Examining the relationship between race and food insecurity in Texas, U.S.

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This paper reports an analysis of food insecurity in Texas, USA, and its relationship with race. The analysis was carried out at the level. Data were obtained from the US Census.

Keywords: Food Insecurity, Race, spatial analysis

Contents

Introduction

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Background

Defining Food Insecurity

Food insecurity refers to the lack of reliable access to sufficient, nutritious food which encompasses four dimensions: availability, access, stability and utilization (Uppal, 2023). Insecure household may face difficulties in acquiring food, affording nutritious meals or maintain stable access due to infrastructure or economic

disruption. According to the USDA, food insecurity can range from limited dietary variety and quality to severe disruptions like insufficient food intake (Coleman-Jensen et al., 2019). Beyond nutritional concerns, it is closely linked to a higher likelihood of chronic illnesses, mental health issues, frequent hospital visits and even mortality (Uppal, 2023). In 2018, around 11.1% of households in the United States, over 14 million, struggle with food insecurity, including 4.3% that experienced very low food security (Coleman-Jensen et al., 2019). On a global scale, rates of food insecurity have been increasing, driven by factors of inflation, economic uncertainty, and systemic inequalities. While these national statistics are alarming, Texas often exceeds national averages, particularly in marginalized and rural areas. In 2020-2022, 15.5% of households were food insecure, exceeding the national average of 12.8% (USDA ERS, 2023). Therefore, highlighting its urgency as a case study for deeper spatial and racial food access disparities (Dean & Sharkey, 20100; Janda et al., 2022). The complex and multifaceted nature of food insecurity calls for both large-scale policy reforms and locally tailored, community-driven strategies.

Structural Causes of Food Insecurity

Food insecurity is associated with various structural inequalities, including income disparities, access to capital, and systemic barriers rooted in racism. Several studies revealed that food insecurity is the result of compounding factors that disproportionately affect racialized communities in the United States. In a systematic review of studies on food deserts by Beaulac et al. (2009), they concluded that socioeconomic deprivation at the community level intensifies individual-level disparities in the United States. Their review concluded that low-income neighbourhoods that were predominantly African American continuously had fewer supermarkets while experiencing limited geographic access to affordable, healthy food (Beaulac et al., 2009). This structural disadvantage hinders an entire community's access to nutritious foods, especially in areas dominated by convenience stores that typically offer unhealthy and expensive food items.

Similarly, Myers and Painter (2017) examined the relationship between race/ethnicity, nativity and food insecurity. They found that Black and Latino households in the United States suffer more than twice as much from food insecurity in comparison to white households, even when accounting for socioeconomic status (Myers & Painter, 2017). Given that minority neighbourhoods have fewer quality supermarkets regardless of socioeconomic status, the authors suggest this gap stems from spatial inequalities. These spatial inequalities indicate that race, independent of income, shapes access to nutritious food. Nam et al. (2015) confirm these findings in their analysis of racial disparities in food insufficiency. In their study, the authors found that Black, Hispanic, and American Indian families experience food insecurity at a statistically significantly higher rate than White families (Nam et al., 2015). When the authors conducted a breakdown of contributing factors, they discovered that this disparity among the minority groups was tied mainly to lower home ownership rates, access to credit, and insufficient financial assets (Nam et al., 2015). These economic disparities increase susceptibility during times of financial hardship, restricting minority families' ability to protect themselves from food insecurity. Collectively, the research conducted emphasizes that the intersection of race and socioeconomic class creates compounded disadvantages for families of non-White backgrounds. Furthermore, this suggests that food insecurity in the United States, particularly in Texas, is not solely tied to income but several other systemic barriers that are shaped by racial inequality.

Race, Place, and Access

Texas food insecurity is deeply shaped by spatial and racial inequalities in food access. In rural Central Texas, residents often face limited access to supermarkets and healthy food outlets, typically traveling long distances for groceries and relying on nearby convenience stores with fewer nutritious options. This geographic isolation, coupled with underdeveloped infrastructure and lack of public transportation, contributes to higher food prices and limited dietary quality compared to urban areas (Dean & Sharkey, n.d.; Dean & Sharkey, 2011). Janda et al. (2022) further support these findings, examining food insecurities across different geographic contexts in Travis County. They found that individuals living in rural zip codes were more than twice as likely to experience food insecurities compared to those in urban areas. This remains significant even after controlling for factors like income, educational level, employment status and access to transportation (Janda et al., 2022). Additionally, Janda's 2020 dissertation research documented rural and peri-urban callers to the 2-1-1 helpline in Central Texas. The finding shows that these areas were significantly more likely to seek help with food assistance. This was true for individuals living in zip codes that lacked

supermarkets, emphasizing the role that geographic proximity plays in shaping spatial disparities in food access.

Race and geography shape disparities in food insecurity across Texas. The Supplemental Nutrition Assistance Program (SNAP), formerly known as food stamps, was established to combat food insecurity among low-income populations providing assistance to purchase food.Yet disparities persist even among SNAP-eligible households. Samuel et al. (2023) found that across the United States, SNAP-eligible Black and multiracial households experience higher rates of food insecurities compared to White counterparts. This disparity was especially evident among those who were not enrolled in the program. Among households not participating in SNAP, those that identify entirely Black were 52% more likely to experience food insecurity compared to White households. Similarly, multiracial households faced a 42% higher risk of food insecurity than their White counterparts. Importantly, among households actively participating in SNAP, the racial disparities in food insecurity were no longer observed. This suggests that while food assistance programs can help reduce the effects of structural inequalities, it does not entirely eliminate them (Samuel et al., 2023). In Central Texas, Janda et al. (2022) reported that Hispanic participants had 2.79 times greater odds of being food insecure than participants who were non-Hispanic white. This aligns with the broader finding identifying that race/ethnicity often intersect with income in shaping food insecurity risk (Janda et al., 2022). Janda and others highlight that communities of color are disproportionately affected by systemic barriers such as reduced access to full-service grocery stores and over reliance on small retailers with fewer healthy options (Beaulac et al., 2009; Walker et al., 2010; Janda et al., 2022).

Rural Texans face unique and persistent barriers to food security, often shaped by limited infrastructure, social isolation and inadequate food retail presence. Dean and Sharkey (2011) emphasized that rural areas not only lack supermarkets, but exhibit weaker social networks and less communal support. These factors further undermine resilience against food insecurity. Janda et al. (2022) extends on this understanding by showing that rural residents in Central Texas often live farther from supermarkets, an average of 1.66 miles but closer to convenience stores with an average of 0.67 miles. This proximity gap disproportionately affects low-income and Hispanic households, exacerbating nutritional disparities and increasing vulnerability to food insecurity (Janda et al., 2022).

Moreover, the uneven distribution of food retailers and limited transportation options in rural areas indicate that effective solutions must be customized to local needs and the resident's lived experiences. Janda et al. (2022), emphasize the importance of incorporating factors such as perceived accessibility, community preferences and cultural appropriateness. These factors are often overlooked in conventional approaches to identify food deserts.

Policy Landscape and Limitations

SNAP (formerly known as food stamps) is the largest federal food assistance initiative in the United States. It is designed to alleviate food insecurity by providing financial support for low-income families. While SNAP reduces food insecurity by helping millions of families each year, its effectiveness is still limited by structural and environmental factors. Grummon and Taillie (2018) found that even with SNAP participation, there are still racial disparities in purchasing patterns. Their findings show that Black SNAP participants tended to purchase more processed meats, sweeteners, and low-nutrient foods compared to White participants of the program (Grummon & Taillie, 2018). Notably, these disparities do not appear in non-participating families. This suggests that the SNAP program, although it may aid in access to food, does not enhance diet quality equally among different racial/ethnic groups (Grummon & Taillie, 2018).

Odoms-Young (2018) highlights how these disparities are influenced by structural racism in food systems and public policy. Factors such as housing segregation, financial inequality, and high incarceration rates disproportionately impact communities of colour (Odoms-Young, 2018). These factors create barriers to food assistance and healthy food options. The author also notes that these racial disparities exist even when socioeconomic factors are removed (Odoms-Young, 2018), highlighting once again that race independently impacts access to nutritious foods.

A study of a low-income Latino neighbourhood in Upstate New York by Lopez-Class and Hosler (2010) revealed that most local stores that accepted SNAP still provided limited access to nutritious items and high food prices. For example, only one store in the entire neighbourhood carried high-fiber bread compared to seven in the adjacent non-Latino neighbourhood (Lopez-Class & Hosler, 2010). On top of this, many of the

stores were not disability-accessible and public transport to these locations was insufficient (Lopez-Class & Hosler, 2010). Consequently, residents without cars were often forced to rely on smaller retailers with higher prices and fewer nutritional options, which erodes the intended support of SNAP assistance (Lopez-Class & Hosler, 2010).

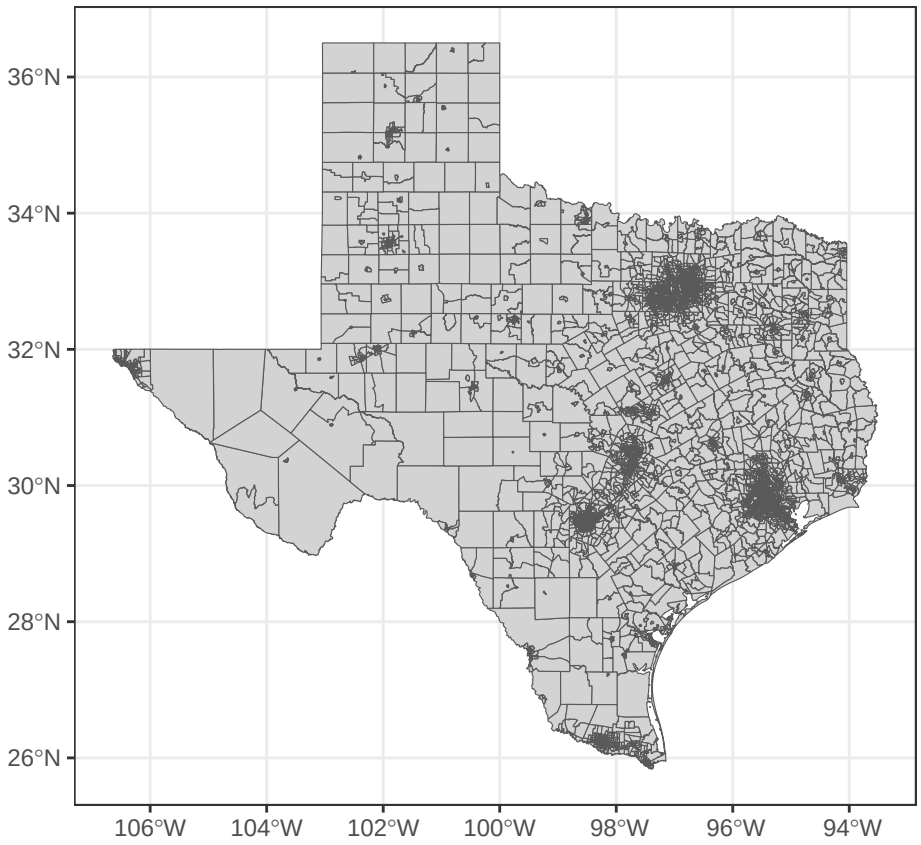
In conclusion, while SNAP has been critical for tackling food insecurity, its current system fails to address the disparities in purchasing patterns of minority groups and the system issues that lead to these racial and geographic disparities. Effective policy reforms are required to consider inequitable food access caused by transportation limitations, and racial and place-based disparities that constrain how SNAP assistance is used.

Gaps in the Literature

Despite substantial research on food insecurity in the United States, particularly in Texas, a significant gap remains. The gaps are seen in studies that integrate both spatial and racial/ethnic dimensions using spatially explicit methods. Most of the existing studies focus on racial disparities (e.g. food insecurity among Black, Latino and immigrant community) or spatial disparities (e.g. rural-urban food deserts) but rarely examine how race, place and poverty interact at a localized scale (Beaulac et al., 2009; Myers & Painter, 2017). Myers and Painter (2017) found persistent food insecurity divide across racial/ethnic and nativity lines, even after controlling for socioeconomic status. On the other hand, spatial studies like Janda et al. (2022) and Lopez-Class & Hosler (2010) underscore geographic barriers like proximity to supermarkets but does not consistently take into account for racialized experiences of those affected. Furthermore, studies examining the impact on SNAP on reducing disparities have primary used cross-sectional or nationwide datasets. This often fails to capture how SNAP participation intersect with race and geographical context at a local level (Grummon & Taillie, 2018). This leaves an analytically blind spot regarding localized, intersectional factors of food insecurity in Texas. This project hopefully contributed to closing this gap by using inferential and spatial statistical methods to examine how race, income, location and SNAP usage interact, offering a greater understanding of food access inequalities in Texas.

Study area

Food insecurity was studied at the tract level in the state of Texas (see Figure 1). There are 6896 tracts in the state, and each of these tracts was used in the analysis. In the U.S., around 11.1% of households experience food insecurity. Texas faces higher rates, with 14% of families identifying as food insecure in 2018 (Coleman-Jensen et al. 2019). The state was selected for this reason, having a higher rate of food insecurity in the country. There are many studies conducted in Texas that detail the relationship between food insecurity and other variables. In a study by Beaulac et al. (2009), it was found that food access in the U.S. is significantly impacted by both income and race. This study was conducted to analyze the spatial patterns between these variables and discuss the potential reasons for them. Tracts were chosen due to their small size, allowing for more effective comparisons between places within the state when compared to counties, which are much larger and do not represent within-state differences in food security and demographics.



Data

The data used for the project primarily comes from the U.S. Census Bureau. This data can easily be imported into R using the "tidycensus" package. Additionally, the "tidyverse" package will be used since it contains key libraries such as "ggplot2" which will allow us to plot the census data for each county within Texas, making any spatial patterns easily identifiable. The full list of packages included within the tidyverse is available on their website. The "sf" package for Simple Features will also be imported to make spatial data easier to create and visualize. Likewise, we will use packages such as "gt" and "kableExtra" to create clean looking tables.

Listed below are the U.S. Census Bureau variables used with their respective R codes (that allow us to import the data directly into R through the tidycensus package). The data used will be from 2023 which is the most recent year in which the data is available in R.

```
data <- data.frame(
  Name = c("Food stamp count", "Total population", "White population", "Black population", "Asian popula
  "R_Code" = c("B22003_002", "B01003_001", "B02001_002", "B02001_003", "B02001_005", "B02001_004", "B02
  "Additional_Notes" = c("
Not converted into per capita, will be done using the population variables.", "", "", "", "", "", "", "
```

The food stamp count is crucial to use to identify food security or insecurity in each county, as that is the most relevant quantitative data relating to food security that we could find. By converting food stamp usage to per capita rates (using the population for each county), the similarities and/or differences in food stamp usage (and consequently, food security/insecurity) can be mapped using ggplot2. This can then be compared to racial demographics (mapped by comparing the white, black, Asian, American Indian and to see if there is a potential correlation between race and food insecurity/food stamp usage.

Methods

Methods for Descriptive & Spatial Statistics

County-level data on food stamp usage and race in Texas were analyzed using the df_race.rds shapefile. This shapefile included variables such as the percentage of residents receiving food stamps and racial composition. It was imported into R and reprojected using st_transform() to EPSG:3857 to ensure accurate distance-based and spatial relationship calculations.

To visualize the geographic distribution of food stamp usage, an initial choropleth map was created using ggplot() and geom_sf(), with the variable food_stamp_p representing the percentage of food stamp recipients in each county. The scale_fill_viridis_c() was used to apply a colour gradient that improves interpretability for viewers by emphasizing variation in values. Prior to analysis, counties with missing values were excluded using filter(!is.na(food_stamp_p)) to prevent skewed results and ensure clean spatial computations.

To analyze local spatial interactions, a neighbourhood structure was established using Queen contiguity through the poly2nb() function, which identifies counties as neighbours if they share a boundary or a corner point. This structure was then transformed into a spatial weights matrix using nb2listw(), allowing the influence of neighbouring counties to be incorporated into subsequent spatial analyses.

Spatial moving averages (SMAs) were computed using lag.listw() for key variables such as food stamp usage (sma_food_stamp_p) and racial proportions (e.g., sma_white_p, sma_black_p, sma_asian_p, sma_american_indian_p, sma_pacific_islander_p, sma_other_p). SMAs provide a smoothed view of regional patterns by averaging the values of surrounding counties instead of the raw data. This approach emphasizes clusters of consistent low or high values, making the broader spatial trend easy to identify.

A null simulation envelope was generated to assess whether observed spatial patterns were stronger than would be expected under random distribution. It involved randomizing the food stamp usage values using a sample (food_stamp_p) and recalculating the SMA of the randomized data. Therefore, it created a baseline scenario representing spatial randomness, allowing for visual and statistical comparison with the actual SMA pattern. The difference between the observed and randomized results offers insight into the presence and strength of spatial autocorrelation within the data.

The local Gi* statistic (Local G) was computed using localG() from the spdep package to identify areas of statistically significant clustering. This technique evaluates each county's value relative to the average of its neighbouring counties and generates a Z-score. This Z-score determines whether it belongs to a statistically significant high-value cluster (hotspot) or a low-value cluster (coldspot). The analysis was applied to food stamp usage and racial proportion to explore the spatial overlap between race and food insecurity. The resulting Gi* values were incorporated using mutate() and converted to numeric format using as.numeric() to enable plotting. Since localG() outputs a specialized object class, converting the results to numeric format was required to ensure compatibility with ggplot() for mapping and visualization.

Lastly, maps were generated to visualize the Gi* Z-scores using ggplot() and scale_fill_gradient2(), with a midpoint of zero. Red tones indicated statistically significant hotspots (high-value clusters), blue/green tones indicated coldspots (low-value clusters), and yellow areas represented neutral or non-significant regions. This mapping approach successfully highlighted clusters of food insecurity and racial distribution, offering a spatial perspective for understanding systemic disparities among the counties in Texas.

Methods for Regression

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Additional Methods

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Analysis

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Conclusions and Recommendations

Throughout the use of different inferential and spatial statistical methods, patterns of food access inequalities within counties of Texas were revealed which brings a closer look to the relationships between race, income, location, and SNAP usage. It is evident that there are clear patterns of spatial autocorrelation which suggest that high food stamp usage is prevalent in the southern areas of Texas. This is shown by the strong clustering pattern portrayed in the map for spatial moving average, thus, supporting the conclusion that the use of food stamps in counties of Texas are not by random. Moreover, various racial groups such as the Black population portray a strong pattern of clustering while others seem to be more dispersed with minimal clusters shown just like the White population. The clustering patterns may suggest that regions with high food stamp usages also have high concentrations of specific racial groups which can lead to structural and system inequalities within the community. It is recommended that additional research is completed to verify the trends and patterns of this study with higher accuracy and precision. Further exploring the relationship between racial groups, SNAP usage, income, and location will help better understand the importance of each variable. Moreover, implementing stronger statistical and analytical methods that are rigorous in value can further support the concluding results.

References

Beaulac, J., Kristjansson, E., & Cummins, S. (2009). A systematic review of food deserts, 1966–2007. *Prevention of Chronic Disease, 6*, A105. https://resolver-scholarsportal-info.libaccess.lib.mcmaster.ca/resolve/15451151/v06i0003/nfp_asrofd1.xml

Coleman-Jensen, A., Rabbitt, M. P., Gregory, C. A., & Singh, A. (2019). *Household Food Security in the United States in 2018 (Economic Research Report Number 270).* https://doi.org/10.22004/ag.econ.301167

Dean, W. R., & Sharkey, J. R. (2011a). Food insecurity, social capital and perceived personal disparity in a predominantly rural region of Texas: An individual-level analysis. *Social Science & Medicine, 72(9)*, 1454–1462. https://doi.org/10.1016/j.socscimed.2011.03.015

Dean, W. R., & Sharkey, J. R. (2011b). Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. *Journal of Nutrition Education and Behavior, 43(6)*, 426–433. https://doi.org/10.1016/j.jneb.2010.07.001

Government of Canada, S. C. (2023, November 14). *Food insecurity among Canadian families.* https://www150.statcan.gc.ca/n1/pub/75-006-x/2023001/article/00013-eng.htm

Grummon, A. H., & Taillie, L. S. (2018). Supplemental Nutrition Assistance Program participation and racial/ethnic disparities in food and beverage purchases. *Public Health Nutrition, 21(18)*, 3377–3385. https://doi.org/10.1017/S1368980018002598

Hernandez, D. C., Reesor, L. M., & Murillo, R. (2017). Food insecurity and adult overweight/obesity: Gender and race/ethnic disparities. *Appetite, 117*, 373–378. https://doi.org/10.1016/j.appet.2017.07.010

Janda, K. (2020). *A Geospatial Examination Of The Association Between Geographic Food Access And Food Insecurity In Central Texas: The Role Of Race/Ethnicity And Urbanicity* [Master's thesis, UTHealth School of Public Health]. Dissertations & Theses (Open Access). https://digitalcommons.library.tmc.edu/uthsph_dissertsopen/134

Janda, K. M., Ranjit, N., Salvo, D., Hoelscher, D. M., Nielsen, A., Casnovsky, J., & van den Berg, A. (2022). Examining geographic food access, food insecurity, and urbanicity among diverse, low-income participants in Austin, Texas. *International Journal of Environmental Research and Public Health, 19(9).* https://doi.org/10.3390/ijerph19095108

Lopez-Class, M., & Hosler, A. S. (2010). Assessment of community food resources: A Latino neighborhood study in upstate New York. *Journal of Poverty, 14(4)*, 369–381. https://doi.org/10.1080/10875549.2010.517070

Myers, A. M., & Painter, M. A. (2017). Food insecurity in the United States of America: An examination of race/ethnicity and nativity. *Food Security, 9(6)*, 1419–1432. https://doi.org/10.1007/s12571-017-0733-8

Nam, Y., Huang, J., Heflin, C., & Sherraden, M. (2015). Racial and ethnic disparities in food insufficiency: Evidence from a statewide probability sample. *Journal of the Society for Social Work and Research, 6(2)*, 201–228. https://www.journals.uchicago.edu/doi/10.1086/681574

Odoms-Young, A. M. (2018). Examining the impact of structural racism on food insecurity: Implications for

addressing racial/ethnic disparities. *Family & Community Health, 41*(Suppl 2 FOOD INSECURITY AND OBESITY), S3–S6. https://doi.org/10.1097/FCH.0000000000000183
Ramphul, R. (2020). *Using Spatial Methods To Better Understand Food Insecurity And Snap Under-Participation In Texas* [Master's thesis, UTHealth School of Public Health]. Dissertations & Theses (Open Access). https://digitalcommons.library.tmc.edu/uthsph_dissertsopen/227
Samuel, L. J., Crews, D. C., Swenor, B. K., et al. (2023). Supplemental Nutrition Assistance Program access and racial disparities in food insecurity. *JAMA Network Open, 6(6)*, e2320196. https://doi.org/10.1001/jamanetworkopen.2023.20196
USDA (2025). Food Security in the U.S. - Key Statistics & Graphics. Available at: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics#:~:text=13.5%20percent%20(18.0%20n
Walker, R. E., Keane, C. R., & Burke, J. G. (2010). Disparities and access to healthy food in the United States: A review of food deserts literature. *Health & Place, 16(5)*, 876–884. https://doi.org/10.1016/j.healthplace.2010.04.013