Investigation Into Food Insecurity Measurement Methods

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Introduction

One of the most pressing issues surrounding human development is that of food insecurity. Food insecurity is defined by the United States Department of Agriculture (USDA) as "a house-hold level economic and social condition of limited or uncertain access to adequate food," while Feeding America, a nonprofit that devotes itself to combatting hunger and food insecurity, defines food insecurity as "a household's inability to provide enough food for every person to live an active and healthy life" (Dragas Center, 2020)(Gundersen et al., 2021). This second definition is in line with what Amartya Sen believes about human development: in order to be able to achieve freedoms that are a marker of a developed society, one must not have to worry about fulfilling basic needs, such as food and healthcare (Sen, 2010). Thus, alleviating food insecurity will open other avenues to increasing human development. Since the 2008-2009 economic recession, food insecurity in the United States has not lessened in severity, even though the economy has bounced back (Fleischer et al., 2017). This is a trend that is noticeable at the national level, as well as at the local level, evidenced by studies done in places such as New Hampshire, Roanoke, and Hampton Roads, that describe high levels of food insecurity even as the global economy recovers. Food insecurity is complex in its determinants; there is a struggle between demands and resources within families that often lead to other necessities, such as medicine, being chosen over food insecurity (Fleischer et al., 2017). Food insecurity problems differ in severity and type across the nation and can be measured in up to five different dimensions: accessibility, availability, affordability, accommodation, and acceptability. Different dimensions of food insecurity serve varying purposes for informing policy decisions. Two important methodologies that will be discussed further in this paper are that of using poverty and population density information to identify areas at risk for food insecurity based upon the relative

density of food sources to population density, as well as using Geographic Information Systems (GIS) in order to examine geographic and geospatial data related to the availability of food sources. Investigation of these existing methodologies will seek to answer the research question: how can we measure, describe, and propose solutions to food insecurity, with the hope of applying it to a study of the transportation networks and food sources in the Hampton Roads region of Virginia.

Method Investigation One

One method of investigating food insecurity is using population density data as well as data regarding the percentage of families below the poverty line in order to determine areas at risk for food insecurity. This method was used in the paper *Mapping Food Insecurity and Food Sources In New Hampshire Cities and Towns*, which was developed by a team of researchers at the University of New Hampshire in 2012. The population density and percentage of families below the poverty line data was collected from the New Hampshire Community Profiles, Economic and Labor Market Information Bureau. The data was then separated into towns and counties and put into a map format with overlaying layers depicting population density in counties in New Hampshire, percentage of families living below the poverty line in counties in New Hampshire, and the risk of food insecurity, which was calculated by the researchers and is explained further in this investigation. All three of these factors were visually represented in a color-coded map (See Figure 1).

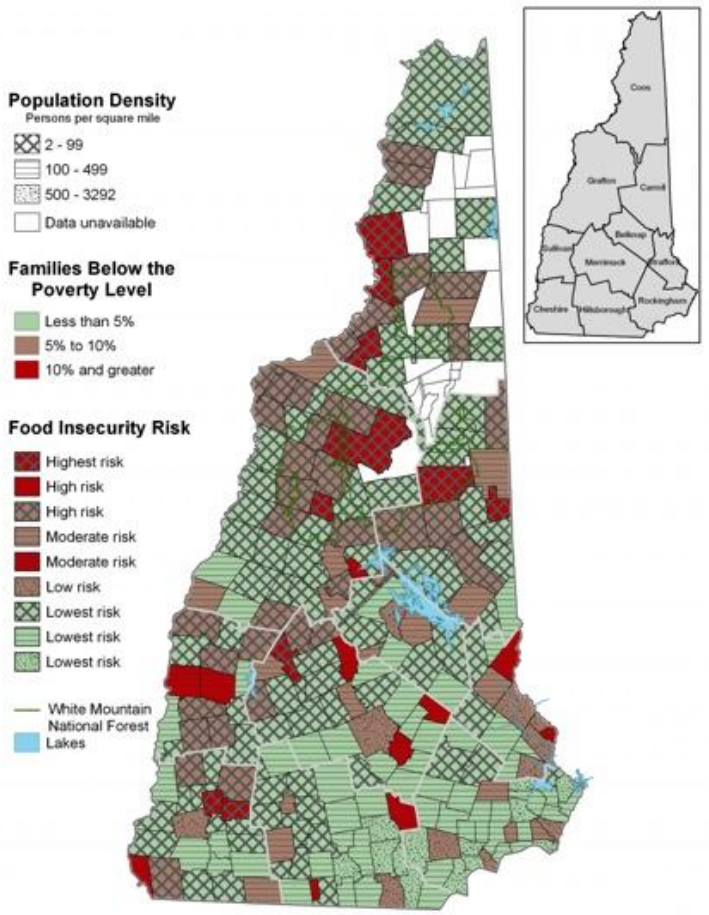

Figure 1. A visual representation of New Hampshire towns and cities categorized by their risk of food insecurity, population density, and percentage of families beow the poverty level

In order to build upon the data regarding population density and percentage of families in poverty, the researchers devised and subsequently plotted a scale on a map in order to visually show the areas at risk for food insecurity. The scale uses two measures taken from already existing data sets: population density and percent of families below the poverty line and labels counties and towns in nine increments ranging from highest risk to lowest risk. Those labeled as highest risk are those with the largest population density and most percentage of people in poverty (relative to the other areas in the state), those labeled high risk were either moderate

population density and a large percent of people in poverty, or moderate percent of people in poverty and smallest population. This ranking system continues down to the lowest risk, with poverty being considered as a stronger risk factor than population density.

The population and poverty data came from the New Hampshire government, meaning that it is highly valid, as the government is a trustworthy source of census data. However, it is not the most reliable source due to censuses only occurring every ten years, so the data moves further from being reliable as time increases. This study occurred in 2012, so the data from the 2010 census was very likely to be representative of the population and economic situation in 2012, however, it does not hold true for subsequent years in the decade, or the current decade and year of 2021.

The researchers not only used population data in order to determine the areas at risk for food insecurity and where researchers are lacking, but they also used data regarding the public food programs available in the state, such as SNAP, as well as food resources, such as convenience or grocery stores. The data for food stores, such as fresh food retail, grocery stores, and convenience stores, were collected from InfoUSA. The data for farm food as well as locations where there were school lunch programs, summer food programs, and other various fresh fruit and vegetable programs, food pantry data, and various programs for women and children were all derived from data from the New Hampshire government, such as the Department of Education and the Department of Health and Human Services. The data regarding which areas of the state offered the Supplemental Nutrition Assistance Program (SNAP) was collected from the U.S.D.A. Food and Nutrition Service. The data regarding food sources were also collected and visually represented on a location map of the state, with different colored dots representing different types of food programs and the dots showing the locations of the

programs. The public food sources in different cities and counties were divided into regions so that it is clearer and easier to determine exactly where resources are needed and the density of food sources (See Figure 2). The same was done for retail food sources.

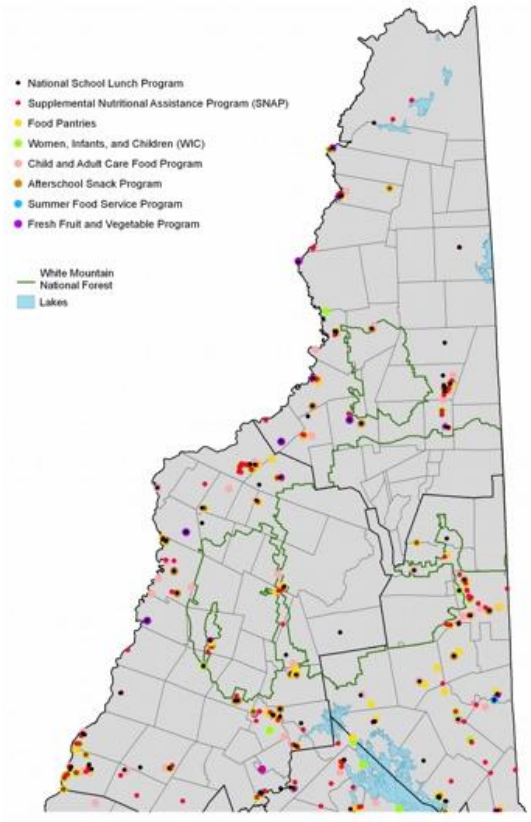

Figure 2. Public food sources in the Northern Region of New Hampshire, 2011

The data displayed on this map is highly valid as well as reliable, as a majority of the data is from the New Hampshire State government and the United States government. The governments of both states and the nation regularly keep track of what kind of food programs are offered. InfoUSA is a reputable source of information, known for providing data to professionals, as well as for its technology and marketing services.

The method of visually representing food insecurity as well as calculating areas at risk for food insecurity is highly important to advancing the understanding of food insecurity. According

to the paper, the information will be presented to stakeholders in New Hampshire policymaking. These policymakers want to see where food insecurity is greatest, where the most need is necessary, and where there are gaps in resources. By overlaying the maps of food insecurity risk areas and food sources, it is easy and clear to see what areas need assistance and lack proper food sources. This method can be used in other states that have high food insecurity, or even states with low average food insecurity but have pockets of inequity, to determine where needs have to be met. If I were to carry out my research proposal, this is the method I would use a preliminary investigation into where there are gaps in resources and areas at high risk for food insecurity in Virginia.

Method Investigation Two

The second methodology that will be discussed in this review comes from a paper done by a team of researchers at Virginia Tech, called *Strategically Siting Urban Agriculture: A socioeconomic analysis of Roanoke, Virginia.* The researchers used Geographic Information Systems (GIS) in order to analyze demographic data as well as geospatial data gathered in two different ways: from public databases and from on-site observations in the city of Roanoke. They used this data to determine which areas of the city could benefit most from an increase in urban agriculture as a fresh food source. In order to determine an area's susceptibility to food insecurity and contributing factors to what areas of the city need the most assistance, the researchers considered the factors of income, educational attainment, the type of household (such as couple or single parents), employment status, and poverty status by household. All of these factors were obtained from the United States Census Bureau's 2013 five-year summary. This data is reliable and valid due to it being drawn from the United States Census Bureau and is more accurate than

the previous article's data due to it being from a more updated census summary, rather than from the every-ten-years census. This data was processed using the spatial unit of analysis of census block groups, which are used worldwide to analyze socioeconomic data and are smaller subdivisions of census tracts. The researchers also subdivided the population by gender, the transportation system that they use to get to work, and the type of household.

In addition, to using socioeconomic factors to determine different areas of the city's need for urban agriculture, the researchers also evaluated "the local access to affordable and nutritious food" in order to confirm that the food desert in the city as identified by a city official was in fact a food desert, before using it as a factor. In order to do this, graduate students used a checklist of food quality and nutritional quality modified from the Nutrition Environment Measures Study in Restaurants and Nutrition Environment Measures Surveys in Stores in order to record data on food and beverages in each location within a half-mile buffer around the geographic center of the census block group area. The students noted nutritional quality and availability in categories such as availability of protein, or percentage of sugar-sweetened beverages (See Figure 3). The graduate students repeated this testing over a 12 month period to ensure averages of data; the validity of the data was also increased because the researchers tested the checklist in other neighborhoods and modified it before conducting the study in Roanoke.

Food group from MyPlate[a]	Specific food or beverage	Food stores offering item (%)	
Grains		Whole-grain breads	35.3
Fruit	To be encouraged	Apples (fresh)	11.8
		Bananas (fresh)	5.9
		Oranges (fresh)	11.8
	To be limited	Fruit canned in sugar syrup	88.2
Vegetables		Leafy greens (fresh)	11.8
		Onions (fresh)	17.6
		Peppers (fresh)	11.8
		Tomatoes (fresh)	17.6
Protein foods		Hot dogs	35.3
		Lowfat hot dogs	11.8
		Turkey dogs	5.9
		Eggs	64.7
		Beans	70.6
		Tuna (canned)	64.7
Milk	To be encouraged	2% or low-fat milk	29.4
	To be limited	Whole milk	88.2
100% fruit juice		Orange juice only	88.2

[a]Based on ChooseMyPlate.gov food categories.

Figure 3. A summary of the food offered in stores in Roanoke, Virginia, as divided into food groups identified by MyPlate

After collecting data, the researchers ranked each block group to identify which ones would gain the most benefit from urban agriculture. For each of the ten parameters, a field was added to the block group's attribute table and a GIS query was used to answer the parameter questions, resulting in yes or no responses for each one. For the first six parameters, as follows, a "Yes" means that the block group is above the national average: 1) student eligibility rate per elementary school for NSLP, 2) poverty rate, 3) unemployment rate, 4) the percentage of population with less than high school diploma, 5) percentage of female-headed households, 6) the percentage of children. For the next three parameters, a "No" meant presence and "Yes" meant needs presence: 7) park, 8) community garden or farm, 9) supermarket or superstore. Finally, the tenth parameter indicates whether the group is in the city-identified food desert. After calculating a number for severity in each block, a map was created and it was determined that the sectors of the city most in need of urban agriculture were those situated just outside of the food desert (See Figure 4).

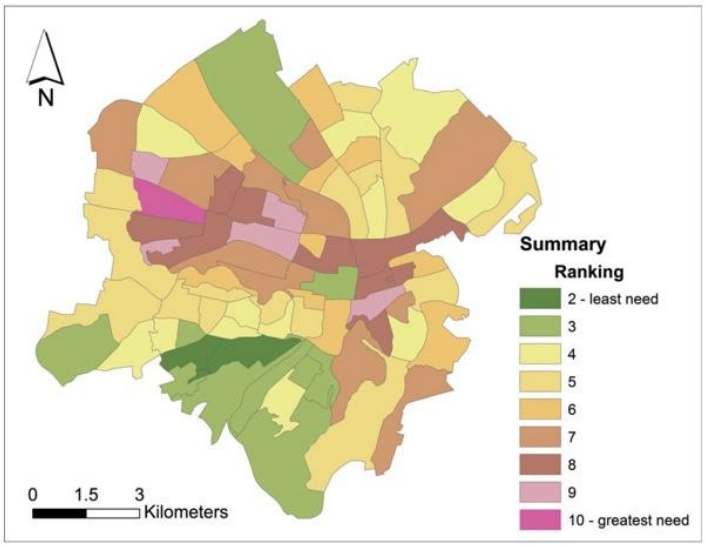

Figure 4. A visual representation of which census block groups in Roanoke, Virginia are most in need of urban agriculture to combat food insecurity

This particular paper that the method was performed in had a goal of discovering areas in the city of Roanoke, Virginia that would most benefit from an increase in urban agriculture as a food source. In other contexts, GIS can be used to understand food security and how many different factors can predict an area's susceptibly to food insecurity. In addition, it can help to identify areas most in need of assistance or resources related to food security.

Comparing Two Methodologies

The two methodologies complement each other; the New Hampshire study's method is a less exact and more geographically applicable method than the Roanoke study's method. One commonality between both methods is their use of food source data in order to categorize food insecurity. One method is not better or more accurate than the other, rather, the second methodology mentioned builds upon the first one in order to categorize food insecurity in a

different way. While the New Hampshire method identifies and categorizes food insecurity by county, the Roanoke methodology uses GIS to look at one specific city and is able to get more detailed information about the food insecurity within different areas of the city. The New Hampshire method is likely to be more effective if one is analyzing food insecurity on a larger scale, and can be used to identify an area to focus on further. Subsequently, the methodology of ranking areas at risk used in the Roanoke study can then be applied to that small area to get more specific data regarding food insecurity in the city, town, or county. In this way, they are complementing each other and can be used in tandem.

The New Hampshire study determined that those most at risk for food insecurity were those in rural and remote areas, where there was limited access to retail food sources as well as public programs, regardless of if food programs were offered in schools. On the contrary, the study done in Roanoke, Virginia, found that high population centers were at risk for food insecurity due to the lack of nutritious food sources and the high abundance of cheap but unhealthy food products found in sources such as convenience stores. These differences provide evidence for the importance of measuring food insecurity in local areas, as trends can differ in different towns, cities, and states. Though poverty is a common factor in predicting food insecurity, the specificities of the food insecurity problems that an individual will face vary based upon their geographic and socioeconomic situation. A commonality between the results of the studies is that a lack of retail food stores and restaurants correlates with poverty and food insecurity and that access, not availability, to proper food sources are the main determinants of food insecurity in both rural and urban communities.

Conclusion

Though there is an abundance of studies regarding the availability of food sources as a measure of food insecurities, there is a lack of studies examining the access to food sources as a measure of food insecurity. According to a study that was a systematic review of over 50 food insecurity studies, there is a need for a better way to measure accessibility using GIS, but also without GIS because data is oftentimes removed from the humanity of situations, such as in identifying what constitutes a neighborhood (Caspi et al., 2010). This can lead to a mismatch between GIS data and evaluative survey data. The gap of studies relating to accessibility can be further narrowed by looking at a gap that the study on New Hampshire communities identified: a lack of data regarding transportation between towns and food sources, which could be a potential problem or solution to rural food insecurity (Wauchope and Ward, 2012). Thus, the gap that would be addressed in further hypothetical research is transportation networks between communities and food sources in the Hampton Roads region of Virginia and how that relates to food insecurity in the region.

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