming homogeneous density of residents within the census tracts.

Supplemental Resource Access

Community gardens, food pantries, and farmers markets are a means of supplemental access to food for many individuals. We asked if these resources expanded access for the LI-LA parcels identified in previous steps. We identified every community garden, food pantry, and farmers market in the City of Kalamazoo on Google Maps and uploaded the layer to QGIS as a KML file. Within the city, we generated 0.25-mile buffers around these additional access points as above, assuming as before that this distance represents a reasonable distance for residents to walk to these food sources. We clipped the LI-LA layer again with this new buffer layer, since additional walkable zones around additional sources of quality foods would increase access and therefore decrease the size of the LI-LA.

Greater Barriers to Access

In our QGIS analysis, we did not consider obstacles residents might face when walking to bus stops or directly to grocery stores: availability of walking paths or safe sidewalks, crosswalks, presence of graveyards, schools, or industrial sites, etc. To investigate some of these obstacles for a subsample of the city, we selected the highest income tract and lowest income tract for comparison. The census tract that had the highest income (tract 12) was in the Westnedge Hill, Oakland, and Winchell neighborhoods (Figure 2) with a median income of $76,339. The lowest income tract (tract 15.04) had a median income of $21,786 and was in the neighborhood that encompassed the Western Michigan University (WMU) and Kalamazoo Regional Psychiatric Hospital (KRPH) campuses. Because this tract is comprised of university student housing and we did not account for dining halls, we also examined the second lowest income tract (15.07) with a median income of $26,045, located on the Eastside of Kalamazoo. Using the "Random points inside polygon" tool in QGIS, three random points within each of these three tracts were created. We used the Kalamazoo County roads layer (Michigan GIS Open Data, n.d.) to determine the street address nearest to each randomly selected point, and used Google Maps to determine the time it would take a resident to get to the grocery store. Time of day for the estimate was set to Saturday April 15th at 12 noon. For each point, the time spent driving, walking, and riding the bus to the nearest grocery store or supermarket was recorded (Table 1; Figure 2). Estimates do not include wait time at bus stops, which are similar throughout the transit system.

Results

There are 28 census tracts in the City of Kalamazoo. Fifteen of these tracts were categorized as low-income: any tract where 50% or more of households fell below the 2018 median income of Kalamazoo, MI ($44,296). The other 13 tracts were identified as medium to high-income (Figure 1). The total population within the City of Kalamazoo is 80,047 people. Of that total population, 53,845 people fall into low-income tracts (67%) and 26,202 people fall into medium to high-income tracts (33%).

All grocery stores in Kalamazoo fall within a 0.25-mile buffer of the city bus routes. We classified the low-income areas that fall outside the 0.25-mile buffer around the bus routes as LI-LA (Figure 3). Only 6,015 (11%) of the 53,845 low-income residents of Kalamazoo fall within LI-LA areas. However, most households (88%) use their own vehicle to get to the store (Ver Ploeg et al., 2015). Therefore, in addition to bus transportation, we

Figure 2. Case Study: Time Comparison of Grocery Store Access Based on Income

Three census tracts were mapped (15.04, 9, and 12) on QGIS to estimate commuting time to the closest grocery store on a Saturday at 12:00 PM from the averages of three random points (Table 1). Kalamazoo bus routes are shown in gray and a Google Maps overlay is present.

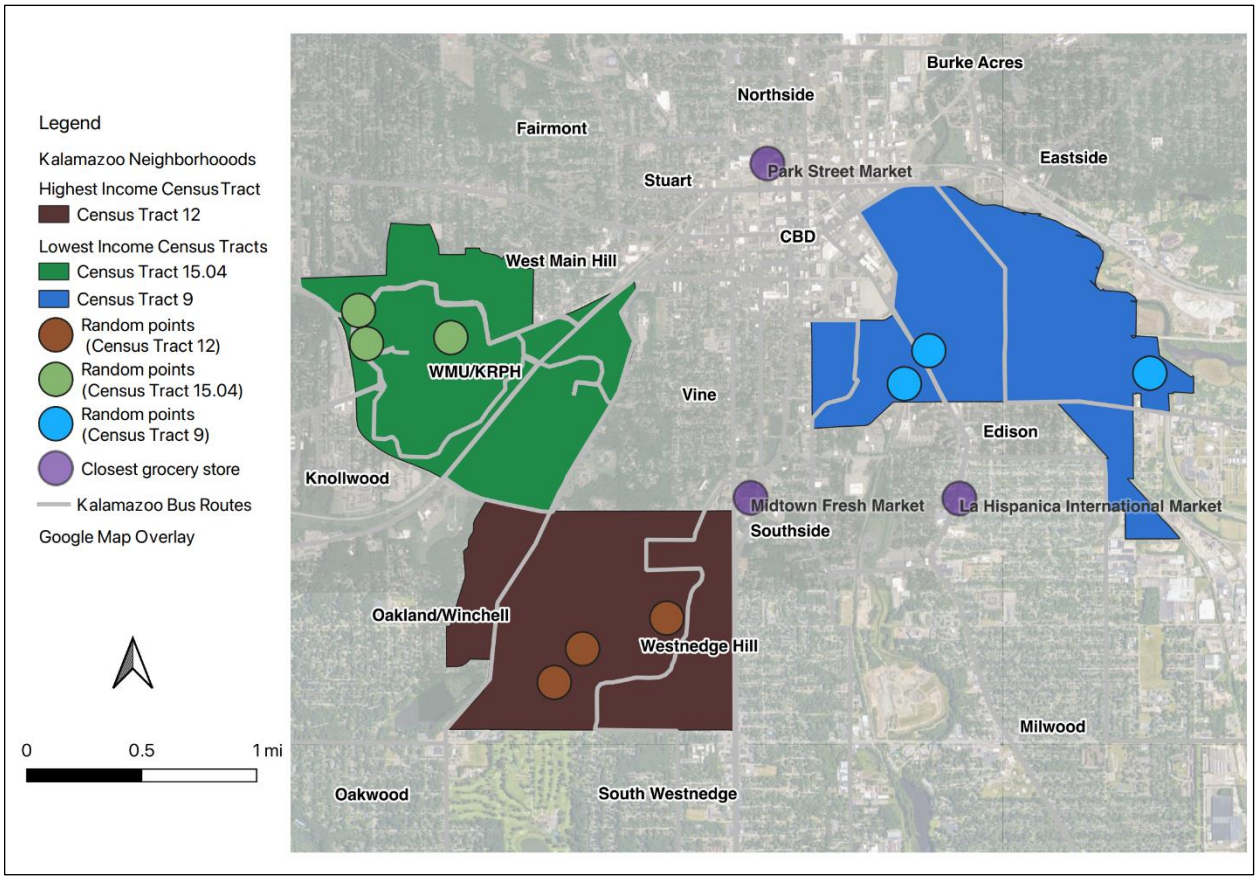


Table 1. Access to Grocery Stores from Three Random Points in Each of the Three Census Tracts

Time and distance to stores by car, bus, and on foot are shown for the highest-income tract (12, brown in Figure 3), and the two lowest-income tracts (15.04 and 9). Measurements are in miles or minutes:seconds.

Census Tract	15.04	Standard Deviation	9	Standard Deviation	12	Standard Deviation
Mean Distance Of Closest Grocery Store (Miles)	2.33	0.12	1.00	0.28	1.33	0.25
Driving (Average time in minutes:seconds)	8:20	2:37	3:30	2:32	4:20	0:48
Bus Commute (Average time in minutes:seconds)	21: 40	1:41	12:40	14:10	24:49	18:50
Walking (Average time in minutes:seconds)	40:00	3:34	19:20	9: 25	21:00	9:09

also looked at accessibility by car and walking. We estimated the time it would take to travel to the nearest grocery store by either bus, foot, or car for residents in the highest income tract and the two lowest income tracts within the City of Kalamazoo (Figure 2). We found nearly double the driving time and double the walking time in the lowest income tract compared to the highest income tract (Table 1). Since that lowest income tract comprises of students at Western Michigan University, who

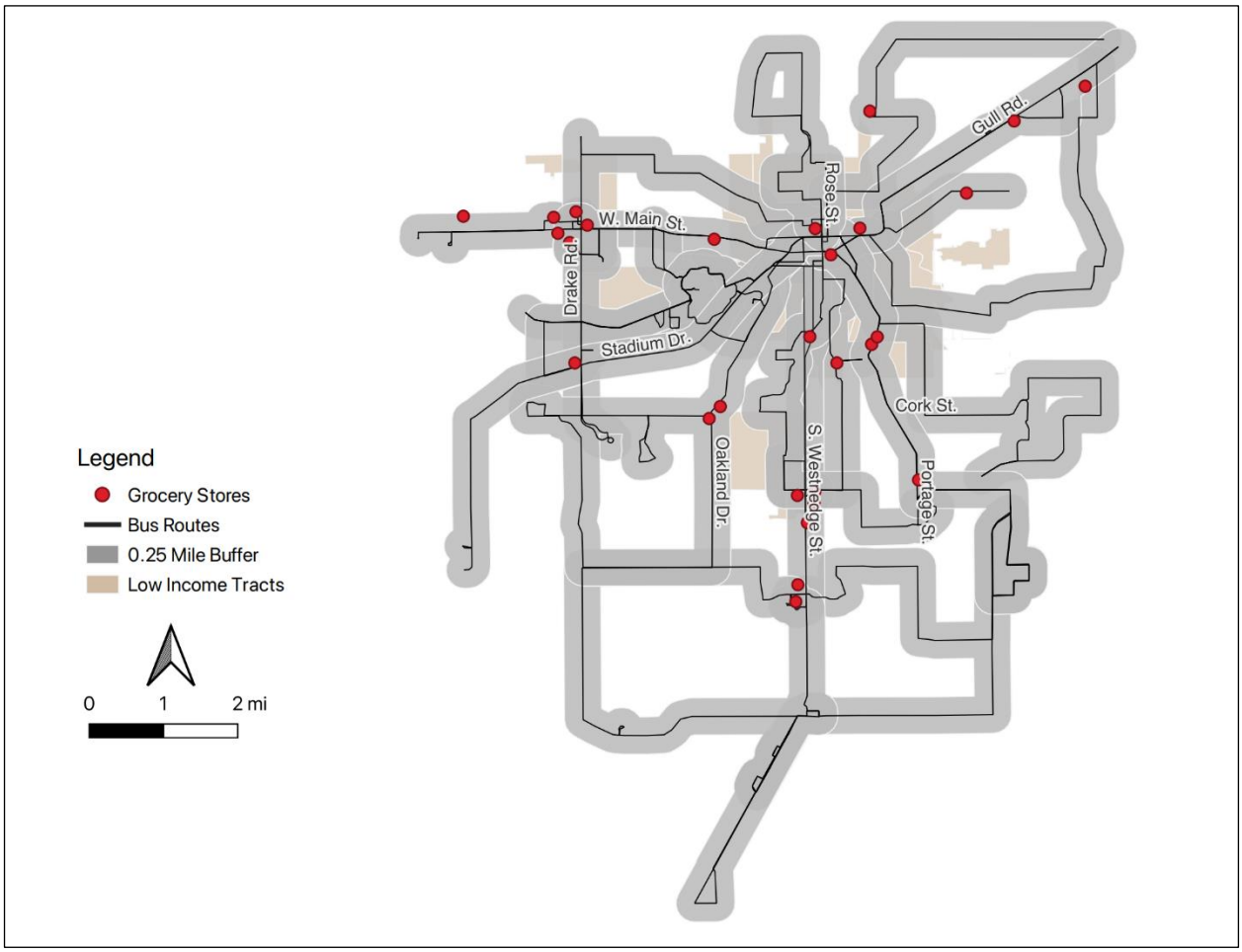
may be low-income but also may have access to dining halls and do not represent typical residents, we also considered the second lowest income census tract (Tract 9). For that comparison, we did not find a clear difference in bus, walking, or driving access to grocery stores.

Solutions to improve healthy food access include encouraging the establishment of farmers markets, community gardens, and food pantries (Kotval-K et al., 2021). We looked at the location of the community gardens, food pantries, and farmers markets in relation to the areas of LI-LA to grocery stores by bus (see Figure 3). With a 0.25-mile walkable buffer around these food access points, we found that they assisted an extra 537 people out of the 6,015 people (9%) within the areas of LI-LA (Figure 4; see light green areas for improved access to healthy food options within low-income areas). With the addition of these alternative healthy food resources, 5,478 people (91% of LI-LA) are left without access to healthy food options (almost 7% of the total city of Kalamazoo).

We then looked at food retail stores which promote unhealthy eating—convenience stores, corner stores, and dollar stores (Xin et al., 2021). We will refer to all of these mentioned unhealthy food access points as convenience stores. We identified 31 convenience stores by the NAICS classification within the City of Kalamazoo and

Figure 3. Grocery Store Access via Bus Routes in Kalamazoo, Michigan

Grocery stores were classified using the NAICS classification system and were mapped in red. All bus routes within the City of Kalamazoo were mapped with a 0.25-mile buffer in gray. The 0.25-mile buffer indicates walkability to and from a bus route. Low-income tracts (census tracts in the city that fell below the 2018 median income) are depicted in beige.



within a 0.25-mile distance outside of the City of Kalamazoo (Figure 5).

Of these retailers, 25 convenience stores with 0.25-mile walking buffers fell into low-income tracts (81%). We compared low-income and medium and high-income tracts and their access to convenience stores. Of the 53,845 people within the low-income tracts, 14,446 people (27%) fall within a 0.25-mile walkable radius of a convenience store, compared to only 2,336 (12%) of the 26,202 people in medium to high-income tracts. We also compared access to grocery stores between low-income tracts and medium to high-income tracts. Of the 26,202 people that fall into medium to high-income tracts, 1,443 people (6%) fall within a 0.25-mile walkable radius of grocery stores, compared to 6,296 of the people (12%) who fall in low-income tracts with access to grocery stores.

Discussion

This study reveals some important insights into food access in our city. First, we found that only 11% of residents in low-income census tracts do not have access by public buses to full-service grocery stores. In the City of Kalamazoo, all grocery stores fall within a 0.25-mile walkable radius of the bus routes. Households who use or qualify for food assistance programs like SNAP are more likely to rely on public transit, walking, or a ride from a friend or family member to get their

Figure 4. Map of Areas with Low Income and Low Access to Grocery Stores with Community Gardens, Food Pantries, and Farmers Markets

The low-access areas are based on the low-income areas outside the 0.25-mile buffer of Figure 2 and are shown in darker green. Alternative points of food access were mapped. A 0.25-mile buffer around these alternative food access points was mapped, and the low-access areas that overlapped with these points are shown in light green.

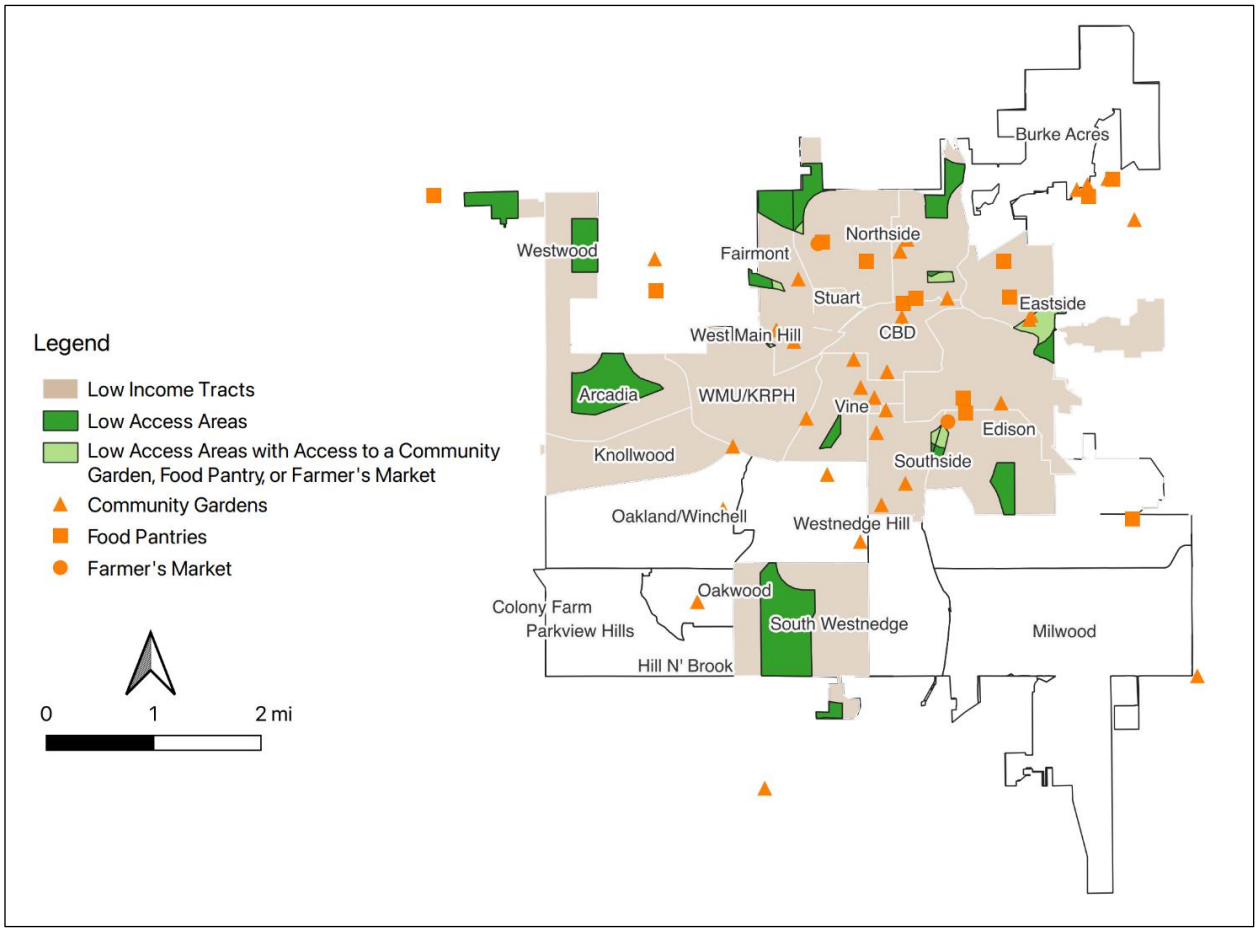
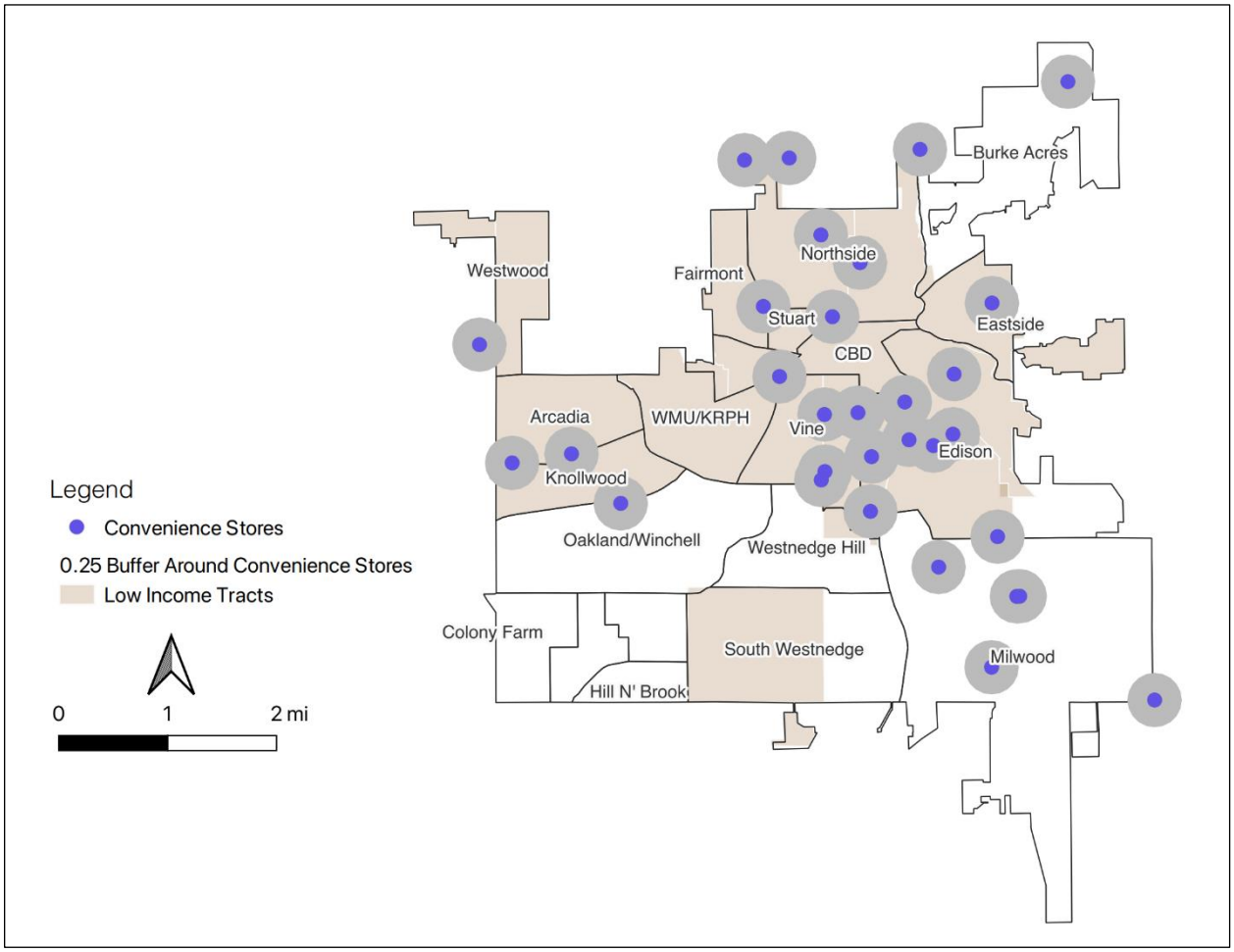


Figure 5. Map of Convenience Stores with 0.25-Mile Buffer in Kalamazoo, Michigan

Convenience stores classified through the NAICS classification system were mapped in purple with a 0.25-mile buffer shown in gray. Low-income tracts (any tract that fell below the 2018 median income of $44,296) are shown in beige.



groceries than more well-off residents. A USDA survey found that 68% of SNAP recipients drove their own car to the grocery store compared to 95% of households who earn too much to qualify for these programs (Schmitt, 2015). Although households who qualify for or collect food assistance benefits sometimes must rely on other means of transportation besides their own car to get their groceries, most people do not use public buses to get to the store, regardless of income (Jiao et al., 2011; Ver Ploeg et al., 2015).

Our case study looked at possible ways for Kalamazoo residents to get to the nearest grocery store, either by car, walking, or bus. The lowest income tract (Tract 15.04; composed mostly of Western Michigan University students) had nearly double the amount of driving and walking time compared to the highest income tract (Tract 12). Overall, there was no difference in driving or walking time between the second lowest income tract (not university students, Tract 9) and the highest income tract (Tract 12). This case study, using random points within tracts, may not capture the most prevalent patterns of transportation to the nearest grocery store in low-income compared to high-income tracts. Future studies should incorporate interviews that can more clearly assess the ways people get to food access points.

While supermarkets are the major grocery resource for U.S. households, the availability of

other healthy food options has increased (Ma et al., 2018; USDA, 2022a). Other points of healthy food access include community gardens, food pantries, and farmers markets, which provide additional access to healthy foods, but are seasonal and often unreliable, meaning that families cannot always count on them for weekly needs (Du Toit et al., 2022). Furthermore, not all residents feel a sense of belonging at farmers markets. For example, Russomanno and Tree (2021) found that shoppers who received SNAP benefits reported feeling excluded at farmers markets. We found that in the areas of low income and low access to grocery stores by bus (LI-LA), these seasonal food resources added little additional access, only aiding an extra 9% of low-income residents. We suggest that these permanent and nutritious access points, particularly food pantries, could be better placed in low bus route access locations.

The proximity to food retailers influences where and how people shop. Limited access to healthy food options like grocery stores can result in residents relying on smaller stores like convenience stores (Ver Ploeg et al., 2015). In this study we included dollar stores, which have greatly expanded nationally (Dollar General, Dollar Tree, and Family Dollar), gas stations, and corner stores in our definition of convenience store because all of these retailers stock foods that tend to be higher in calories and lower in nutrients, and also lack fresh produce (Xin et al., 2021). Households that are low income with limited access to grocery stores are more likely to spend more money at convenience, dollar, and drugstores compared to households with easier access to grocers (Ver Ploeg et al., 2015). In Kalamazoo, we found that the residents within the low-income areas had more walkable access (defined as a 0.25-mile radius) to convenience stores (27%) compared to medium to high income residential areas (12%). This difference aligns with past research and highlights that convenience stores tend to be found in low-income areas within Kalamazoo. Residents in low-income tracts are less likely to own a car (Rhone et al., 2017), and, therefore, may purchase food at a more conveniently located retailer with less healthy food options.

Disparities in access to food among census tracts are a great concern because access influences dietary choices, which in turn influence rates of obesity and other chronic diseases. Research has suggested that residents with better access to grocery stores and limited access to convenience stores have healthier diets and less risk of obesity (Larson et al., 2009; Rose & Richards, 2004). Reduced access to healthy food choices for low-income households is linked to poor diet quality (Ziso et al., 2022).

Other barriers to sustainable food access consist of lack of nutritional and culinary education, kitchen access, and time spent shopping and cooking meals (Soliah et al., 2019; Wolfson et al., 2019). Education around food security through nutritional education and peer education, community-based participatory research, and policy changes in supplemental nutrition programs can help to create better access to food. An example of this can be seen through the creation of meals with a variety of seasonal fruits and vegetables purchased from affordable farmers markets (Ziso et al., 2022). Acknowledging areas of low food access as we have done in Kalamazoo is the first step toward improvement. City planners can help regulate placement of convenience stores while appealing to more permanent grocery stores using tax breaks or other incentives. Cities can also increase the well-being of residents by sponsoring education programs about food (Ziso et al., 2022) and by facilitating the placement of more permanent food access points with healthy food options in these LI-LA areas.

We recognize that our study does not incorporate interviews. We made assumptions based on previous literature to understand barriers to food access in our city. Interviews with the local residents and with leaders of community gardens, farmers markets, and food pantries are necessary to fully understand the story of food access in Kalamazoo. Future work should incorporate such qualitative research to better understand how people get their shopping done, and whether these habits vary based on census tract and income. We did not account for the presence of barriers to access from infrastructure such as graveyards, parks, and school campuses in our analysis, instead assuming that census tracts were homogenous with adequate

well-maintained sidewalks. We also recognize that the realities of mid-western winters might seriously change food shopping habits. Our analysis was strictly geographic in nature and did not incorporate processes or policies that may ameliorate or exacerbate lack of food access. For example, during the COVID-19 pandemic, many food pantries delivered meals to families, and many services now exist for door-to-door deliveries. Future studies might investigate how different household income levels take advantage of such delivery services, as well as look into the public-school nutrition programs, which may supplement food access for families with children.

A lack of access to food is not natural (as the term "food desert" can imply), but the result of historical and persistent economic and structural actions such as redlining, transportation planning, zoning, and other city planning decisions (Kotval-K et al., 2021; Zhang & Debarchana, 2016). In the City of Kalamazoo, bus routes provide wide access to grocery stores; likely the stores were sited on widely used transportation corridors when they were established in the late 20th century (Shultz-Purves, 2013). Using geography only, we have identified areas within the City of Kalamazoo where 7% of the population has no easy access to healthy foods. We have also shown that these same areas have the easiest access to highly processed, less nutritious foods via convenience and dollar stores. We hope that community leaders, working with city planners and residents, can focus improvements to food access infrastructure in these areas.

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References

Boustan, L. P. (2007). Black migration, white flight: The effect of black migration on northern cities and labor markets. *The Journal of Economic History*, *67*(2), 484–488. http://www.jstor.org/stable/4501161

Breyer, B., & Voss-Andreae, A. (2013). Food mirages: Geographic and economic barriers to healthful food access in Portland, Oregon. *Health & Place*, *24*, 131–139. https://doi.org/10.1016/j.healthplace.2013.07.008

Brones, A. (2018) *Karen Washington: It's not a food desert, it's food apartheid.* Guernica. https://www.guernicamag.com/karen-washington-its-not-a-food-desert-its-food-apartheid/

Center on Budget and Policy Priorities [CBPP]. (2023, February 13). *Michigan Food Assistance Program fact sheet.* https://www.cbpp.org/sites/default/files/atoms/files/snap_factsheet_michigan.pdf

Chenarides, L., Cho, C., Nayga, R. M., & Thomsen, M. R. (2021). Dollar stores and food deserts. *Applied Geography*, *134*, Article 102497. https://doi.org/10.1016/j.apgeog.2021.102497

Du Toit, M. J., Rendón, O., Cologna, V., Cilliers, S. S., & Dallimer, M. (2022). Why home gardens fail in enhancing food security and dietary diversity. *Frontiers in Ecology and Evolution*, *10*. https://doi.org/10.3389/fevo.2022.804523

Ferris, J., Norman, C., & Sempik, J. (2001). People, land and sustainability: Community gardens and the social dimension of sustainable development. *Social Policy & Administration, 35*(5), *559–568*. https://doi.org/10.1111/1467-9515.t01-1-00253

Hilmers, A., Hilmers, D. C., & Dave, J. (2012). Neighborhood disparities in access to healthy foods and their effects on environmental justice. *American Journal of Public Health*, *102*(9), 1644–1654. https://doi.org/10.2105/AJPH.2012.300865

Jiao, J., Moudon, A. V., & Drewnowski, A. (2011). Grocery shopping: How individuals and built environments influence choice of travel mode. *Transportation Research Record*, *2230*(1), 85–95. https://doi.org/10.3141/2230-10

Kantor, L. S. (2001). Community food security programs improve food access. *Food Review/National Food Review*, *24*(1), 20–26. https://doi.org/10.22004/ag.econ.266234

Kotval-K, Z., Khandelwal, S., & Wills, K. (2021). Access to foods using Grand Rapids, Michigan, as a case study: Objective versus subjective issues. *Journal of Agriculture, Food Systems, and Community Development*, *10*(3), 145–159. https://doi.org/10.5304/jafscd.2021.103.008

Kordon, S., Miller, P. A., & Bohannon, C. L. (2022). Attitudes and perceptions of community gardens: Making a place for them in our neighborhoods. *Land*, *11*(10), 1762. https://doi.org/10.3390/land11101762

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments. *American Journal of Preventive Medicine*, *36*(1), 74–81. https://doi.org/10.1016/j.amepre.2008.09.025

Leroy, J. L., Ruel, M., Frongillo, E. A., Harris, J., & Ballard, T. J. (2015). Measuring the food access dimension of food security: A critical review and mapping of indicators. *Food and Nutrition Bulletin*, *36*(2), 167–195. https://doi.org/10.1177/0379572115587274

Long, C. R., Bailey, M. M., Cascante, D. C., Purvis, R. S., Rowland, B., Faitak, B. M. S., Gittelsohn, J., Caspi, C. E., English, E. S., & McElfish. P. E. (2023). Food pantry clients' needs, preferences, and recommendations for food pantries: A qualitative study. *Journal of Hunger & Environmental Nutrition*, *18*(2), 245–260. https://doi.org/10.1080/19320248.2022.2058334

Ma, X., Sharpe, P. A., Bell, B. A., Liu, J., White, K., & Liese, A. D. (2018). Food acquisition and shopping patterns among residents of low-income and low-access communities in South Carolina. *Journal of the Academy of Nutrition and Dietetics*, *118*(10), 1844–1854. https://doi.org/10.1016/j.jand.2018.04.017

Michigan GIS Open Data. (n.d.). *GIS Open Data: State of Michigan.* https://gis-michigan.opendata.arcgis.com/

Odoms-Young, A., & Bruce, M. A. (2018). Examining the impact of structural racism on food insecurity: Implications for addressing racial/ethnic disparities. *Family & Community Health*, *41*, S3–S6. https://doi.org/10.1097/FCH.0000000000000183

Rhone, A., Ver Ploeg, M., Dicken, C., Williams, R., & Breneman, V. (2017). *Low-income and low-supermarket-access census tracts, 2010-2015*. U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/webdocs/publications/82101/eib-165.pdf

Rose, D., & Richards, R. (2004). Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. *Public Health Nutrition*, *7*(8), 1081–1088. https://doi.org/10.1079/phn2004648

Ross, A., Krishnan, N., Ruggiero, C., Kerrigan, D., & Gittelsohn, J. (2018). A mixed methods assessment of the barriers and readiness for meeting the SNAP depth of stock requirements in Baltimore's small food stores. *Ecology of Food and Nutrition*, *57*(2), 94–108. https://doi.org/10.1080/03670244.2017.1416362

Russomanno, J., & Tree, J. M. J. (2021). Assessing sense of community at farmers markets: A systematic review. *Journal of Agriculture, Food Systems, and Community Development*, *10*(2), 489–506. https://doi.org/10.5304/jafscd.2021.102.032

Schmitt, A. (2015). *5 things the USDA learned from its first national survey of food access*. Streetsblog USA. https://usa.streetsblog.org/2015/04/10/5-things-the-usda-learned-from-its-first-national-survey-of-food-access/

Shepard, D. S., Setren, E., & Cooper, D. (2011). *Hunger in America: Suffering we all pay for*. Center for American Progress. https://www.americanprogress.org/wpcontent/uploads/issues/2011/10/pdf/hunger_paper.pdf

Shultz-Purves, S. (2013). *Inverting the atlas: Geographically based food security in Kalamazoo.* Unpublished undergraduate thesis. Kalamazoo College, Kalamazoo, Michigan.

Soliah, L. A. L., Walter, J. M., & Jones, S. A. (2012). Benefits and barriers to healthful eating: What are the consequences of decreased food preparation ability? *American Journal of Lifestyle Medicine*, *6*(2), 152–158. https://doi.org/10.1016/j.appet.2015.11.030 https://doi.org/10.1177/1559827611426394

Steuteville, R. (2017, February 7). *Great idea: Pedestrian shed and the 5-minute walk*. Public Square. https://www.cnu.org/publicsquare/2017/02/07/great-idea-pedestrian-shed-and-5-minute-walk

U.S. Census Bureau. (n.d.) *Kalamazoo County, Total Population, Average Median 2018 Income* [Prepared using Social Explorer]. Retrieved April 1, 2023, from https://www.socialexplorer.com/us-census-data

U.S. Census Bureau. (2022). *North American Industry Classification System*. https://www.census.gov/naics/

U.S. Department of Agriculture [USDA]. (2019) *Snap store locations*. Food and Nutrition Services. https://usda-fns.hub.arcgis.com/datasets/USDA-FNS::snap-store-locations/explore

USDA. (2022a) *Key Statistics & Graphics*. USDA Economic Research Service. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/key-statistics-graphics/

USDA. (2022b) *Food Access Research Atlas*. https://www.ers.usda.gov/data-products/food-access-research-atlas/documentation/#:~:text=Definition%3A%20A%20tract%20in%20which,supermarket%2C%20regardless%20of%20vehicle%20availability

U.S. Department of Health and Human Services [HHS]. (2023). *Food Accessibility, insecurity and health outcomes*. National Institute of Minority Health and Health Disparities. https://www.nimhd.nih.gov/resources/understanding-health-disparities/food-accessibility-insecurity-and-health-outcomes.html

Wolfson, J. A., Ramsing, R., Richardson, C. R., & Palmer, A. (2019). Barriers to healthy food access: Associations with household income and cooking behavior. *Preventive Medicine Reports*, *13*, 298–305. https://doi.org/10.1016/j.pmedr.2019.01.023

Ver Ploeg, M., Mancino, L., Todd, J.E., Clay, D.M. and Scharadin, B. (2015) *Where do Americans usually shop for food and how do they travel to get there? Initial findings from the National Household Food Acquisition and Purchase Survey*. U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/webdocs/publications/43953/eib138_errata.pdf?v=9685.2

Xin, J., Zhao, L., Wu, T., Zhang, L., Li, Y., Xue, H., Xiao, Q., Wang, R., Xu, P., Visscher, T., Ma, X., & Jia, P. (2021). Association between access to convenience stores and childhood obesity: A systematic review. *Obesity Reviews*, *22*(1), Article e12908. https://doi.org/10.1111/obr.12908

Yang, Y., & Diez-Roux, A. V. (2012). Walking distance by trip purpose and population subgroups. *American Journal of Preventive Medicine*, *43*(1), 11–19. https://doi.org/10.1016/j.amepre.2012.03.015

Zhang, M., & Debarchana, G. (2016). Spatial supermarket redlining and neighborhood vulnerability: A case study of Hartford, Connecticut. *Transactions in GIS*, *20*(1), 79–100. https://doi.org/10.1111/tgis.12142

Ziso, D., Chun, O. K., & Puglisi, M. J. (2022). Increasing access to healthy foods through improving food environment: A review of mixed methods intervention studies with residents of low-income communities. *Nutrients*, *14*(11), Article 2278. https://doi.org/10.3390/nu14112278