Visualizing a Local Food Bank's Chronic Health Disease Population

Mikaya Hamilton, Steven Jiang, and Lauren Davis
Department of Industrial and Systems Engineering
North Carolina Agricultural and Technical State University
1601 E Market St., Greensboro, NC 27411, USA

Abstract

Food insecurity hinders individuals from the healthy and sustainable life they truly deserve. Unfortunately, food insecurity and chronic health diseases affect millions of people across the United States. Food banks are constantly fighting the uphill battle against food insecurity to supply adequate, relevant, healthy meals to those who need them. Oftentimes hunger relief organizations lack data and software tools that could aid strategic decision-making. A local food bank faces this exact problem and is struggling to find clients that face chronic health diseases in their service area. This study uses data from the local food bank to develop visualizations that investigate the health considerations of the population they serve. The results easily found a specific county with the largest number of health considerations and a zip code with the highest number of individuals facing hypertension. Dominant chronic health considerations highlight the importance for food banks to diversify their food selections. It is important for the local food bank to know what foods are essential within each county and zip code area to provide services that will be valuable to those who need them. This study benefits food banks so they can yield better service to the community.

Keywords
Food insecurity, chronic health disease, food bank, and visualization.

1. Introduction
About 89.8% of Americans who are food secure always had access to a dependable and healthy supply of food that contributed towards a sustainable lifestyle in 2021 (Coleman-Jensen et at. 2021). On the contrary, food insecurity is still a huge problem that many households face. Food insecurity is a condition where a household has limited or uncertain access to an adequate food supply (Gundersen and Ziliak 2015). In 2021, 3.8 percent of the households faced exceptionally low food insecurity, and 10.2% were food insecure (Coleman-Jensen et al. 2021). These numbers are not significantly different from the previous year.

A food bank is a non-profit organization that collects and distributes food to the community and partner agencies. There are uncertainties in both supply and demand resulting in complex operations. Due to the complicated process and the substantial amount of information, organizations are forced to make decisions that may not benefit food distributions, inventory control, and coordination with agencies to serve the community. Not only is distributing the food difficult but serving relevant food that the community wants and needs. Many organizations spend time focusing on the coordination of getting food to homes, but they do not focus on household preferences based on culture and chronic health considerations.

The initiative for food banks to provide healthy food is crucial especially since there is an inordinate amount of health disparities in the minority population. Minorities are 1.5 to 2 times more likely to have chronic diseases than Whites, which is heavily related to income, race, and ethnicity (Price et al. 2013). For instance, American Indian or Alaska Native (14.5%), African American (12.1%), Hispanic or Latino (11.8%), and Asian (9.5%) people are more likely to be diagnosed with diabetes than White people (7.4%) (Centers for Disease Control and Prevention 2022). Not to mention, diabetes can cause other diseases like high blood pressure, hypertension, high cholesterol, and high triglycerides. These diseases could lead to other serious implications like heart disease, stroke, blindness, kidney failure, and even death (Centers for Disease Control and Prevention 2022). Chronic conditions most often are related to obesity, which is extremely serious.

According to a Diabetes and Obesity Map, the southern region of the United States has a higher density of people that are obese and diagnosed with diabetes than the mid-west, western, and eastern regions (Centers for Disease Control and Prevention 2019). The pressure on food banks to serve healthy foods is extreme due to the excessive rates of obesity and chronic diseases in America. More importantly, food banks need to equitably distribute healthy foods to their communities since minorities are more likely to have chronic diseases that could lead to serious implications. If food banks do not serve healthy food, then individuals may not use the food that is given to them which will force them to seek other options. This may lead to a shift of household resources that could have gone towards other expenses (United Way of Olmsted County 2017). To efficiently serve these populations, hunger relief organizations must gather data to make inferential and strategic decisions on how to get food and resources to areas that need it.

Food Banks can utilize several software tools to collect data but there is not enough context on how these software tools can be used in food assistance programs (Martin et al. 2022). Based on an interview conducted with several food banks partnered with Feeding America, food banks have the option to choose their data platform. Feeding America is the nation's largest hunger relief nonprofit organization and they have about 200 affiliated food banks that serve food-insecure households across the nation. The organization launched a new Neighbor Intake platform as part of the Service Insights Initiative in 2022 (Feeding America 2022). This platform offers food banks its newly launched data system at no cost. However, it could be difficult for food banks to transfer data to the new neighbor intake platform and learn new features and capabilities. In previous years, Feeding America encouraged food banks to use Link2Feed, a client management system built for hunger relief organizations over other similar software platforms like Oasis or Primarius. Feeding America offers services to food banks that choose to still use Link2Feed instead of the new Neighbor Intake platform. Link2Feed is a digital management and analysis software system that aids food banks in gathering data by tracking client participation, total meals served, waste, automating compliance, and more importantly client demographic data (Link2Feed, 2022). Clients are queried through an entry form that asks questions about their race, ethnicity, gender, age, household income, health, etc. The software allows food banks to sort data, generate reports, and view a heat map of those in need by using geodata. Currently, eighty food banks across the United States have implemented this software to detect program goals and their impact on communities and improve decision-making.

1.1 Objectives
Link2Feed offers the capability to collect data from the communities they serve. However, many food banks cannot analyze the data collected using a simple approach such as visualization. The local food bank has an inadequate ability to identify clients with chronic health diseases with what the tool currently offers. Therefore, the objective of this study is to provide the local food bank with a dashboard, comprised of visualizations, to help them identify chronic health diseases within the population they serve. Thankfully, the data can be exported to other platforms, allowing even more capabilities to understand the data. This will ultimately give food banks the power to make better food and resource allocation decisions.

2.0 Literature Review
Recent studies have shown the application of Link2Feed in areas such as tracking usability, evaluating food insecurity within university student populations, and improving clients' health. Baniya & Weech (2019) studied and conducted testing regarding Link2Feed's usability for a food bank and concluded that the tool lacks the capability to meet the needs. Another study uses Link2Feed data to find the determinants of food insecurity within a university (Low 2018). They surveyed college students about their access to food and insecurity levels to determine how food deserts exist on campuses. A more relevant and recent case study conducted by Branton (2022), describes how a food bank improved client health with Link2Feed software. They mentioned that donations had to be returned or thrown away because they do not fit within the client's needs, so the food bank needed to understand how to equitably distribute food to their networks. Within the "Dietary Considerations" section in Link2Feed, they used the "Statistics Report" to find where their partner agencies served the highest population of diabetics to distribute the supplies to those agencies (Branton 2022). The case study only refers to clients who have diabetes when there are many types of chronic diseases. A statistical report can be too complicated when analyzing which areas have an immoderate concentration of needs based on their health. Further research can be done to show the needs of other types of diseases using Link2Feed data with a more visual approach.

3.0 Methodology

To truly utilize Link2Feed data to meet the health consideration needs of the food bank, this study applies the human-centered design methodology. The user is kept at the center of the design to ensure its accuracy and usability. An interview with a local food bank was conducted via Zoom to understand their needs and requirements. This local food bank serves 18 counties, has almost 200 partner agencies, and it is currently using the Link2Feed software. This food bank has a specific need to create an initiative to serve underserved populations related to chronic diseases. To do so, the number of individuals is identified geographically so the food bank can equally distribute their services based on how many people are in need, the chronic health diseases they face, and where they live. So, a geographical heat map is used to visualize the food bank's service areas with high and low densities of individuals that have chronic diseases. However, the geographical heat map that Link2Feed currently provides does not consider the health considerations in an area. It only provides a view of aggregated data, like the total meals served across the food bank's service area. Due to the software's limitations in geographically understanding specific types of data, the client responses (Link2Feed data) will be visualized in software called Tableau. The food bank specified they prefer a map showing the health considerations for at least one household member with diabetes, hypertension, or heart disease based on zip code and county level. This study applies the food bank's Link2Feed data to create a dashboard of visualizations to meet their expectations. The ability to do this will increase the number of people served in local areas thus largely improving human life to end food hunger.

4.0 Data Collection

The local food bank exported the Link2Feed data in an Excel sheet and provided a desensitized version to use in this study. However, many typos and duplicates of information were found in the datasheet since clients were voluntarily tasked to fill out a form. The errors were mainly found in zip code and county responses. A function in Excel was used to correct basic misspellings of counties, but some responses were checked and corrected manually. The duplicate rows of information were analyzed to make sure there were no significant changes between the sets of information. Once the data was cleaned, the local food bank's partner agency locations were listed in a second sheet and imported to Tableau.

5. Results

A total of twelve visualizations were developed on a dashboard and the food bank was kept at the center of the design process. The visualizations, comprised of heat maps, graphs, and charts, were used to identify extreme concentrations of health considerations in an area. Based on these visualizations, the user can identify which county or zip code has the most or least number of individuals with health considerations. Figures 1 and 2 display heat maps of the number of health considerations represented by the darkness of color in each county and zip code. In addition, they display the partner agency's exact address with black dots on the county level and orange dots within zip codes. Two counties with the darkest hue color identify the most populated area with health considerations at 52,227 and 43,639 people. Whereas one specific zip code with highly concentrated individuals that have the highest total of health considerations is 29,160 people.

The three categories of health considerations identified by the local food bank were visualized as well. The user can search the type of consideration, county, or partner agency by typing in values or using a drop-down list. For example, Figures 3 and 4 show the county and zip code heat maps for hypertension.

The heat maps are crucial for the local food bank to geographically identify vulnerable service areas, but analyzing the data is equally important. It was discovered that Forsyth County has the highest total of health considerations at 53,227 people. When comparing diabetes, heart disease, and hypertension in Figure 5, not only did Forsyth County have the most cases in each category, but 57.50% of individuals mostly struggle with hypertension overall. On the other hand, 35.64% of individuals face diabetes and 6.86% of people have heart disease, which is least common in the food bank's service area.

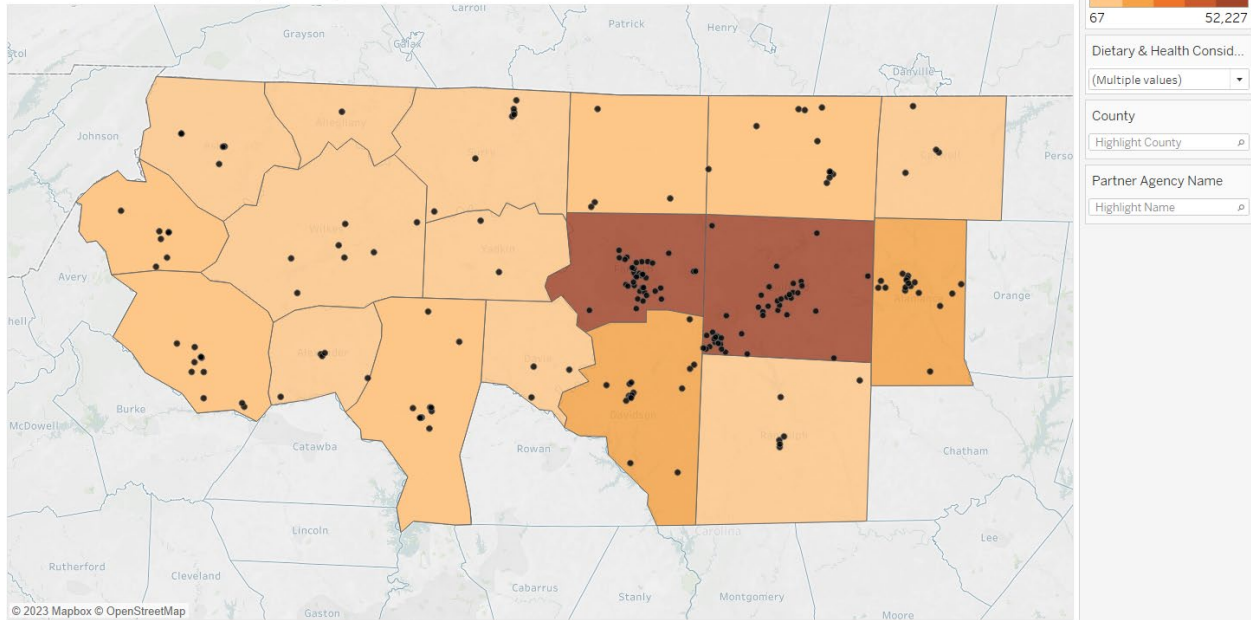Health Considerations by County

Figure 1: Total number of Health Considerations by County
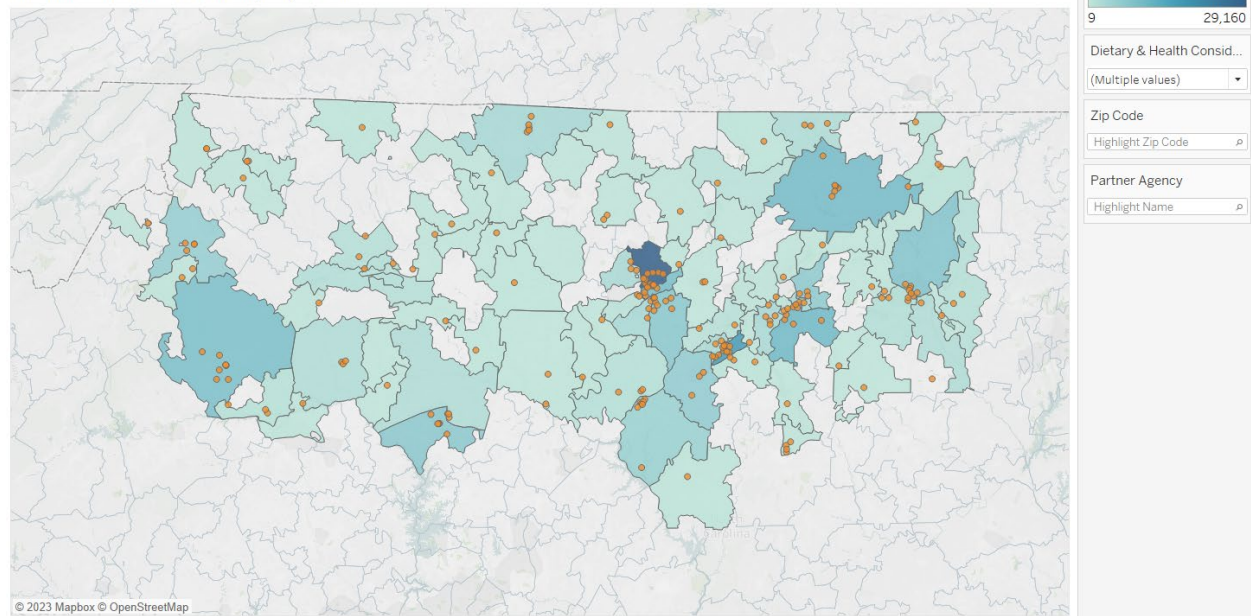
Health Considerations by Zip Code

Figure 2: Total number of Health Considerations by Zip Code
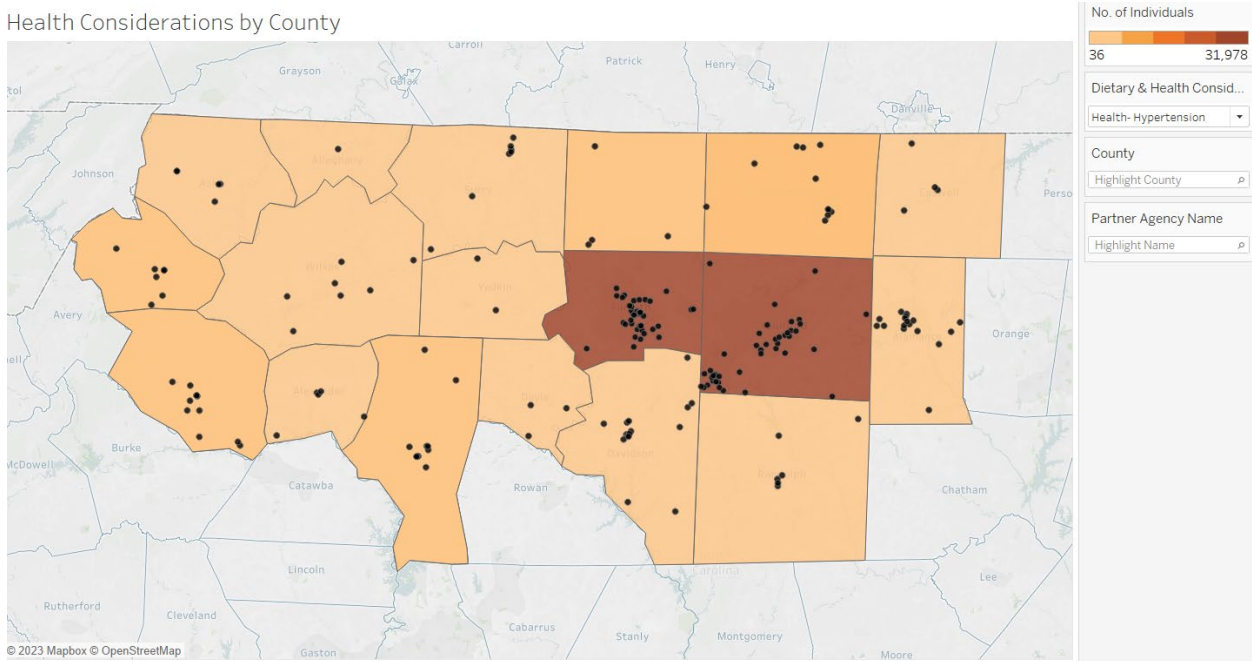
Health Considerations by County

Figure 3: Heat map of Hypertension by County

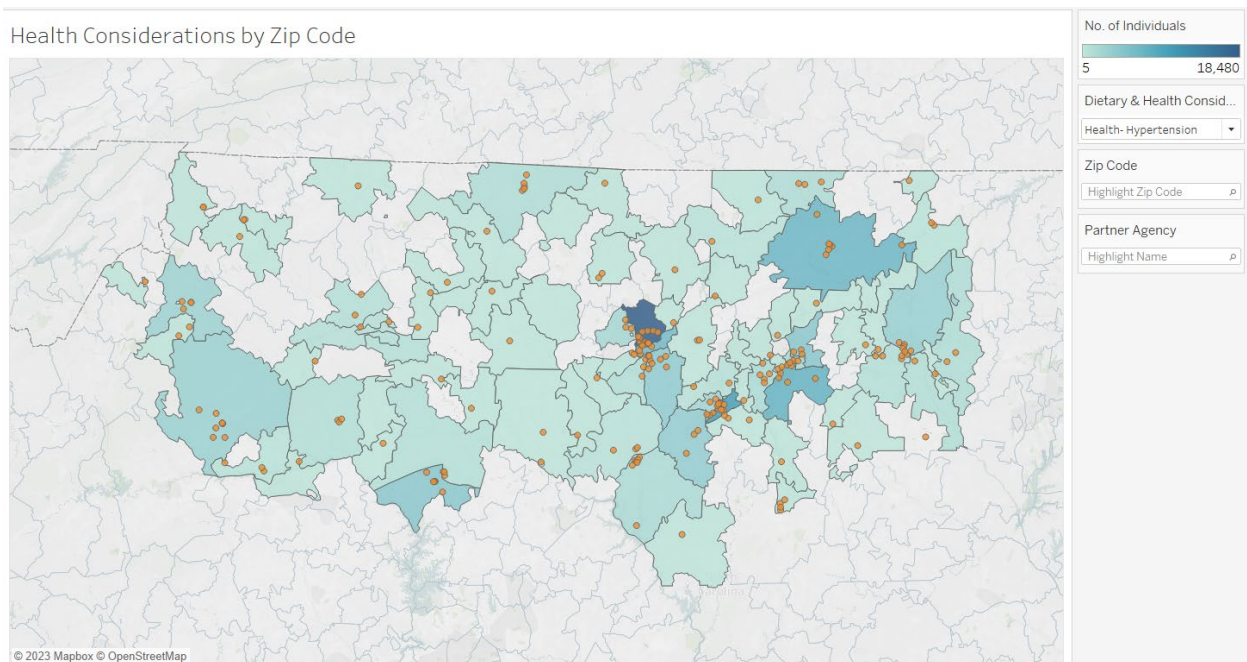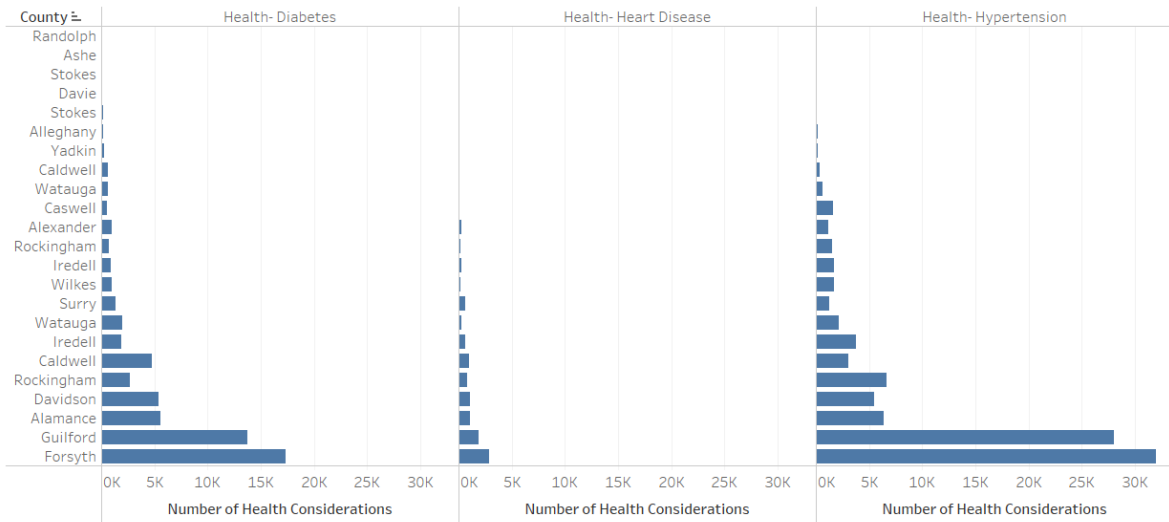Health Considerations by Zip Code

Figure 4: Heat map of Hypertension by Zip Code

Figure 5: Comparison of Health Considerations by County

After reviewing the county levels, the user can pinpoint specific communities that face chronic health diseases by zip code. Figure 6 shows a tree map of the total number of health considerations and a bubble chart that compares each category by size. The treemap identified the zip code, 27105, contributing 17.11% of the total number of people suffering from chronic health diseases (29,160 neighbors). When comparing the three categories in Figure 7, the same zip code contributed to the highest number of individuals that have hypertension (10.84%), diabetes (5.28%), and heart disease (.99%).
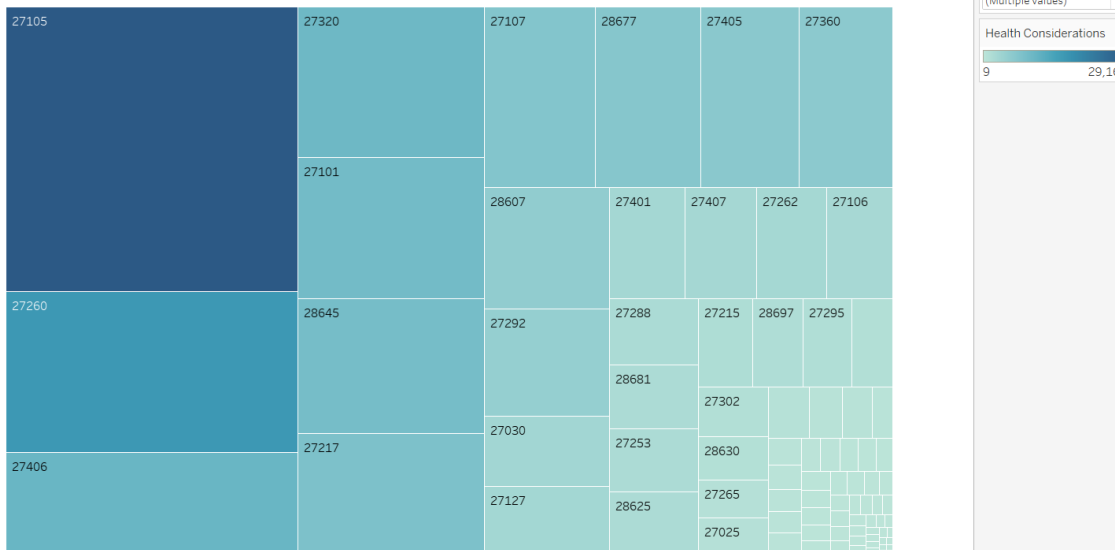

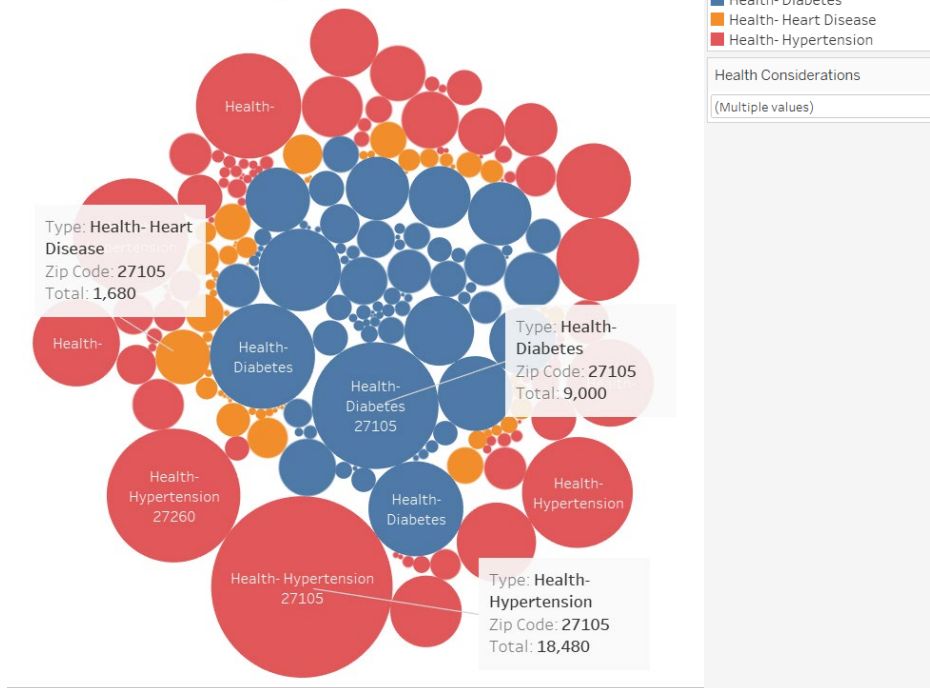Figure 6: Treemap of the total number of Health Considerations by Zip Code

Figure 7: Comparison of Health Considerations by Zip Code

Further insights into the health considerations regarding the client's race/ethnicity were explored and can be valuable for the local food bank. Although it is not a requirement set forth by the food bank, understanding the health disparities and popular chronic health diseases among different racial and ethnic groups can inform the food bank to better serve its neighbors.

Based on Figure 8, it is evident that African Americans face more implications of chronic health diseases compared to other racial groups. 59.78% of African Americans experience health considerations while Asians and Native Americans have the lowest prevalence of health diseases with 0.77% and 1.18% respectively.

Figure 9 provides a visualization that compares the three categories of health diseases to the client's race/ethnicity. This data highlights African Americans experiencing higher rates of hypertension and diabetes compared to other minorities and races. Meanwhile, White Americans have a lower overall rate of chronic diseases at 32.86% which consists of hypertension and diabetes as well.

The data visualizations from Figures 8 and 9 suggest that the food bank can consider providing culturally relevant foods that accommodate the specific dietary and health needs of different racial groups. The local food bank can prioritize providing foods that meet the requirements for lowering the risks of chronic health conditions like hypertension which is more prevalent among African Americans and White Americans. The local food bank can align its services with the health needs and cultural backgrounds of its neighbors so the organization can play a significant role in promoting healthier lifestyles.
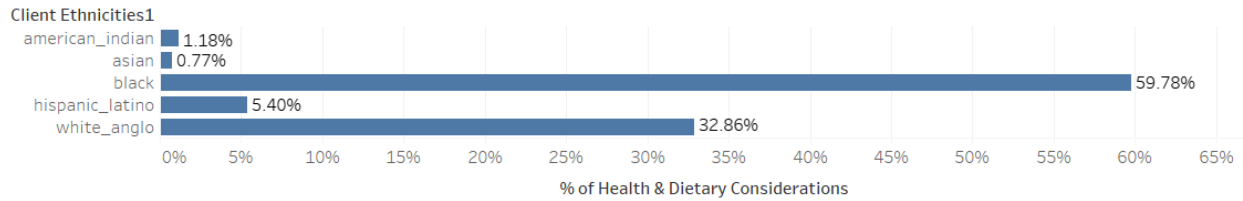
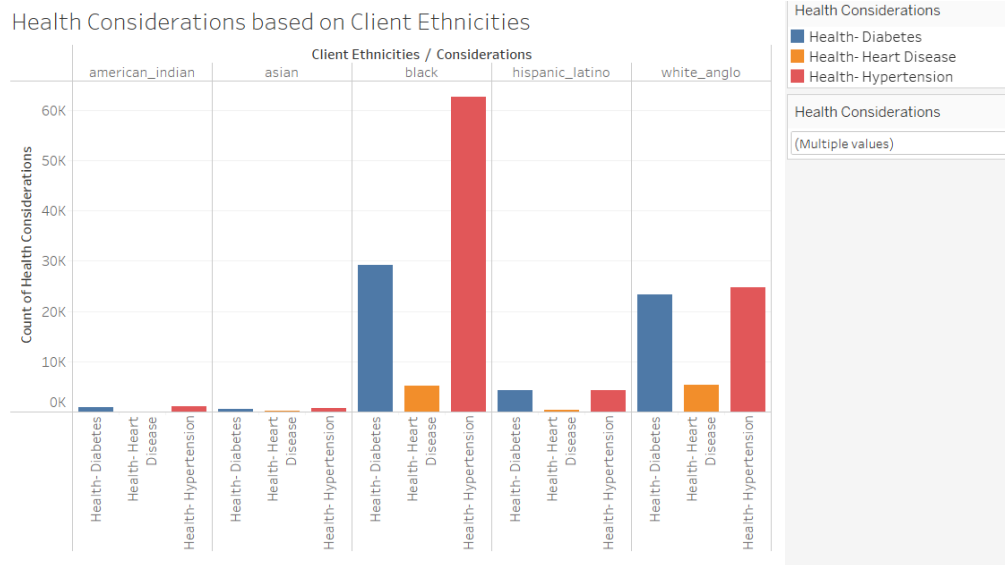Figure 8: Health Considerations by Client Ethnicity/Race

Figure 9: Health Considerations Compared to Client Ethnicity/Race

These visualizations can assist the food bank in making better strategic decisions. After reviewing the data, food banks can distribute healthy foods to certain counties and zip codes based on each health consideration. On a county level, the food bank may want to prioritize Forsyth and Guilford County and the zip code 27105 since there are many people who face chronic health diseases in these areas. More precisely, almost 60% of people faced hypertension, which was more frequent at the county and zip code levels. Additionally, data suggests that 59.78% of African Americans and 32.86% of White Americans struggle with chronic health diseases. Therefore, the visualized data can assist the food bank to identify the most vulnerable community.

6. Conclusion
Eating healthy foods and having access to healthy foods should be the same for everyone. Hunger relief organizations play a huge part in serving and feeding our communities. People are food insecure, and it is also clear that people across the country are facing health diseases. These chronic diseases can be mitigated with access to healthy foods, which is why there needs to be a push for healthy access. For these food banks to serve, they need to be equipped with the knowledge and easy-to-use tools to help them assist others.

This research was able to provide a solution to the local food bank's needs. The products of this study, specifically the dashboard comprised of data visualizations, can offer several benefits to the local food bank. This organization can save money, make data-driven decisions, and become more responsive to the needs of the community.
First, the food bank can optimize its distribution strategies by identifying the specific counties and zip codes people face chronic diseases. The local food bank can ultimately save money since they can focus on areas with higher needs, ensuring that the right amounts of food are provided to underserved communities. This targeted approach will ultimately reduce waste and efficiently allocate resources which will lead to cost savings for the organization.

Secondly, this study can help the hunger relief organization improve its responsiveness. The data visualizations show up-to-date data on hypertension, diabetes, and heart disease rates in their service areas. The food bank can monitor trends or changes in health diseases over time. Thus, they can quickly adapt and provide services that address emerging needs. For example, if there is an increase in heart disease in a specific county or zip code, the food bank can provide more heart disease-friendly food options to support that area.

Lastly, the insights provided by the dashboard allow the organization to make strategic decisions based on accurate information. The organization can find patterns and disparities related to chronic health diseases and clients' race/ethnicity. Ultimately, these data-driven decisions can lead to more effective and impactful distribution. The dashboard is practical, and anyone can simply understand the data outputs. Additionally, the research findings can be shared with other organizations. The local food bank can collaborate with healthcare professionals, partner agencies, and government agencies to coordinate efforts to address common health conditions. These partnerships can help the food bank amplify its impact on the community and improve the community's health for good.

Acknowledgments

References

Baniya S., Weech S., Data and Experience Design: Negotiating Community-Oriented Digital Research with Service-Learning, *Purdue Journal of Service-Learning and International Engagement*, vol. 6, no. 5, 2019.

Branton, E. Daily Bread Food Bank Improved Client Health with Link2Feed's Food Bank Software, link2feed.com, para. 4, Mar. 16, 2022. Available: https://www.link2feed.com/client-story-client-needs/, Accessed Feb. 3, 2023.

Coleman-Jensen, A., Rabbitt, M.P., Gregory, C.A., Singh, A. Household Food Security in the United States in 2021. Washington, DC: *U.S. Department of Agriculture, Economic Research Service*, 2022.

Centers for Disease Control and Prevention, Age-Adjusted Prevalence of Diagnosed Diabetes and Obesity Among Adults, by County, United States. Diabetes and Obesity Maps, Centers for Disease Control and Prevention National Center for Chronic Disease Prevention and Health Promotion, 2019. Available: https://www.cdc.gov/diabetes/data/center/slides.html , Accessed Jan. 14, 2023.

Centers for Disease Control and Prevention, Diabetes Report Card 2021, US Department of Health and Human Services, 2022. Available: https://www.cdc.gov/diabetes/library/reports/reportcard.html, Accessed Feb. 3, 2023.

Feeding America, How Feeding America Ends Hunger, Feeding America, 2022. Available: https://www.feedingamerica.org/our-work, Accessed Jan 27, 2023.

Gundersen, C. and Ziliak, J.P., Food Insecurity and Health Outcomes, *Health Affairs*, vol. 34, no. 11, November 2015. Available: https://www.healthaffairs.org/doi/epdf/10.1377/hlthaff.2015.0645, Accessed January 27, 2023.

Link2Feed. *Food Bank & Pantry Software Solutions*. Food is a Catalyst for Changing Lives. 2022. https://www.link2feed.com/who-we-serve/food-banks-pantries/

Low, H.T., Determinants of Food Insecurity within University Student Populations: Results of a College Food Pantry Survey, *M. S. thesis, Portland State University*, Portland, OR, 2018.

Martin N.M., Barnett D.J., Poirier L., Sundermeir, S.M., Reznar, M.M., Gittelsohn,.J., Moving Food Assistance into the Digital Age: A Scoping Review, *Int. J. Environ. Res Public Health*, vol. 19, no. 3, 2022.

Price J.H., Khubchandani, J., McKinney, M., Braun, R., Racial/Ethnic Disparities in Chronic Diseases of Youths and Access to Health Care in the United States," *Biomed Res Int,* vol. 2013, no. 787616, 2013.

United Way of Olmsted County, "Culturally-Responsive Food Strategies," *United Way of Olmsted County,* 2017. [Online] Available: https://www.uwolmsted.org/food-security, Accessed Dec 23, 2022.

Biographies

Mikaya Hamilton is currently a second-year Ph.D. student and Chancellor's Distinguished Fellow at the illustrious North Carolina Agricultural and Technical State University. Her research interests are related to combating food hunger. In 2021, she graduated Summa Cum Laude with a bachelor's degree in industrial and systems Engineering from North Carolina A and T.

Steve Jiang is an Associate Professor in the Department of Industrial and Systems Engineering at North Carolina A&T State University. His research interests include visual analytics and human systems integration as applied to manufacturing, service, and healthcare industries. He is an active member of IISE, HFES, and ASEE.

Lauren Davis is a Professor in the Department of Industrial and Systems Engineering at North Carolina A&T State University. Her research interests are in the management of for-profit and not-for- profit/humanitarian supply chains with a specific focus on performance in environments constrained or uncertain supply, uncertain demand, and disruptions in operations caused by extreme events. She is an active member of IISE and INFORMS.