An Exploratory Framework to Interpret County-Level Indicators of Food Insecurity

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ABSTRACT

In 2017, 12.5% of the population was estimated to be food insecure (FI) with wide regional variation. County-level FI is closely associated with, but likely more complex, than the county-level poverty rates. Therefore, we sought to identify a more nuanced framework for understanding factors contributing to FI. In an exploratory design, we studied 32 counties stratified by high and low FI and poverty, which were defined in terms of the national averages. Once stratified, counties were analyzed across 14 metrics within four summary domains: food access, food affordability, overall health environment, and county innovation. Having a stronger health environment was correlated with lower FI; correlations between the remaining three summary domains and FI were not significant. This was an initial effort to conceptualize potential markers of FI into a coherent framework using publicly available population-level health metrics. Future research could expand the sample and add additional metrics.

KEYWORDS: food insecurity, framework, social determinants of health

INTRODUCTION

In 2017, an estimated 12.5% of United States households were food insecure.[1] Food insecurity (FI) is defined as a "lack of consistent access to enough food for an active, healthy life."[2] FI contributes to the selection of poorer quality foods, delaying necessary medical care and medications, increased emergency department use, and increased hospitalizations.[3,4] In the US, there are wide county-level variations in FI, ranging from a high of 36% in Jefferson County, MS, to only 2.9% in Steele County, ND.[5] FI disproportionately impacts specific areas of the country including the South, rural areas, and low-income areas.[5]

The Supplemental Nutrition Assistance Program (SNAP) is the nation's largest federal food assistance program.[6] However, while SNAP has been shown to significantly reduce FI, beneficiaries can remain food insecure even while enrolled in SNAP.[6] Beyond federal food assistance programs like SNAP, WIC, funding through the Older Americans Act, and the School Meal Program, there are many local, regional, state, and national organizations working to combat FI. This ranges from national anti-hunger organizations such as Feeding America,[5] to local food pantries and soup kitchens, to innovative non-profits like Health Leads which works with health systems to connect at-risk patients to social services including food,[7] to progressive health systems such as Cincinnati Children's[8] and Boston Medical Center that have developed in-hospital food pantries and food prescription programs.[9] There are also a number of novel insurer-non-profit initiatives.[10,11]

While there are many innovative efforts across the country aiming to reduce FI, the scope, degree, and reach of these programs varies widely. Given the complex nature of FI and the variation in the availability of resources, health systems, policy makers, non-profits, and other entities need to understand qualities contributing to a county's ability to address FI in order to prioritize the development and piloting of interventions and community partnerships for at-risk populations. To better understand the characteristics that may contribute to counties' ability to address FI, we first examined the correlation between county FI rates and county poverty rates. Recognizing that there are many other factors also impacting food availability and access, we developed a set of 14 metrics across four domains we hypothesized would be associated with FI rates. We then examined how these characteristics varied across 32 counties within the four summary domains: counties with low FI rates and low poverty rates, low FI and high poverty, high FI and low poverty, and high FI and high poverty.

METHODS

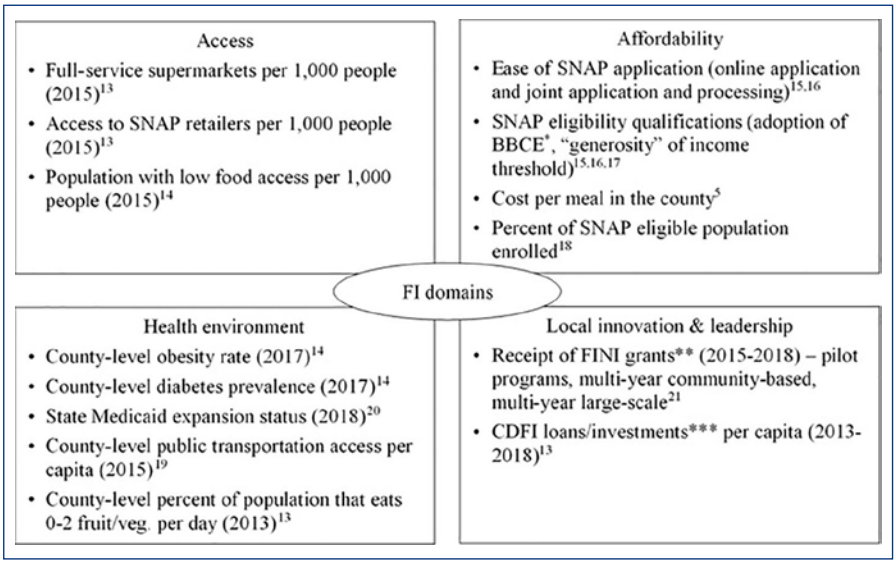
Food Insecurity Framework

Counties with low FI were defined as those with FI rates below the 2017 national average of 12.5%;[5] high FI was defined as being above the national average. Low poverty counties were defined as those with poverty rates below the national average of 12.3%; high poverty counties were above the national average.[12] County-level food insecurity data were obtained from Feeding America's Map the Meal Gap,[5] and county-level poverty data were obtained from the U.S. Census Bureau's Small Area Income and Poverty Estimates.[12] We then sampled 32 counties nationally from urban and rural geographies stratified across four summary

domains: counties with low FI rates and low poverty rates, counties with low FI and high poverty, counties with high rates of FI and low poverty, and counties with high FI and high poverty.

A member of the research team (ET) conducted exploratory key informant interviews with a resource coordinator from a large food bank, peer navigators from a community non-profit that helps connect food insecure individuals with local resources, and a physician at a major academic medical center that has led several initiatives to address patient food insecurity. Informed by relevant literature and findings from these exploratory interviews, we then developed a framework to further contextualize county-level indicators of FI using 14 metrics across four domains: access to food, affordability of food, overall health environment, and local innovation/leadership (**Figure 1**).

Figure 1. Food Insecurity (FI) Framework



Notes:

* Broad-based Categorical Eligibility (BBCE) is defined as when states opt to enable individuals and households to become categorically eligible for SNAP if they qualify for other non-cash Temporary Assistance for Needy Families or state Maintenance-of-Effort programs (e.g., earned income tax credits, subsidized employment, Head Start, etc.).[17] Counties received 1 point if they are within a state that has adopted any form of BBCE and 0 if they adopted none.

** Receipt of FINI grants (2015-2018): established in the 2014 Farm Bill and administered by the USDA's Food and Nutrition Service and National Institute of Food and Agriculture; it is designed to incentivize the purchase of fruits and vegetables by SNAP clients; awards are given to farmers markets, supermarkets, convenience stores, and retail food stores; awards are either pilot programs (1 year, up to $100,000), multi-year community-based projects (up to $500,000), and multi-year large-scale projects ($500,000 or greater)[21]

*** CDFI loans and investment per capita (2013-2016): Investments to programs that is designed to finance food retailers that opt to locate in an area that otherwise lacks healthy food access[13]

Measures and Data Sources

Access Domain

The access domain was comprised of the following county-level measures:

- Number of full-service supermarkets
- Number of SNAP retailers
- Number of residents with "low food access," defined as the prevalence of limited supermarket access per 1,000 residents in a county

Data for these measures were obtained from the Robert Wood Johnson Foundation's (RWJF's) Healthy Food Access Portal.[13,14] Raw county-level numbers for each measure were divided by county population to create a rate per 1,000 inhabitants to facilitate comparison across counties. Measures were binary, with values above the county mean for each measure coded as "1" and values below the mean coded as "0." Scoring for these and all subsequent measures are detailed in **Appendix Table 1**.

Affordability Domain

The affordability domain was comprised of the following measures:

- Ease of applying for SNAP
- SNAP eligibility qualifications
- Percent of SNAP eligible population enrolled
- Average cost per meal

Each of these measures was assessed at the state-level with the exception of average cost per meal, which was available at the county-level.

Ease of applying for SNAP was a composite variable defined by whether a state 1) allowed online applications and 2) allowed joint application and processing of Medicaid and SNAP applications. Data were sourced from the USDA's Food and Nutrition Service 2017 SNAP State Options report.[15]

A state's SNAP eligibility qualifications was a composite measure defined as 1) whether a state had adopted some form of Broad-Based Categorical Eligibility (BBCE) and 2) the SNAP eligibility threshold for gross income as a percent of the federal poverty level (FPL, baseline federal criteria is gross income <130% of the FPL).[5] Data were obtained from the USDA State Options Report and the Economic Research Service's SNAP policy database.[15,16] BBCE

enables individuals and households to become categorically eligible for SNAP if they qualify for other cash assistance programs such as Temporary Assistance for Needy Families (TANF) or state Maintenance-of-Effort programs (e.g., earned income tax credits, subsidized employment, Head Start, etc.).[17] 84% percent of the counties were in states that had adopted some form of BBCE.[17] Increases of the gross income limit for SNAP eligibility beyond 130% of the FPL reflect the additional leniency adopted by states enabled by BBCE.[17]

The percent of a states' eligible beneficiaries enrolled in SNAP was determined using a Mathematica report on enrollment trends among eligible beneficiaries in 2015.[18] We focused on SNAP rather than other federal food assistance programs that target FI (i.e., The Special Supplemental Nutrition Program for Women, Infants, and Children [WIC], school-sponsored lunch programs, etc.) as SNAP has been shown to substantially reduce FI and provides a metric for all US households rather than only households with children.[6]

County-level cost per meal was determined using data from Feeding America's Map the Meal Gap, which is calculated using the average dollar amount spent on food per week by food-secure individuals divided by 21 meals and weighted for the national average cost per meal and local cost-of-food indices.[5]

Health Environment Domain

The health environment domain included the following measures:

- County-level obesity rate (2017)
- County-level diabetes prevalence (2017)
- State Medicaid expansion status (2018)
- County-level public transportation access per capita (2015)
- County-level percent of population that eats 0-2 fruit/veg. per day (2013)

Each of the variables was assessed at the county-level except for Medicaid expansion status as of 2018, which was assessed at the state level. We reviewed RWJF's Healthy Food Access portal reports contain data on fruit/vegetables consumption as well as their 2017 "County Health Rankings" detailing the county-level diabetes and adult obesity prevalence.[13,14] To classify the access to public transportation, we reviewed the 2015 Unlinked Passenger Trips Per Capita data published by the American Public Transportation Association to assess the number of unlinked passenger trips, which we then divided by the total population.[19]

The Kaiser Family Foundation provides data on the Medicaid expansion status as of 2018.[20]

Local Innovation and Leadership Domain

The local innovation and leadership domain was comprised of the following measures:

- Receipt of FINI grants (2015–2018) – pilot programs, multi-year community-based, multi-year large-scale
- CDFI loans/investments per capita (2013–2018)

Receipt of USDA Food Insecurity Nutrition Incentive (FINI) grants between 2015-2018 was assessed at the state level while Community Development Finance Institution (CDFI) loans/investments per capita between 2013 and 2018 were assessed at the county level. FINI grants were chosen as an indicator of the presence of SNAP incentive programs as they are awarded for projects aimed at increasing and incentivizing the purchase of fruits and vegetables by SNAP beneficiaries.[21] CDFI loans and investment per capita (2013-2016) were selected as they were viewed as investments designed to finance food retailers that opt to locate in an area that otherwise lacks healthy food access.[13] They were detailed in the RWJF Healthy Food Access portal reports.[13]

Statistical Analyses

Descriptive data for each of the 32 counties in the framework were compiled for each of the 14 metrics. Counties were then given a summary score across each of the four domains, which are summarized in **Table 1**. The summary score indicates the county's performance within the four domains. Scoring criteria are detailed in **Appendix Table 1**. County-level outcomes for each of the 14 metrics are available in **Appendix Table 2**.

To assess the relationship between each category and the county-level food insecurity rates, we analyzed the correlation coefficients with a threshold for statistical significance defined as $p<0.05$. Analyses were conducted using R version 4.0. This project used publicly available county data and met criteria for research exemption 4 under the Revised Common Rule of 2018.

RESULTS

Sample Characteristics

Among the 32 counties studied, rates of food insecurity ranged from a low of 5.4% to a high of 36.3% (mean 14.4%). Poverty rates ranged from 5.0% to 39.9% (mean 16.0%). Counties represented 26 states from throughout the country with less representation (2/32) from the East Coast. Full sample characteristics are listed in **Appendix Table 2**.

Relationship between FI and the 4 Domains of Food Access, Food Affordability, Health Environment, and Local Innovation

We found a statistically significant, positive correlation between FI rates and poverty rates across the 32 counties ($r=0.78$, $p<.001$) (**Appendix Figure 1**). We scored each county, and determined there was no single criteria sufficient (in isolation) to conclude whether a county had a high or low FI rate (**Table 2**). Figure 2 highlights the association between the four summary domains for FI and the county-level FI rates. Overall, **Figure 2** supports the conclusions from **Table 2** that there is no sufficient indicator to explain the variation in FI rates across poverty categories. However, we see that

Table 1. Summary of County-Level Food Insecurity across Four Domains

		Food insecurity summary domains			
		Access	Affordability	Health Environment	Local Innovation & Leadership
		max score 3	max score 6	max score 5	max score 2
High resources and low food insecurity	Adams, CO	1	2	5	2
	Carlton, MN	2	5	4	2
	Carroll, MD	1	6	4	2
	Monmouth, NJ	1	5	5	1
	Rio Blanco, CO	3	3	5	2
	Aurora, SD	2	1	4	2
	Eureka, NV	0	4	4	0
	San Diego, CA	1	5	5	2
High resources and high food insecurity	Washington, UT	0	3	5	2
	Ray, MO	1	3	3	0
	Okaloosa, FL	0	6	2	2
	Brazoria, TX	1	4	1	2
	Camas, ID	0	3	4	1
	Dewey, OK	2	4	1	1
	Keweenaw, MI	1	6	2	2
	Tuolumne, CA	1	5	3	2
Low resources and low food insecurity	Northumberland, VA	3	3	4	2
	Adams, WI	0	5	1	1
	Blackford, IN	3	4	3	0
	Rabun, GA	3	3	1	2
	Liberty, MT	1	4	5	1
	Caledonia, VT	3	5	5	2
	Traverse, MN	2	4	3	2
	Polk, OR	0	5	2	2
Low resources and high food insecurity	Jefferson, MS	3	3	0	1
	Greene, AL	2	4	1	1
	Edgecombe, NC	2	5	1	2
	Lake, TN	2	2	1	0
	Houston, TX	2	4	2	1
	Vanderburgh, IN	2	4	2	1
	Somerset, MD	0	5	1	2
	Apache, AZ	0	4	2	2

the health environment was negatively associated with food insecurity.

Access: For access, there was a non-significant, slightly positive association between higher Food Access scores (i.e. better access to full-service super markets and SNAP retailers, and a lower population with low food access) and higher FI rates ($r = 0.16$, $p = 0.37$) (**Figure 2, panel A).**

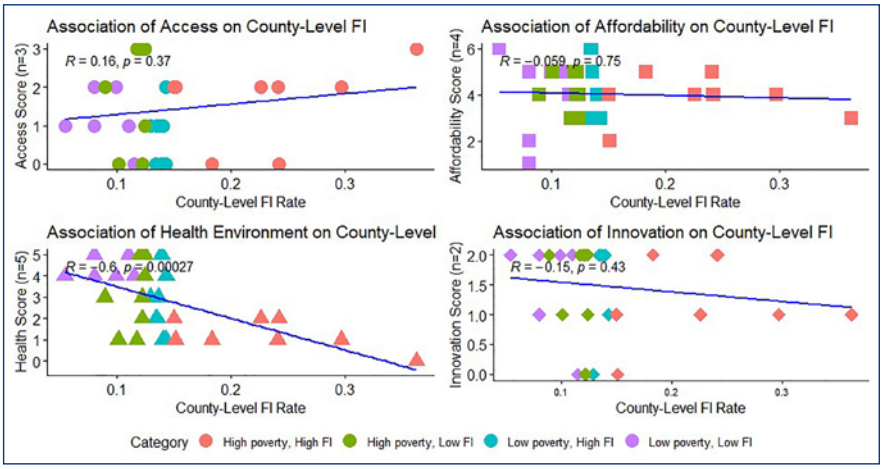
Affordability: We did not find a significant relationship between our summary affordability domain (defined by SNAP eligibility, application qualifications, and enrollment rates and the cost per meal in the county) and FI rates ($r = -0.07$, $p = 0.72$) (**Figure 2, panel B**). While counties with low FI rates and low poverty tended to have the highest affordability scores, there were counties with low poverty and high FI rates and high poverty and low FI rates that also scored highly in the affordability domain.

Health: There was a statistically significant negative correlation between a higher Health Environment score and a higher FI rate ($r= -0.6$, $p<.001$; **Figure 2, panel C**). Counties that scored higher in the Health Environment criteria (i.e., had a lower prevalence of adult obesity and diabetes, a lower percentage of the population eating only 0–2 servings of fruits and vegetables per day, more use of public transportation (which we viewed as a proxy of better access), and were in Medicaid Expansion states had lower FI rates. This inverse relationship is exemplified by Jefferson County, MS, which had a FI rate of 36% and a corresponding 0 points in the Health Environment category.

Innovation: There was a non-significant negative correlation between our summary Local Innovation and Leadership domain and FI rates ($r = -0.15$, $p = 0.43$). Counties with low FI and low poverty were highly prevalent among those with the highest Innovation scores. (**Figure 2, panel D**). Whereas counties high FI and high poverty rates were less likely to have received FINI or CDFI grant funding, which could spur innovative interventions to reduce FI.

Figure 2. Outcome of County-Level Food Insecurity Analyses across 32 Counties, Four Domains, and 14 Metrics

Source: County-level FI rate analyzed from Feeding America's 2017 Map the Meal Gap data[5]



DISCUSSION

In this work we used publicly available data to characterize local FI. Specifically, we combined county- and state-level measures of the food environment, health environment, state-level policies, and local leadership into a coherent framework. We found that while poverty rates are highly correlated with FI rates, of the other domains we had hypothesized would be correlated with FI, only the health environment had a statistically significant relationship with FI. This underscores the complex nature of food insecurity, and the difficulty of distilling non-financial aspects of food insecurity such as limited access to foods or local leadership into composite scores or metrics. While many of the metrics used were not independently associated with FI, a more nuanced scoring system and/or modelling to adjust for multiple covariates may have allowed for a better understanding of these relationships. Analysis of our framework highlights that across metrics, counties with low FI did not have universally high scores whereas counties with high FI did not have universally low scores across summary domains. This heterogeneity across metrics accentuates both the complexity of FI and also that a well-coordinated response requires a network of state policy makers, initiatives, and investments.

There were several limitations to this research. First, counties were selected based on poverty and FI rates, and therefore they often represented regions that were more extreme. This selection criteria also likely influences the relationship between the summary domains and county-level FI. Second, some of the metrics may be collinear and we did not standardize scoring across metrics, which collectively might either over-weight or under-weight the influence of certain concepts in our scorings. Third, in many instances we dichotomized continuous measures, which may have masked variability in those measures across the 32 counties. Fourth, the findings are based on 32 counties out of 3,141 counties nationally, which may limit the external validity.[22] Although in this exploratory study several of our summary domains were not significantly associated with FI, it is possible results would vary with a larger national sample. Fifth, our findings are observational and reflect associations, not causation. Finally, none of the criteria directly measure the degree or number of agencies seeking to address FI in each county. Future research could build on these findings to further understand the key determinants of county-level FI to help address the wide disparities we see in FI rates across the country.[5]

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