INFLUENCE OF FOOD DESERTS AND SOCIOECONOMIC FACTORS ON OVERALL COMMUNITY HEALTH

By

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A Capstone Project Submitted for Graduation with University Honors

May 12th, 2023

University Honors

University of California, Riverside

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ABSTRACT

Food deserts are regions that struggle with obtaining access to healthy, nutritious food such as fresh fruits and vegetables due to socioeconomic factors. Most commonly, food deserts are in areas where the poverty level is equal to or greater than 20% and where the nearest grocery stores are miles away or do not offer affordable options for healthy food. Socioeconomic factors, such as lower-income and limited access to reliable transportation, not only prevent specific communities from obtaining nutritious food but also negatively impacts the overall health of these populations. Chronic diseases are exacerbated without healthy food and adequate healthcare, and young adults and children in food deserts are much more likely to develop type 2 diabetes, obesity, and heart disease in the future due to a lack of proper nutrition provided at a younger age. When drawing comparisons among communities with food deserts versus communities with a larger median household income, there are fewer cases of diabetes and heart disease in wealthier regions, which can be attributed to an increased focus on preventative measures including increased healthy food options, fitness, access to primary care physicians, reliable transportation, health education, and increased time and money to spend on a healthier lifestyle. To protect the health of underserved populations, increased research, funding, and awareness of food deserts will ultimately nourish and preserve the wellbeing of these communities and contribute to healthier lifestyles and futures.

ACKNOWLEDGEMENTS

I am extremely grateful for my faculty mentor, Dr. Andrew Subica, who has been such a great motivator and provided so much support throughout my journey with my Capstone project. I am also very thankful for Dr. Qiuxi Li who graciously spent her time teaching me how to work with mapping programs and guiding me through some aspects of my project that were new to me. I appreciate the University Honors program for giving me the opportunity to work with amazing faculty and students and for supporting me to present at a research symposium, something that I did not think was possible. Finally, I am so blessed to have the full support of my parents and siblings who continuously support me throughout my educational journey. With their love and prayers, I have been able to navigate high school and college as a first generation college student, and I look forward to the rest of my journey.

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BACKGROUND

Food deserts are defined as regions that struggle with obtaining access to healthy, nutritious food such as fresh fruits and vegetables due to a variety of socioeconomic factors that arise from the social and built environment. Most commonly, food deserts are in areas where the poverty level is equal to or greater than 20% and where the nearest grocery stores are miles away or do not offer affordable options for healthy food (Caporuscio, 2020). According to the USDA, they estimate that around 19 million residents currently reside in low income areas that have less access to grocery stores. With such a large population struggling to access food, these food deserts make it difficult for the surrounding community to get the proper nutrients necessary to sustain a healthy diet and lifestyle.

The boundaries of a food desert are commonly defined by the demographics of the region. For example, food deserts in urban areas mean that there is a majority of the population that lives over 1 mile away from an affordable grocery store while in rural areas, a majority of the population lives over 10 miles away from an affordable grocery store (poverty.org). Purely looking at geographical location, it may be easier to identify food deserts by visualizing population density and distance to a nearby grocery store. By mapping a region with population density and highlighting areas further from urban areas, it is possible to predict which areas are further away from accessing reliable food sources.

While mapping distance to grocery stores is a valid method to identify food deserts, there are numerous factors that contribute to the presence of a food desert. Socioeconomic factors are critical to take into consideration when characterizing a food desert since many food deserts are caused by an intersection of location and outside limitations. Issues such as limited access to reliable transportation, lack of health insurance, strained household income, and health literacy

prevent specific communities from obtaining nutritious food and limit their opportunities to improve their lifestyle. Communities in high poverty areas tend to be minority communities or areas with a larger population of people who may not be as educated on eating nutritious food and properly maintaining their health. Additionally, lower income families are much less likely to be able to afford private transportation and healthier food options, and as a result, they may rely on cheaper options that surround them. This is important to consider when analyzing why communities further from more urban areas still have relatively high rates of obesity and diabetes as an area that may not be considered to be food insecure.

When drawing comparisons among regions with food deserts versus regions with a larger median household income in more developed communities, there are fewer cases of diabetes and heart disease in wealthier regions. This can be due to a general difference in the racial and ethnic demographics of the two regions, however, it is also possible that a wealthier region has a heightened focus on preventative measures including more healthy food options, fitness, access to primary care physicians, reliable transportation, health education, and increased time and money to spend on a healthier lifestyle. Only looking at distance to grocery stores could limit the depth of understanding about food deserts which is why taking other factors into account can help better understand the health of communities in food deserts and how they have been impacted by food insecurity.

OBJECTIVE

Riverside county is one of the largest counties in California. With 28 main cities present in both rural and urban areas of Riverside county, many of these communities have been identified as at risk when it comes to food insecurity. These communities are identified as at risk because the many communities have distances to grocery stores that are greater than 1 mile and greater than 10 miles. With this limited access to grocery stores, the main food options in these regions are now fast food restaurants. The Center for Health Journalism writes, "with over 800,000 people living below the poverty line in the Inland Empire and a sizable portion of its adults obese, there is cause for concern about the food — or lack thereof — going into resident's bodies," (Rojas, 2022). As these communities are now limited to what food they can obtain, this brings up the issue of the type of food they are more likely to eat. Furthermore, these communities also tend to have high rates of obesity and diabetes prevalence even though they have limited access to grocery stores, most likely due to the cheap and numerous fast food places that are in closer proximity.

The CDC PLACES mapping program contains US Census data on numerous health risk behaviors and health outcomes. The CDC categorizes obesity and diabetes as health outcomes, and the prevalence of these two outcomes are visualized on their mapping feature. Using this map, it is evident that counties with known food deserts, such as Riverside and San Bernardino counties, have a greater prevalence of both obesity and diabetes when compared to surrounding communities. Riverside county's obesity prevalence was 34.4% in 2020 while San Bernardino county's was 39.0% in 2020. Orange County, the county located next to Riverside county, has an obesity prevalence of 23.0% in 2020. Similarly, the 2020 data shows that Riverside county's

diabetes prevalence was 11.4%, San Bernardino county's was 11.8%, and Orange county's was 10.1%.

Although this data on its own may not be as useful as an indicator, it becomes more concerning when looking at the median household incomes for these counties as well. By using median household income as a way to compare the counties to one another, Riverside County had a median household income in 2017-2021 of $76,066 and San Bernardino County had a median household income in 2017-2021 of $70,287. Orange County had a median household income in 2017-2021 of $100,485, which is significantly higher than the other two counties, prompting the question as to why Riverside and San Bernardino have larger prevalence of obesity and diabetes even though the median income is lower. Knowing that Riverside County has communities that are considered low income and are considered food deserts due to their access to grocery stores, it is important to study how living in these food desert areas of Riverside County can contribute to higher prevalence values of obesity and diabetes.

With this background information, this project's purpose is to look at a variety of factors that contribute to food deserts and understand how certain factors play a role in overall health determination of Riverside county. Using the food desert definition, this project will use a variety of methods to look at food access and health outcomes of obesity and diabetes. Particularly, this project will focus on comparing the number of fast food restaurants versus grocery stores in the different cities of Riverside County and looking to see if this factor alone can be used to assess health outcomes. Does counting the number of fast food restaurants versus grocery stores provide a reliable indicator of a food desert and health outcomes in obesity and diabetes of Riverside County? The methods, research, and analysis presented will assist in supporting or disputing this question.

DESIGN AND METHODS

Section 1: ArcGIS/ArcMAP maps of fast food restaurants, grocery store access by distance, and health outcomes of obesity and diabetes

Food desert data can be clearly seen using mapping software to display the different regions and their data. For this reason, the first part of this project aimed to use online Census Tract data and CDC data to create visual imagery of Riverside County. The program used to visualize the data is ArcMap which is a part of the ArcGIS desktop application. Data can be uploaded into this application as files with location coordinates, and the uploaded data chosen will populate on the map.

The data for the maps created were all obtained from online data using websites such as the CDC, USDA, and US Census Bureau. These websites contain a large database of content that can be downloaded in the proper format for the ArcMap program. Since food desert mapping relies heavily on geographical location, using census data will give a very accurate representation of the population in a specific geographic region. For this reason, the first set of maps downloaded data from the USDA and regarding low access/low income populations and their distance from grocery stores. This data was merged along with Riverside County census tract data which would allow the map to match up the low access/low income data with the various tracts in Riverside county. This process was done three times in order to visualize data for the number of people that are low access/low income that live 1 mile, 10 miles, and 20 miles from the nearest grocery store.

The next map that was created was to visualize the number of fast food restaurants along with population density in Riverside county. To create this map, the data was downloaded from an online data source: Datafiniti Fast Food Restaurants Across America from Kaggle. This

dataset contained the location of fast food restaurants around the United States, and it was open for public download in the appropriate format for ArcMap. The fast food restaurant locations were then merged with United States Census Bureau data on population density in Riverside County. This population density data is available online to download in the ArcMap format in order to visualize which regions of Riverside County are more densely populated than others. Merging these two datasets with the various tracts in Riverside County provided a map showing the population density and number of fast food locations within Riverside County which will be used for later data analysis.

The third set of maps created focused on obesity and diabetes health outcomes. Health outcome data was downloaded from the CDC website. Their website contains a plethora of data regarding various health parameters that are available for public download in the correct format for ArcMap. The obesity health outcome data and diabetes health outcome data were downloaded and merged with the various tracts in Riverside County. Merging the two datasets provided maps that show regions with different prevalences of obesity and diabetes. To enhance this dataset and provide more relevant information, the fast food data downloaded from Datafiniti Fast Food Restaurants Across America from Kaggle was also merged with the health outcomes maps. This step was important in order to visualize the number of fast food locations along with the two health outcomes this project is looking at.

The purpose of creating these maps are in order to see which regions are not only food deserts (by looking at distance to grocery stores) but also to see where the majority of fast food locations are. If there are fast food locations in food desert regions, it also becomes possible to compare these maps with the health outcome maps to see if there are any overlaps in data.

Furthermore, these maps are crucial in the following section of data collection as these maps will serve as a visual representation of the quantitative data collected through a different method.

Section 2: Number of fast food restaurants and grocery stores by county along with health outcomes of obesity and diabetes

The second part of data collection focuses more on quantitative data collection. Although the previous mapping section is immensely beneficial in looking at the large area being studied, this project aims to specifically look at the number of fast food restaurants versus grocery stores in a specific region and determine if this value is a reliable indicator of a food desert and of health outcomes in obesity and diabetes.

In order to collect this quantitative data, the first step began with obtaining a list of every city in Riverside County and inputting them into a master data table. The names of each city within Riverside County was taken from the Riverside County website (https://rivco.org/cities). The city names were used for each county because data accession online is much easier with the exact city name. Many websites, such as the CDC, USDA, and US Census Bureau, use city names when providing data online. Furthermore, Riverside County is very large, and by looking at the 28 cities that make up this county, the data is presented more clearly and is not as overwhelming.

After obtaining the names of all 28 cities, population data taken from the US Census Bureau was input into the master data table alongside the name of the city. The data taken from the US Census Bureau's website (census.gov) provided the population of each city taken in July 2021. This data was included in the master data table as a way to look at the relative populations of each city. Since population data is important to consider when looking at income, resources,

and health outcomes, it is important to look at the data results in reflection of the relative population of the city.

To collect the number of fast food restaurants and grocery stores, Google Earth Pro was utilized to get a direct count of the number of each establishment. This computer application was utilized by typing in fast food restaurants and city names in order to search within the city boundaries. Each result for a fast food restaurant was looked at carefully to make sure the city name was correct and within the boundaries of the city. The same process was completed for grocery stores within each city, and this number of each establishment was incorporated into the master data table next to the city name.

In order to collect data that was as accurate as possible while counting the number of fast food locations and grocery stores, a list of the most common chain fast food restaurants and grocery stores was created. Using this filter, each city's fast food restaurants and grocery stores were counted based on if they were restaurants or grocery stores on this list. This was done because many cities have different types of restaurants: fast food, bars, grills, upscale restaurants. For this project, the goal is to look at only fast food restaurants which is why the fast food locations chosen are very common country-wide or state-wide chain restaurants. The same was done for grocery stores. Although there are not as many grocery store chains, a list of the common stores were compiled and served as a filter. This was done because Google Earth Pro does not differentiate between grocery stores and other stores such as gas station shops, convenience stores, and liquor stores. These were not included in the count of grocery stores because they do not provide the same access to necessary food items that a grocery store would. Additionally, many cities have smaller markets and cultural grocery stores. These were not included in the data, because it is difficult to distinguish which are grocery stores on Google

Earth Pro. To make the analysis as clear as possible, only chain grocery stores and bigger name establishments were included.

Table 1: Filter of Establishments used in Data Collection

Fast Food Restaurants	Grocery Stores
Taco Bell	Food4Less
Jack in the Box	Smart and Final
Del Taco	Walmart
McDonald's	Target
Carl's Jr	Cardenas
Burger King	Aldi
Arby's	Super Rancho
KFC	El Super
Popeyes	Qwik Market
Subway	Stater Bros
Casteñedas	Rancho Grande Markets
Wingstop	Sprouts
Juan Pollo	Vons
Little Caesars	Albertsons
In N Out	Superior
Dominos	99 Ranch
Farmer Boys	Ralphs
Pizza Hut	Trader Joe's
Starbucks	Costco
Chick fil A	Sam's Club
Five Guys	Grocery Outlet
Sonic	Winco
Wendy's	Whole Foods
Bakers	Food Mart
Farmer Boys	
Wienerschnitzel	
Raising Canes	
The Habit	
Panda Express	
El Pollo Loco	

The last step in collecting quantitative data was to incorporate health outcome data for obesity and diabetes for each city. This was done by using the CDC PLACES online program (https://www.cdc.gov/places/). This online program from the CDC website allows users to search

for specific cities and access health outcome data for the entire United States. Using this program, only cities within Riverside County were placed into the search area, and the health outcome data for obesity and diabetes were collected. This data was placed into the master data table alongside the city name, population, and number of fast food restaurants and grocery stores.

DATA RESULTS

Section 1: ArcGIS/ArcMAP maps of fast food restaurants, grocery store access by distance, and health outcomes of obesity and diabetes

Figure 1: Low Access/Low Income Population at 1 Mile of Grocery Stores

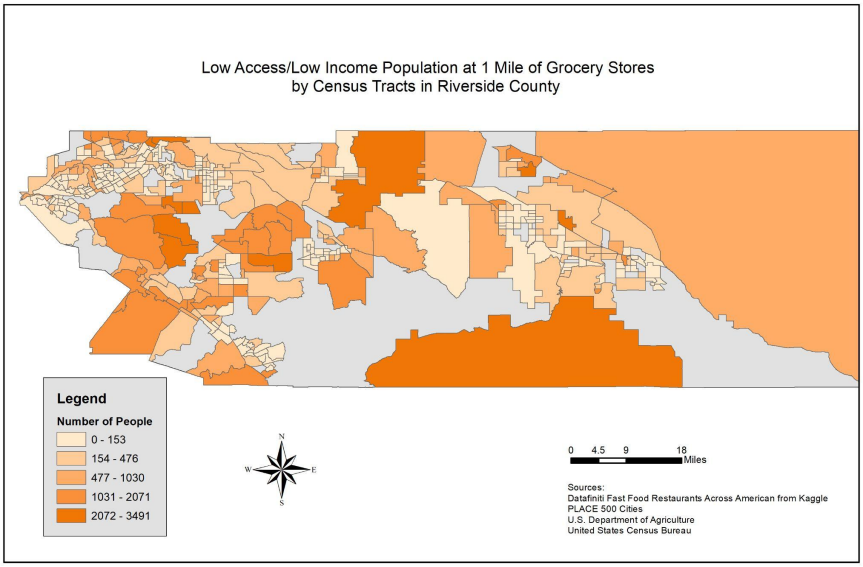


Figure 2: Low Access/Low Income Population at 10 Miles of Grocery Stores

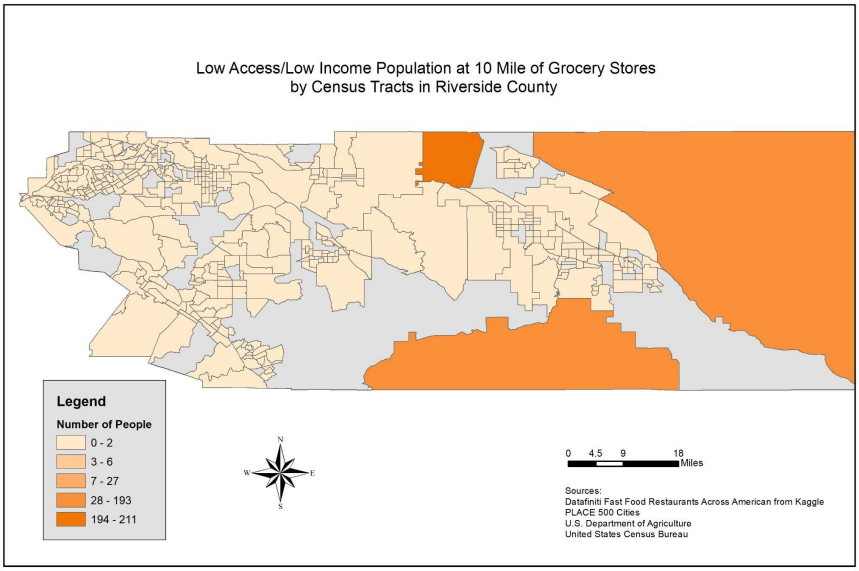


Figure 3: Low Access/Low Income Population at 20 Miles of Grocery Stores

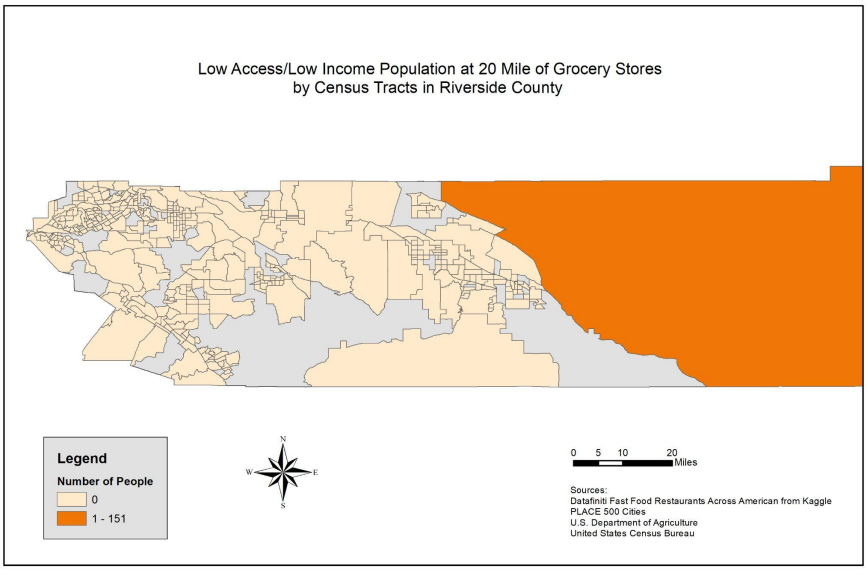


Figure 4: Fast Food Locations and Population Density by Census Tract

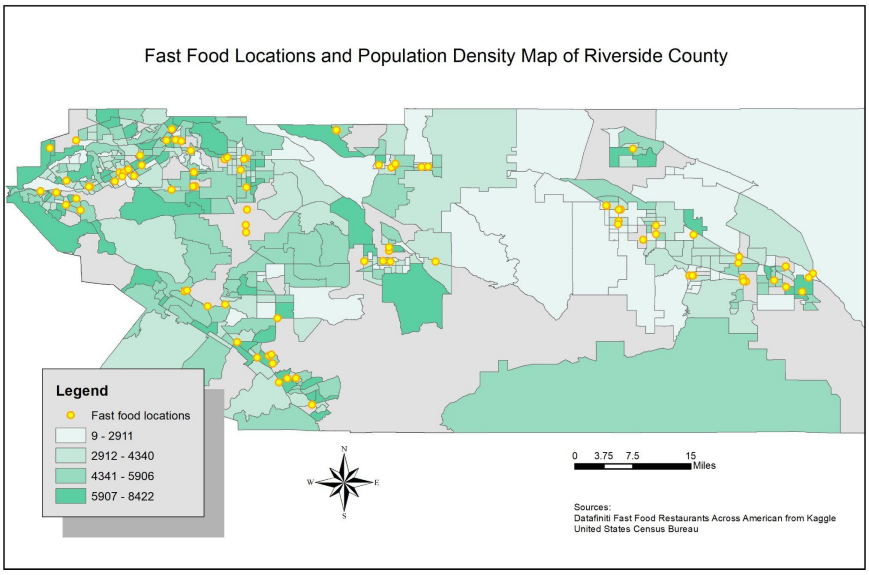


Figure 5: Prevalence of Obesity and Fast Food Locations by Census Tract

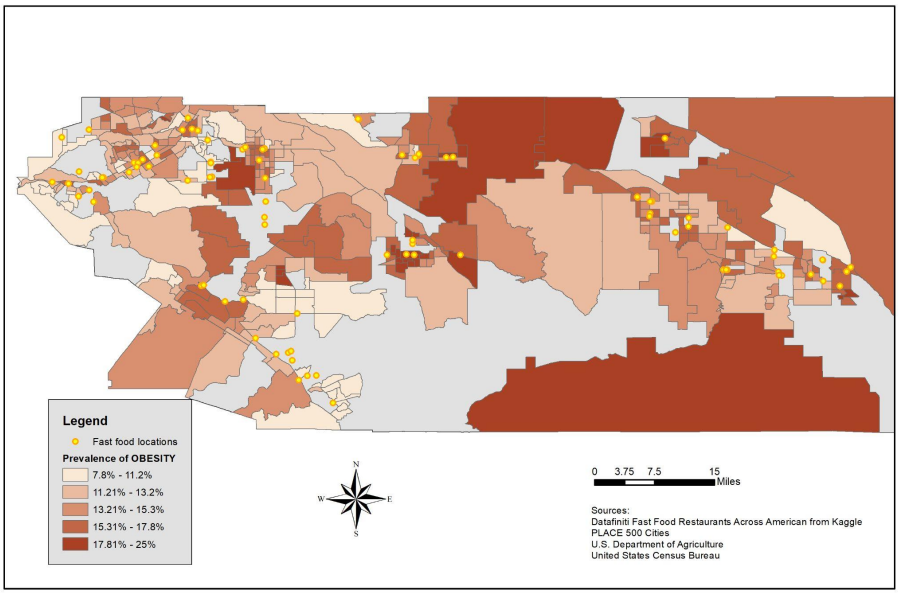
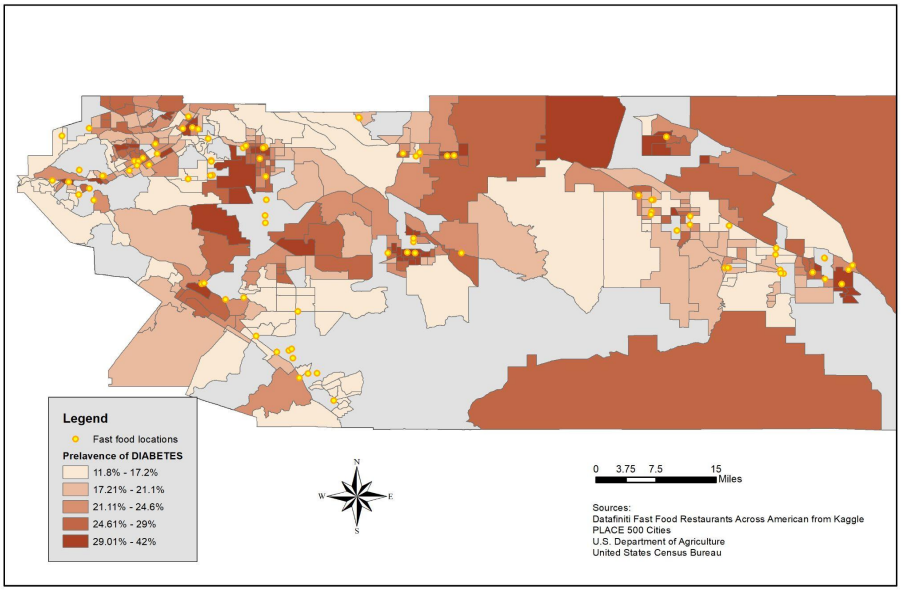


Figure 6: Prevalence of Diabetes and Fast Food Locations by Census Tract



Looking at these maps, it is much easier to visualize food deserts within these regions. For example, in Figures 1-3, the maps highlight areas where the members of the population are at 1 mile, 10 miles, or 20 miles from the nearest grocery store. Figure 1 shows us that there are many regions of Riverside County where people might find it hard to access grocery stores,

regardless of if they live in an urban location. This affirms the statement that food deserts can be present in highly populated areas, because it shows that even if there are grocery stores in a city, the access to grocery stores can be hindered by a number of factors. Figure 2 shows the population living 10 miles from the nearest grocery store, and the map now localizes to areas further inland. These regions are much further larger than the ones from Figure 1, and they encompass a much larger area. Figure 3 shows similar localization to the inland side of Riverside County. Figure 3 shows the number of people living 20 miles from the nearest grocery store. The region highlighted on the map has a population that may be at risk for developing health issues in the future because of how far they live from the nearest grocery store. Their distance from grocery stores could also impact the type of food that they rely on the most to eat and possibly have an effect on their health overall.

Figure 4 focuses on the number of fast food restaurants within an area as well the population density. On this map, we can see that where the population is dense, the number of fast food restaurants in the area increases. For example, cities such as Riverside, Temecula, and Corona have a greater amount of fast food restaurants, and this could be partially explained by how densely populated they are. An increased population density has the potential to attract more fast food companies to open new stores, which is why we see this data.

Figure 5 focuses on the prevalence of obesity as a health outcome along with the number of fast food restaurants. Cities such as Banning, Beaumont, and Desert Hot Springs are further from the main cities, but they have a greater prevalence of obesity. These cities also fell in range of Figure 1 which shows the number of cities that are 1 mile from the nearest grocery store. Since these cities fall within that range, it could indicate that there might be some overlap with access to grocery stores as well what types of food people are more likely to eat in this area.

Interestingly, areas that have a lot of fast food restaurants, as indicated by the map, do not have the highest prevalence values of obesity. Rather, it seems that more rural areas have the biggest values of obesity prevalence. Big cities such as Riverside and Corona have obesity prevalence values that are lower than the previously mentioned cities of Banning, Beaumont, and Desert Hot Springs.

Figure 6 shows the prevalence of diabetes as a health outcome along with the number of fast food restaurants. Similar to Figure 5, there is a pattern of more rural areas with a higher prevalence value of diabetes than some urban areas. The regions highlighted in Figures 2 and 3 seem to correspond with the increased prevalence of diabetes in Figure 6. Furthermore, these highlighted regions have a varying amount of fast food restaurants. Cities such as Riverside and Corona once again have a large number of fast food restaurants but do not have diabetes prevalence values as high as cities such as Perris, Banning, and Desert Hot Springs.

Section 2: Number of fast food restaurants and grocery stores by county along with health outcomes of obesity and diabetes

Table 2: Number of Fast Food Restaurants by City and Health Outcome Prevalence

City Name	2021 Population	Number of fast food restaurants	Number of grocery stores	Number of grocery stores and fast food restaurants	% of fast food restaurants	Prevalence of obesity in adults (%)	Prevalence of diabetes (%)
Banning	30,273	14	3	17	82.30%	34.8	12
Beaumont	55,280	26	6	32	81.30%	27.7	10.1
Blythe	17,793	10	3	13	76.90%	31.9	15.1
Calimesa	10,893	16	2	18	88.90%	27.2	8.6
Canyon Lake	11,166	1	0* due to filter	1	100%	25.8	8

Cathedral City	52,220	29	6	35	82.90%	30.6	11.6
Coachella	42,554	23	9	32	71.90%	35.5	16.5
Corona	159,743	67	28	95	70.50%	27	10.1
Desert Hot Springs	32,716	12	3	15	80.00%	34.1	13.9
Eastvale	71,375	14	3	17	82.30%	23.5	10
Hemet	90,436	46	10	56	82.10%	31.3	11.6
Indian Wells	4,846**	0* due to the filter	0* due to the filter	0	0%	24.5	7.4
Indio	90,416	32	9	41	78.00%	31.5	12.2
Jurupa Valley	106,941	8	2	10	80.00%	31.1	12.2
La Quinta	38,181	16	11	27	59.20%	26.9	8.9
Lake Elsinore	71,563	32	10	42	76.20%	35.3 (2020 data)	11.0 (2020 data)
Menifee	106,401	25	6	31	80.60%	26.9	9.7
Moreno Valley	211,600	67	15	82	81.70%	31	12.5
Murrieta	112,991	47	18	65	72.30%	25.6	8.8
Norco	26,077	17	5	22	77.30%	27.4	9.2
Palm Desert	51,541	34	12	46	73.90%	27.1	8.7
Palm Springs	45,019	27	11	38	71.10%	28.4	9.8
Perris	79,835	35	7	42	83.30%	33.4	14.4
Rancho Mirage	17,303	10	1	11	90.90%	25.7	8.2
Riverside	317,261	110	41	151	72.80%	29.1	10.9
San Jacinto	55,290	27	5	32	84.40%	31.8	12.3
Temecula	110,846	45	16	61	73.80%	24.9	8.5
Wildomar	37,189	14	3	17	82.40%	27.6	9.6

Figure 7: Number of Fast Food Restaurants and Number of Grocery Stores by City

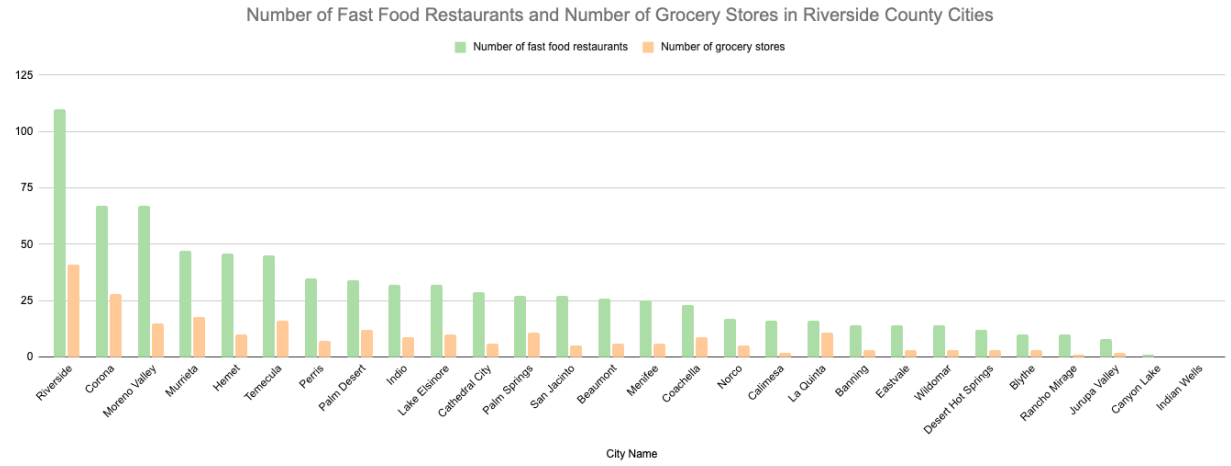


Figure 8: Number of Fast Food Restaurants and Grocery Stores vs. Prevalence of Obesity by City

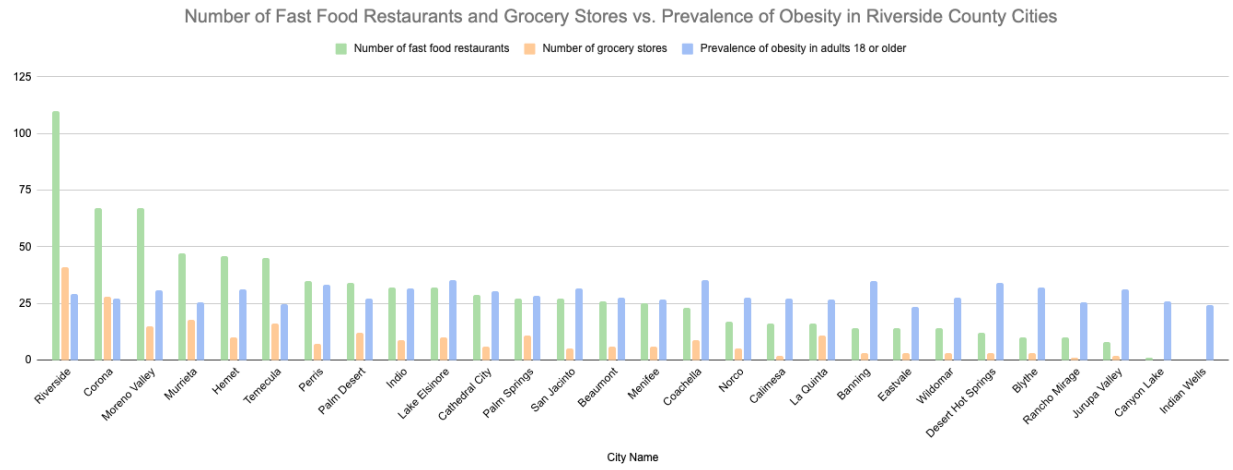


Figure 9: Number of Fast Food Restaurants and Grocery Stores vs Prevalence of Diabetes

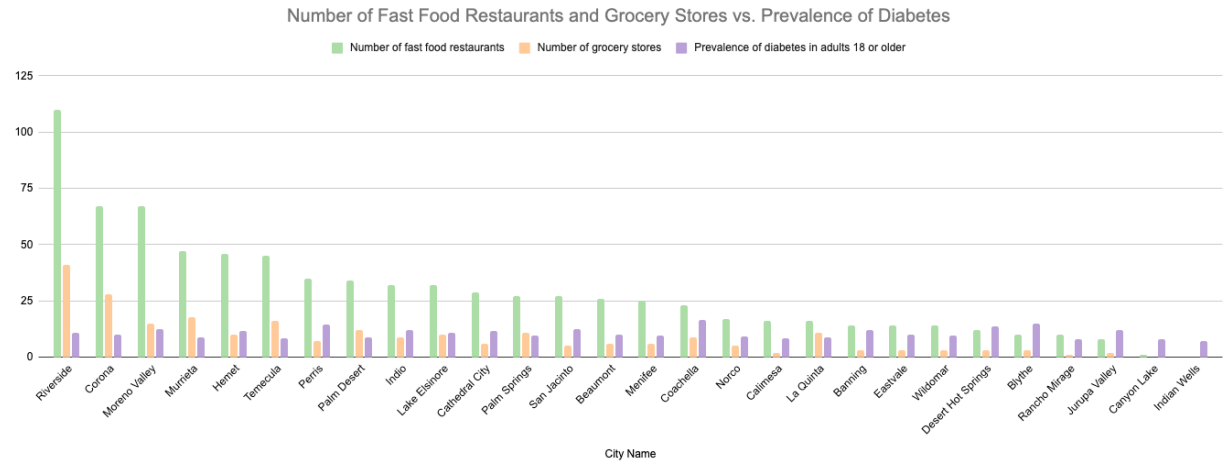


Table 2 shows a compiled list of manual quantitative data collection. After inputting the names of all 28 cities in Riverside County, the following data was collected: population, number of fast food restaurants, number of grocery stores, total of fast food restaurants and grocery stores, % of fast food restaurants (calculated by dividing the number of fast food restaurants by the total of fast food restaurants and grocery stores), prevalence of diabetes, and prevalence of obesity. From this data, we can see that for every city (with the exception of Indian Wells) there were more fast food restaurants than grocery stores. The percentage of fast food restaurants varied for each city, however, the number of fast food restaurants was greater each time. We also see that larger cities tend to have more fast food restaurants and grocery stores. For example, Riverside had 110 fast food restaurants and 41 grocery stores. Banning, on the other hand with a smaller population, had 14 fast food restaurants and 3 grocery stores.

Figures 8 and 9 included the number of fast food restaurants and grocery stores along with the health outcome prevalences of obesity and diabetes. When looking at these graphs, it shows that as the number of grocery stores decreases, the prevalence values for diabetes and obesity tend to increase. It also shows that certain cities are at higher risk depending on location

as well. As previously mentioned, bigger cities tend to have more fast food restaurants and grocery stores because of the market for retailers to open up stores. In areas such as Cathedral City and Coachella, they tend to be more inland of Riverside County and do not have as large of a population. However, their obesity and diabetes prevalence is higher than Riverside city.

DISCUSSION

The purpose of conducting two different parts of this study is to look at both the visual aspect of the layout of Riverside County, as well as to look at the direct number of fast food restaurants and grocery stores in each city. By doing both, it allows for a comparison of data values. Using the data from section of this study, table 2 was updated to look at which cities had the highest percentage of fast food restaurants vs. grocery stores and which of these cities matched up with the obesity and diabetes prevalence maps in section 1 of data collection.

Table 3: Number of Fast Food Restaurants and Grocery Stores (sorted from highest to lowest) by City Updated with Section 1 Data Analysis

City Name	2021 Population	Number of fast food restaurants	Number of grocery stores	Number of grocery stores and fast food restaurants	% of fast food restaurants	Prevalence of obesity in adults 18 or older (2018 data)	Prevalence of diabetes (%)
Canyon Lake	11,166	1	0* due to filter	1	100%	25.8	8
Rancho Mirage	17,303	10	1	11	90.90%	25.7	8.2
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Coachella	42,554	23	9	32	71.90%	35.5	16.5
Palm Springs	45,019	27	11	38	71.10%	28.4	9.8
Corona	159,743	67	28	95	70.50%	27	10.1
La Quinta	38,181	16	11	27	59.20%	26.9	8.9
Indian Wells	4,846**	0* due to the filter	0* due to the filter	0	0%	24.5	7.4

*** Red cities indicate less matching with Section 1 data**

*** Green cities indicate more matching with Section 1 data**

After each city had been manually entered, the 13 cities were organized from highest to lowest value in prevalence of obesity and diabetes. For obesity, 13 values from highest to lowest were Coachella, Lake Elsinore, Banning, Desert Hot Springs, Perris, San Jacinto, Indio, Hemet,

Jurupa, Moreno Valley, Cathedral City, Riverside, and Palm Springs. For diabetes, 13 values from highest to lowest were Coachella, Perris, Desert Hot Springs, Moreno Valley, San Jacinto, Indio, Jurupa, Banning, Cathedral City, Hemet, Lake Elsinore, Riverside, and Beaumont. Once these city names were identified, it was determined that these cities also have a greater number of fast food restaurants than grocery stores.

Although it can not be said for certain, it is possible that an increased number of grocery stores in an area may contribute to the health outcomes of obesity and diabetes. This is evident by the data just discussed above. By looking at the percentages of fast food restaurants to grocery stores in these cities, there are less than 10 grocery stores for 10 of the 13 cities mentioned but the number of fast food restaurants outnumbers that value by a significant amount.

We can tell that for the most part, many of the high percentages matched up higher rates of obesity or diabetes. However, that does not fully mean that this is a good enough indicator of a food desert. This project aims to not only see how many fast food restaurants and grocery stores are in an area but also to see if only looking at that percentage is a good enough indicator of a food desert and related health outcomes. Although cities with larger numbers of fast food restaurants vs. grocery stores ended up having higher rates of diabetes or obesity, this is not the only factor that can play a role in characterizing a food desert. For example, Menifee had around 25 fast food restaurants and 6 grocery stores. This would give a percentage of 80.60%, indicating that this city might have a high obesity or diabetes prevalence. However, according to CDC data, their obesity prevalence was 26.9% and their diabetes prevalence was 9.7%, which was a smaller than expected value, especially when comparing other cities like Indio which had an obesity prevalence of 31.5% and a diabetes prevalence of 12.2% with a fast food vs. grocery store percentage of 78%.

Table 2 shows rows highlighted in green and in red. The rows highlighted in green means that the number of fast food restaurants vs. grocery stores was an accurate representation of their health outcomes, meaning that the high percentage of fast food restaurants had a relationship with higher prevalence values of obesity and diabetes. The red highlighted rows means that the number of fast food restaurants vs. grocery stores was not an accurate representation of their health outcomes, meaning that the high percentage of fast food restaurants did not show a relationship with the health outcomes. As the table shows, the high percentage of values in cities highlighted in red did not have prevalence values as high as the other cities highlighted in green. This indicates that although the number of fast food restaurants vs. grocery stores can be a reliable indicator for some areas, there may be other factors at play that can help explain why certain cities are not well represented by this data. These other factors may include socioeconomic reasons, the demographics of that region, or a lack of data collected or available for public use. This does not mean that looking at the number of fast food restaurants is not useful. Around 15 of the 28 cities showed that the high percentage of fast food restaurants vs. grocery stores did have a relationship with the health outcomes. It does mean, however, that future research should conduct a much larger study with multiple variables to create a more comprehensive picture.

In using this data to understand if a region is a food desert, looking at the number of fast food restaurants vs. grocery stores as well as the location of these cities shows that all of these cities' grocery stores are outnumbered by fast food restaurants. Additionally, Figures 1-3 show the geographical location of where these cities are located, and these figures also highlight that there are food deserts present due to the accessibility to grocery stores. With this information combined with the health outcome maps, it is reasonable to say that cities in Riverside County

are outnumbered by fast food restaurants, and this could be the reason why certain less densely populated cities may have higher obesity and diabetes prevalence.

LIMITATIONS

One of the limitations of this project included finding accurate downloadable data. In section one of data collection, data was downloaded in the shapefile format from the CDC and from the US Census Bureau. Downloaded fast food and grocery data, however, was not as easy because the correct shapefile format was not available or the data was not fully updated in order to reflect the current number of fast food restaurants and grocery stores. In this project, the most accurate fast food data reflecting the most recent year was downloaded, however, there were some inconsistencies with section one data and the actual counted data from Google Earth Pro from section two.

Another limitation in this study is getting an accurate count of fast food restaurants and grocery stores. Google Earth Pro was useful in getting data for each of the 28 cities. One issue however, is that many cities had cultural grocery markets and smaller stores that could have increased the count of grocery stores. These stores were not included because it was difficult to determine if these markets provide the same types of food that a grocery store does. Since only main chain grocery stores were included, the count may have been a little bit inaccurate, however this could be remedied by future research that can have a more in depth look at each of these smaller grocery stores.

FUTURE RESEARCH RECOMMENDATIONS

Future projects that would like to look into food deserts in the Inland Empire, specifically Riverside, would greatly benefit from completing a more thorough research analysis with multiple socioeconomic. Due to barriers in this project with collecting data, future projects that are able to should try to include median household income, access to healthcare, access to health insurance, and even health literacy or education as other factors. These would be important to study because these factors are also relevant when studying underserved populations. Furthermore, looking into demographic factors and studying if there are any correlations between certain racial or ethnic groups and health outcomes could also provide insight into which populations may have a more difficult barrier to overcome when it comes to protecting their health and preventing health issues down the line.

CONCLUSION

Although more data should be collected on other outside factors and a more comprehensive large-scale analysis can be done, this smaller scale research shows that there is a need to look into the health of the cities and monitor them over time while also making changes in their access to grocery stores. Since this data shows that there are such a large number of fast food restaurants in Riverside County cities as opposed to the number of grocery stores, it is reasonable to see high prevalence values of obesity and diabetes in these cities as well. Furthermore, citizens in these communities who are already at a distance from grocery stores may rely on cheaper fast food restaurants for their meals which exacerbates the problem.

In order to remedy this, it will take time and effort to support these communities and offer other sources for healthy food such as community gardens, food drives, and food banks. Health education and teaching the community about the importance of healthy food can instill lifestyle changes that do not have to be out of their financial scope. Increasing the number of grocery stores may seem like another viable option, however, if the food provided in these stores are not affordable, the community may not be able to utilize the food as necessary. Instead, offering food at lower prices and in multiple locations throughout these cities will tremendously increase the number of people who can now change their diets and lifestyles. Ultimately, investing more time in understanding the resources of the community can potentially reduce their at-risk population from health outcomes that could be prevented.

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