

National Food Insecurity

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1 ABSTRACT

Food insecurity is nationally one of the most prevalent nutrition-related health issues. Within recent years its prevalence has skyrocketed and is only causing severe negative health consequences. It is known that there are concentrations of food disparity and low accessibility all over the US, but there is lack of proper representation and awareness. It is important to understand and clearly visualize where and how individuals are struggling throughout the nation, creating a path for a more concrete solution plan to be synthesized. This paper will be addressing these concerns in their specificity. Analyzing the USA as a whole and understanding the variance in concentrations regarding food insecurity is one of the focuses. There are many other factors that influence this concentration such as population, poverty rate, family income, etc., which are correlations studied in this paper.

2 INTRODUCTION

Food insecurity only continues to become a more pressing issue that millions of people in America suffer from. It was reported in 2009 that more than 50 million people in the USA lived in households that were classified as food insecure, with over one-third of these households experiencing a more serious level of food insecurity termed ‘very low food security [2]. It is reaching to be the number one driver of negative health consequences and it does not have restrictions when it comes to whom it can affect. Though it can be influenced by many social and economic factors throughout the nation.

Many efforts in the past have been made and have successfully impacted those who suffer from food insecurity such as more reflective school meal plans [1], but the main issue still arises. In this paper a question that was explored was where exactly in the USA food insecurity exists, this is an important thing to analyze as being able to visualize and map the concentrations of food insecurity and the locations allows for better overall mapping for further studies. It is key to understand not only the location and concentrations but also what exactly causes these differences in terms of society. Considering the data reported from the USDA national census, further analyzing the correlations in terms of the population creates a more unique and specified definition of food insecurity. Having a more concrete visual aid for the data reported Nationally, will make it easier for individuals such as food pantry volunteers to State Representatives to use for pantry donation necessities or efforts to dedicate help to locations in need.

3 RELATED WORK

The Children’s Food Security and USDA Child Nutrition Programs [3] article covers existing USDA programs and their effects on food insecurity among children. The focus was considering that children are not able to mostly account for themselves especially in a school setting due to the nature that they are on their own without familiar influence. There were studies conducted analyzing the U.S. Census Bureau’s Current Population Survey Food Security Supplement to classify the food security level of U.S. households. The study showed that there was a percentage of food insecure prevalent children no matter the household size or distribution, and the implicated food programs

such as the National School Lunch Program did benefit the children that were amongst low-income households. The study further dives into the before and after statistics of implementing the food plans through the help of consistent census studies to further compile how food insecurity impacts children and where they may come from and their overall household. It also tied into how the food programs can not only benefit students in terms of health but how it can also positively impact academics. Influencing this at a young age will help create a healthy pattern. In terms of visualizations, the article uses a horizontal bar graph reflecting the perfect intake of necessary categories of foods that any individual should consume for a healthy lifestyle. This visualization made it easier to see how the NSLP can further adjust their meals and diet plans for the students given the varied data. We can apply this to our project in terms of the types of foods that are somewhat relevant in concentrated areas of the US to further show how food insecurity affects individuals.

Furthermore, The Economics of Food Insecurity in the United States [4] focuses on the determinants of food insecurity in the US, and what exactly its outcomes are. It also addresses that there is intense concern about the direct implications of food insecurity (for example, that children may be skipping meals), and how this is directly associated with negative health outcomes. There has been research conducted regarding the impact of food insecurity on the community and how really it is caused and its second-hand impacts. Most of the reasons were due to financial constraints, considering the household and the impact it has on children. This article focused on the trend of insecurity in the US over time and the extent of its impact and the different relationships between income, family size, and ethnicity. A visualization was created that we as a group can use, where it takes the data of children living in food insecure households compared to very insecure households from 2001-2009. A double-line chart was used to map the 2 data groups over time, something we are looking to add in terms of reported food insecurity over time.

4 USE CASE

This dashboard primarily focuses on the existence and determinants behind food deserts in the United States. The data comes from the Food Access Research Atlas and contains information such as a county’s poverty rate, population, the proportion of citizens with access to a vehicle, whether the county has been flagged as a food desert, and much more for thousands of counties throughout the United States. The dashboard allows users to make effective conclusions involving the locations, factors, and severity of food deserts throughout the US. Along with a visualization showing the locations of the food deserts on a map of the country, there are additional subplots showing relationships between the percentage of people in a county who are food insecure and the population, percentage of people enrolled in the SNAP food stamps program, percentage of people with access to a vehicle, and poverty rate. This allows users to compare the results between possible primary factors to attempt to form a conclusion on what the most significant cause of food insecurity is across the nation. In these graphs, there is an option to view only urban or rural areas, select a specific state, or filter by income.

Someone that could use this tool is a USDA employee in need of supporting evidence for a research project or grant that would build food pantries in food-insecure locations. In such a scenario, they could use the map to find counties with severe food insecurity issues and identify those as points of interest. Additionally, Congress Representatives like Jim McGovern (MA) and Mary Gay Scanlon (PA) could use this dashboard to continue to stress the importance of significant efforts to eliminate food deserts and food insecurity in an easily digestible and powerful manner. As government and state representatives, at most they should be able to understand how to read a US map and then through the help of our visualizations' tooltips, filters, and instructions, understand where the greater concentrations of food deserts are and where help is most needed. The in-depth comparison of different factors allows them to form targeted legislation and split the fight against food insecurity into smaller, more realistic tasks. If one of the representatives were attempting to lobby to pass a new bill that requires a higher density of grocery stores in food insecure areas, they could use the visualization which compares vehicle access and food insecurity to portray the importance of increasing the number of stores in those areas. This tool provides an effective and straightforward medium for representing the scope and reasons for the food insecurity problem in America.

5 DATA

This dashboard utilizes data from the Food Access Research Atlas [1]. This atlas contains comprehensive data about food access in each census tract. The Economic Research Service, a sector of the US Department of Agriculture, gathered this data for the purpose of analyzing food access. Much of the data comes from the 2010 US Census including population data, race, and ethnicity. Income, vehicle availability, and SNAP participation data are from the 2014-18 American Community Survey.

The US Census data is one of the most comprehensive data sets about the US population and is often the best possible look at the state of the US. However, there is a response bias within the data. People are asked to complete the US census, and the survey is adjusted using statistical methods to attempt to make the sample representative of the population. However, there is a nonresponse bias where the people who do respond are not representative of the overall US population. Oftentimes, minorities, immigrants, and those in poverty are underrepresented by the data because they have not been informed of the census and its importance, or they do not have the time and resources to complete it. This means that the number of people with food insecurity is likely artificially low. However, this data is still informative and, while keeping the bias in mind, can lead to some provocative analysis.

To efficiently utilize the data, some cleaning was performed. Thirteen columns of the data were selected that were important to the specific analysis that was performed. The data was filtered for rows that had the marker 1 (signifying true) for the column indicating a low access tract with residents living greater than 1 mile (urban) or 20 miles (rural) from a supermarket.

6 DESIGN PROCESS

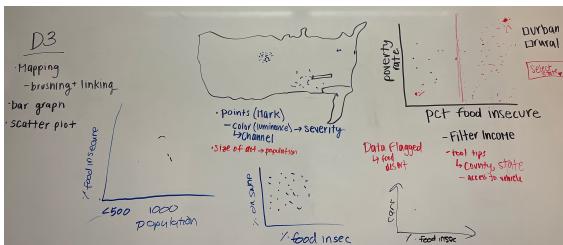


Figure 1: Our initial white board sketches of our potential visualizations. Final, polished sketches are shown in Figure 2.

Our initial sketches for our visualizations [Figure 1] were thought of as separate entities. We focus more on what each chart could show rather than what they could all show together.

The map shows the distribution of the severity of food insecurity across the country. We thought this method would provide a clear picture of where in the country where the highest rates of food insecurity exist.

The scatter plot in the top right of our rough sketch shows the percentage of a county that is food insecure versus the poverty rate of that county. We had a general hypothesis that the greater the percentage of food insecurity, the greater the poverty rate and we would test this hypothesis once we conduct further data analysis. For this visual, we decided it could be useful for the user to be able to toggle between seeing just urban counties, just rural counties, or both, as well as select and deselect certain states from a drop-down menu.

The bottom left scatterplot compares population to the percentage of food insecurity, the bottom middle scatterplot compares the percentage of food insecurity to the percentage of the county on SNAP, and the bottom right scatterplot compares the percentage of food insecurity to the percentage of the county with access to cars.

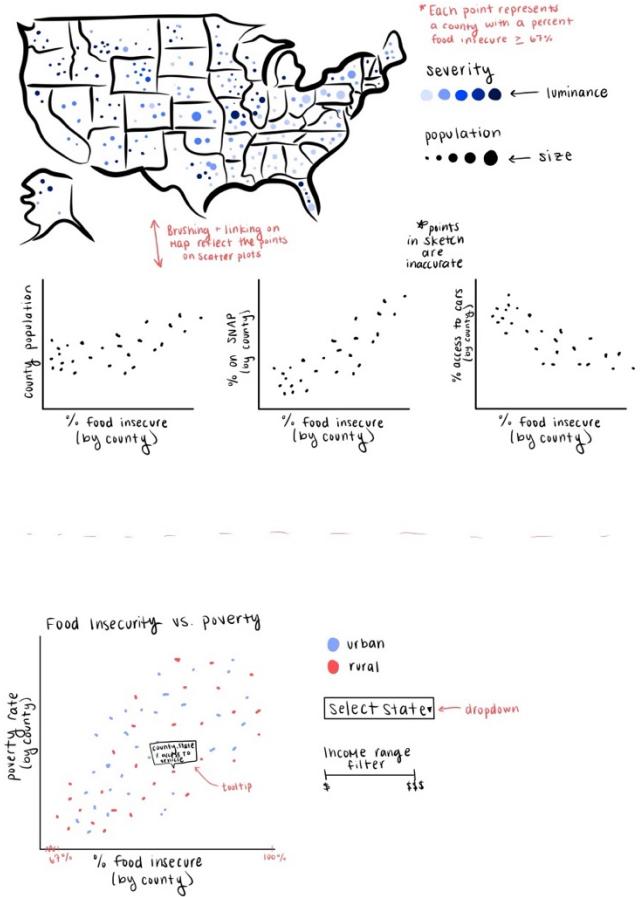


Figure 2: Our final, polished sketches of the encodings we plan to use to explore food insecurity in the United States.

For our final sketch, we realized that we could connect four of our initial sketches to have a more interesting and useful encoding. We still have the map visualization displaying the severity of food

insecurity across the country, but we added brushing and linking functionality, so when a user selects a portion of the map, the three scatter plots below would update.

Since the three scatter plots below the map are connected to the map, we decided to give them all the same x-axis of percent food insecurity for consistency purposes, but they have three different y-axes. The upper-left scatterplot compares the percentage of food insecurity to the county population, the upper-middle scatterplot compares the percentage of food insecurity to the percentage of the county on SNAP, and the upper-right scatterplot compares the percentage of food insecurity to the percentage of the population with vehicle access.

The final visualization we sketched is another scatter plot that is not linked to the visualizations mentioned before. This scatter plot highlights food insecurity versus poverty rate. The user can still choose to view either urban, rural, or both types of counties, but we added a color hue to the graph to differentiate between the two types of counties. We still included the drop-down menu to select specific states to view, and we also added an income range filter to offer a different socioeconomic view of this graph. We decided to utilize the flagged portion of the data set that highlights just those counties that are 67% food insecure or more, so the x-axes on all four scatter plots are broken and start at 67% instead of 0%.

On the map, the marks are points, and the channels are color, specifically luminance, which signifies the severity of food insecurity, size, which signifies population, and brushing and linking. For the other four scatter plot visualizations, the marks are points, and the channels are vertical and horizontal positions. The bottom scatterplot has an additional channel of color, specifically hue, which signifies an urban or rural county.

Over the course of implementing this design a few factors changed. First the definition on which we filtered the data was changed to areas with population that live greater than 10 miles from a supermarket. This allowed for a more accurate view of food insecurity. The poverty analysis scatter plot's color channel was changed due to this because no urban food deserts could be included in the data following this definition. Instead, there is a color scale reflecting the percent of the population on SNAP, which is very relevant to a government worker investigating the effectiveness of their existing program addressing food insecurity. An additional map view was also added in order to include all of the features we wanted in a usable way. One view has a zoom and a tooltip in order to explore the map. The other view is brushable and links to the scatter plots, like in the original design. Tooltips were also added to the linked scatters so that individual county information could be viewed if a point appeared interesting.

During usability testing, we found that people were able to use the tool and gain insight but finding all the graphs and understanding the encoding wasn't immediate. Extra labels and instructions were added to make it clear where to find everything and extra information was added to the legends to clarify what is being shown.

7 FINAL DESIGN

Our final visualization tool is broken down into three pages: Home, Map Analysis and Exploration, and Poverty Rate Analysis. On the top left of every page, we have access to a dropdown menu to navigate through the three pages.

Our Home page sets up the motivations of our reason for pursuing this specific visual analysis project and the background of the data chosen. We have our demonstration and report embedded on this page as well to be easily accessible for users.

Brush over a portion of the map to see the linked points highlighted on the scatterplots below.

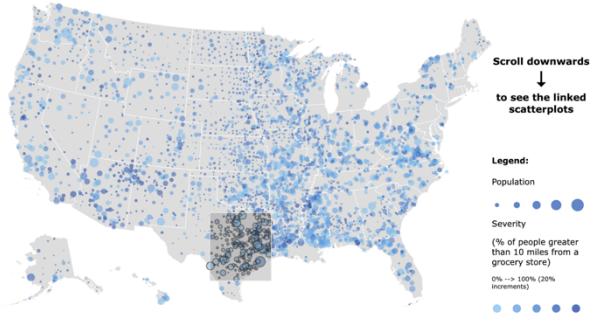


Figure 3: Plotted Food Deserts on US Map with Brushing Functionality, on the Map Analysis and Exploration page

The Map Analysis and Exploration page is the first full visualization page of our project. This page consists of a brushable map and three linked scatter plots. The map has every county from our dataset plotted over the United States through their longitude and latitude. The size of the point is determined by the county population and the luminance of the point is determined by the severity of food insecurity.

% Food Insecure vs. County Population

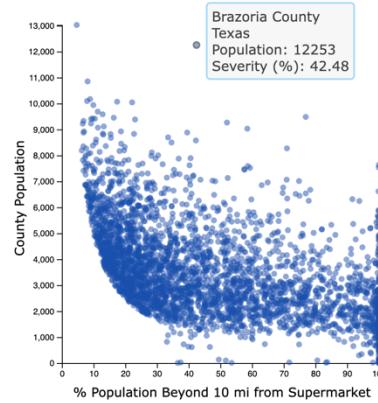


Figure 4: Population Percentage Beyond 10 miles from a Supermarket (Food Insecure) vs. County Population Scatter Plot

% Food Insecure vs. % on SNAP

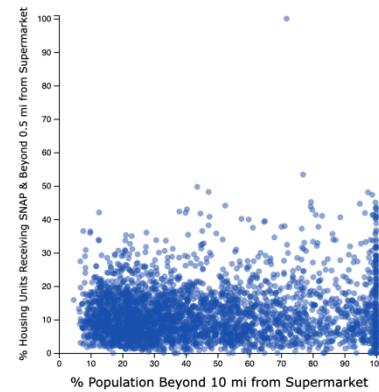


Figure 5: Population Percentage Beyond 10 miles from a Supermarket (Food Insecure) vs. Percentage of the County Population Receiving SNAP Benefits Scatter Plot

% Food Insecure vs. % Without Vehicles

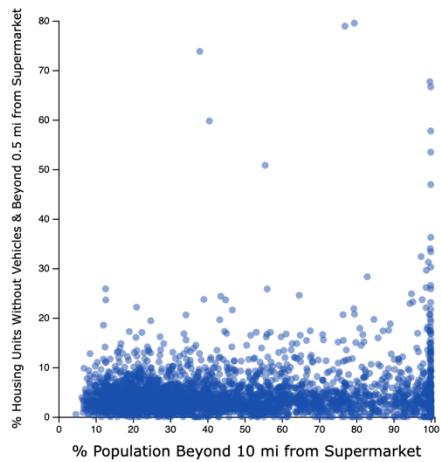


Figure 6: Population Percentage Beyond 10 miles from a Supermarket (Food Insecure) vs. Percentage of the County Without Access to Vehicles Scatter Plot

The three corresponding scatter plots relate to Task 2 noted in the Task Abstraction Appendix: Are there correlations between food insecurity and population, poverty rate, access to vehicles, and membership in the SNAP program? The Percentage of Food Insecurity can also be considered the percentage of the tract that is more than ten miles from the nearest grocery store. The first scatter plot looks at the relationship between the Severity of Food Insecurity and the County Population. The second scatter plot looks at the relationship between the Severity of Food Insecurity and the Percentage of the County Population Receiving SNAP Benefits. Finally, the third scatter plot looks at the relationship between the Severity of Food Insecurity and the Percentage of the County Population Without Access to Vehicles. All three scatter plots have tooltip functionality to give the user more information including county, state, population, and severity of food insecurity.

% Food Insecure vs. County Population

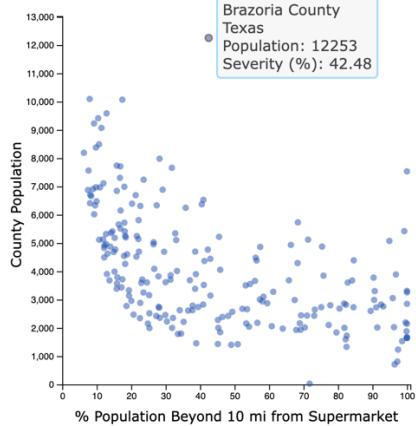


Figure 7: Population Percentage Beyond 10 miles from a Supermarket (Food Insecure) vs. County Population filtered for a region of Texas.

When a portion of the above map is brushed over and selected, the points on all three scatter plots below the map change as well. See the change on the left-most map below. We also incorporated a “reset selection” button to reset any brushed selection and plot all the points back on the scatter plots.

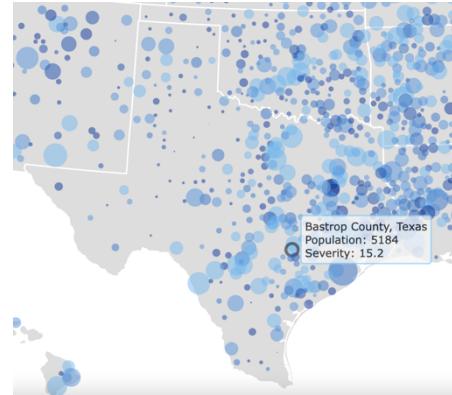


Figure 8: US Food Desert Map Zoomed-In on Bastrop County, Texas, with tooltip on hover.

To further explore the map and provide output for Task 1 from the Task Abstraction Appendix, which is focused on where the areas of need in terms of food insecurity are, we added another map exploration page linked at the top of the map page. This secondary exploration page brings up the same map as the original, but this map has zoom and tooltip functionalities to offer more information to users when observing the food deserts across the United States. The US map was a crucial element in our visual, as having a resource that is visually differentiable and manipulatable allows one to explore and gather the data they may need or want to use for comparisons.

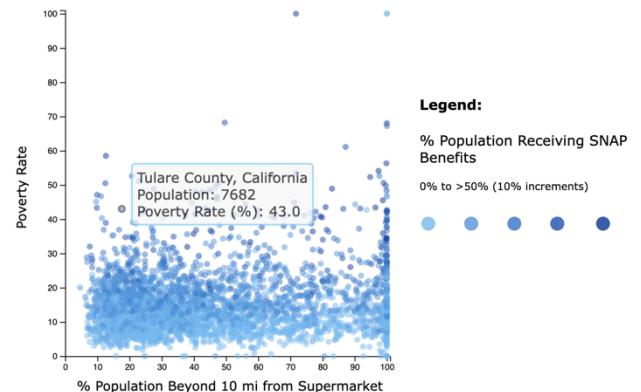


Figure 9: Population Percentage Beyond 10 miles from a Supermarket (Food Insecure) vs Poverty Rate Scatter Plot

Poverty Rate Analysis is our third page and displays the relationship between the Percentage of Food Insecurity (percentage of the tract that is more than ten miles from the nearest grocery store) and Poverty Rate. This goes back to responding to Task 2 and looking for a correlation between Food Insecurity and Poverty Rate. This map also has tooltip functionality, displaying the county, state, population, and poverty rate as a percentage when a point is hovered over. Having a tool that is filterable and visually encoded allows a user that wants to explore and filter to their needs.

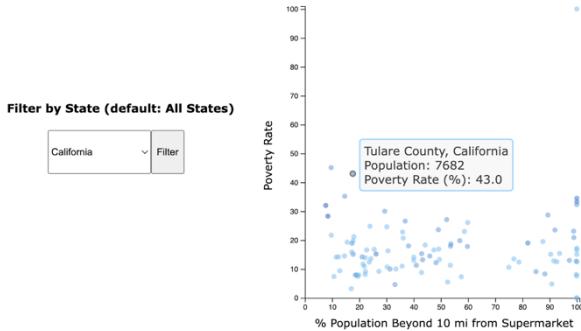


Figure 10: Population Percentage Beyond 10 miles from a Supermarket (Food Insecure) vs Poverty Rate Scatter Plot Filtered for only California counties.

This visualization is able to be filtered by state. The scatter plot still has the tooltip functionality here. We specifically wanted to introduce this filtering option because it can be interesting to see the spread of a specific state after seeing the spread of every plotted point in the United States. Creating the option to filter by state, and including the county in the tooltip creates the convenience of accessibility a user would want when exploring such a broad amount of data that at first glance is nearly impossible to differentiate. Taking the data directly from the USDA and making it more comprehensible for data analysis or even for a general citizen to use creates a more user-friendly experience. Our goal from the start was to create a tool that a variety of users could use, but to emphasize the use for bringing about awareness to a prevalent national issue that continues to affect millions across the nation. It serves its educational and explorational purpose specifically for those experiencing food poverty.

As mentioned in the Use Case section, target users for our tool include USDA employees, congress representatives, and even local food pantry volunteers. Focusing on the Representatives from Congress like Jim McGovern (MA) and Mary Gay Scanlon (PA), they can use this dashboard to gain more insight into the food deserts across the country in an easily digestible and powerful manner and be able to further stress the importance of significant efforts to work towards eliminating food insecurity. Mary Gay Scanlon, who represents Pennsylvania and works for environmental protection, could access our dashboard and utilize the Map Analysis and Exploration page. She could brush and explore the severity of various counties' tracts in Pennsylvania.

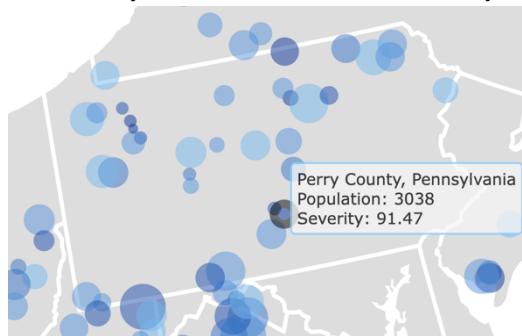


Figure 11: Zoomed-Into Pennsylvania Food Desert Map

For instance, if it was brought to their attention by a population report that there was a flag reported in Perry County that needed addressing, our tool could help. Using the brushing and hovering tooltip, it would show that a tract of Perry County has a population of 3,038 and a reported severity of 91.47%, which is extremely high. Returning to the Map analysis page, brushing around that exact area would then link to the 3 scatter plots reporting the data necessary to learn how to best support the area and those individuals.

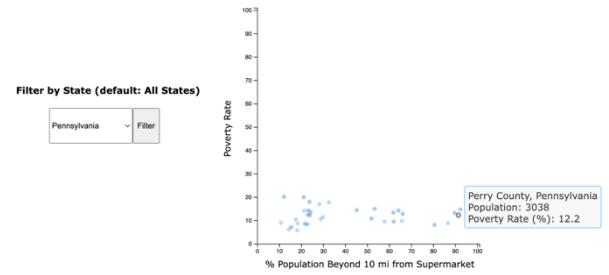


Figure 11: Food Insecurity vs. Poverty Rate scatter plot filtered for Pennsylvania

To explore the poverty rate relating to the Perry County example, Scanlon could access our third page and filter by state. Filtering for PA and hovering over the Perry County point would tell us that the poverty rate of this tract is 12.2%. Our tool is versatile in usability, and due to its easy access and exploratory and clear design, anyone wanting to investigate or gain more knowledge about food insecure locations in the USA can do so.

8 DISCUSSION

This project was created with the goal of creating a tool that would allow government workers and politicians tool gain a more thorough understanding of the food insecurity crisis facing our nation. Currently, many data sets exist surrounding this issue, but it is nearly impossible to grasp the issue and its causes from thousands of rows of data. The numerous facets of the final visualization tool successfully allow one to explore and analyze a complex set of data surrounding food insecurity.

The first goal was to be able to explore where food insecurity was most prevalent and be able to easily view information about that tract in order to identify areas of need. The exploratory map makes it easy to see where in the country food insecurity is occurring, where it is most severe (darker colored dots), to zoom in and investigate areas in depth, and finally to hover over each tract to learn specific information about it. Another exploration tool is the poverty rate analysis scatter plot that allows government officials to investigate the data on a state-by-state basis (often the level of government where issues such as food insecurity are primarily addressed) as well as analyze any trends.

The second goal was to analyze potential causes or indicating factors of a counties' food insecurity, in order to help inform policy action. The three linked scatter plots to the analysis map display links between severity (% of population greater than 10 miles from a supermarket) and potential factors such as population, percent on SNAP, and percent of the population without cars. Brushing the map allowed for a specific view of these factors in different areas of the country that government official could be focused on. The

SNAP analysis through the brushed scatter as well as the color channel on the poverty analysis scatter is particularly relevant to government officials to see if the program aimed to provide food to those in poverty is being effective. As a whole, the tool successfully allows for the exploration and analysis of food insecurity and could certainly provide and first step for officials to find areas of need and begin to develop policy actions to address the issue.

However, there are certainly limitations to the use of this tool. Primarily, the definition of food insecurity used is not all encompassing. For the purposes of this tool and working with such a large set of data, food insecurity was defined to be living beyond 10 miles from a supermarket. This definition ignores many areas where they are closer to a supermarket but may have limited access to reaching it. For example, there are areas in many cities where the only access to food is gas stations and fast food and it is difficult to reach a market using their usual means of transport such as public transportation systems.

Additionally, it is important to acknowledge the limitations of the data itself. It was collected through the US Census, which notoriously underrepresents minorities and people in poverty. These demographics are extremely important to food insecurity metrics. Unfortunately, the US census is the most comprehensive data available, and is the best tool to use to try and address the issue. Finally, the factors contributing to or connected to food insecurity analyzed were limited. There are likely many more contributors that were not taken into consideration that may be more causal and be able to inform better policy.

This tool could be expanded in the future to help address many of these limitations. Creating a better infrastructure for the site would allow for more data to be processed quickly which would allow it to include information about urban food deserts. Additionally, more factors could be included such as age and race demographics and their primary source of food. More factors would allow for a more thorough investigation into what contributes to the creation of food deserts.

9 CONCLUSION

Food insecurity is when a population does not have access to enough or nutritional enough food to live a healthy lifestyle. Currently over 34 million people in the US are food insecure (USDA). This is an important issue facing the United States but identifying it and then addressing it is not an easy task. This visualization tool takes US census data and maps where food insecurity is occurring and provides area specific analysis of contributing factors. Creating this simple way of interacting with the data could provide the basis for identifying areas of need and beginning to inform policy actions to address the issue.

10 REFERENCES

- [1] Alana Rhone. "Food Access Research Atlas", Economic Research Service U.S. Department of Agriculture, March 2022.
- [2] Jonathan Rothbaum, Adam Bee, Mark Klee, Brian Mendez-Smith, "An Overview of Addressing Nonresponse Bias in the American Community Survey During the COVID-19 Pandemic Using Administrative Data", United States Census Bureau, November 2021.
- [3] Katherine Ralston, Katie Treen, Alisha Coleman-Jensen, Joanne Guthrie, Children's Food Security and USDA Child Nutrition Programs, United States Departments of Agriculture, June 2017.
- [4] Craig Gundersen, Brent Kreider, John Pepper, The Economics of Food Insecurity in the United States, Applied Economic Perspectives and Policy Volume 3 Issue 33, pp 281-303, August 2011.

APPENDIX - DATA ABSTRACTION

Each row of the data set represents a census tract that is an extreme food desert (where most residents live greater than 20 miles from a supermarket).

Column Name	Data Type	Definition
State	Categorical Attribute	State name
County	Categorical Attribute	County name
Urban	Categorical Attribute	Flag for urban tracts
POP2010	Quantitative Attribute	Tract population count from 2010 census
OHU2010	Quantitative Attribute	Tract occupied housing unit count from 2010 census
PovertyRate	Ordinal Attribute	Share of the tract population living with income at or below the Federal poverty thresholds for family size
LATracts10	Categorical Attribute	Flag for low access tract when considering 10 mile distance *might change to 20
Lapop10share	Ordinal Attribute	Share of tract population that are beyond 10 miles from supermarket *might use 20
MedianFamilyIncome	Quantitative Attribute	Tract median family income
Iahunvhalfshare	Ordinal Attribute	Share of tract housing units that are without vehicle and beyond 1/2 mile from supermarket
lasnaphalfshare	Ordinal Attribute	Share of tract housing units receiving SNAP benefits count beyond 1/2 mile from supermarket
lakids1share	Ordinal Attribute	Share of tract population that are kids beyond 1 mile from supermarket

Lat	Position	Latitude of the tract
Long	Position	Longitude of the tract

APPENDIX - TASK ABSTRACTION

Task 1: Where are the areas of need in terms of food insecurity?

- High-Level: Consume - Discover - Discover specific data on the map
- Medium-Level: Locate - Location of deserts unknown, target known. Locate deserts on the map
- Low-Level: Identity - Identify food deserts

Task 2: Are there correlations between food insecurity and population, poverty rate, access to vehicles, and membership in the SNAP program?

- High-Level: Consume - Discover - Discover data from the scatter plots
- Medium-Level: Explore - Location and target unknown, find an interesting connection
- Low-Level: Compare - Compare axes of the scatter plots to find correlations