

County-level Food Insecurity and COVID-19 Mortality in the United States: A Spatial Analysis with R-INLA

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Defining Food Insecurity

According to the United States Dept. of Agriculture (USDA) **food insecurity** (FI) is defined as: *a lack of consistent access to enough food for every person in a household to live an active, healthy life.*

FI in the United States

- 13.8 million FI households across the U.S. (10.5%) in 2020¹
 - ▶ Low-income² households: 31.2% prevalence in 2021³
- Racism and housing inequality
 - ▶ Housing/redlining and supermarket redlining⁴
- Government welfare programs mitigate FI⁵
 - ▶ The Supplemental Nutrition Assistance Program (SNAP)
 - ▶ Women, Infants, and Children (WIC)
 - ▶ The National School Lunch Program

¹A. Coleman-Jensen. *U.S. Department of Agriculture, Economic Research Service* (2020).

²Household income below 130% of the poverty line

³A. Coleman-Jensen et al., eds. AP-105. 2022. DOI: 10.22004/ag.econ.329071.

⁴Y. Shaker et al. *Agriculture and Human Values* (2022). DOI: 10.1007/s10460-022-10340-3.

⁵C. A. Swann. *Food Policy* (2017). DOI: 10.1016/j.foodpol.2017.08.006.

FI and Health Outcomes

- FI is associated with deleterious health outcomes^{6,7}
 - ▶ Hypertension
 - ▶ Hyperlipidemia
 - ▶ Depression and suicidal ideation
 - ▶ Diabetes mellitus
 - ▶ Iron deficiency anemia
- Posited mechanisms
 - ▶ Cortisol
 - ▶ Diet quality, inflammation
 - ▶ Competing demands and trade-offs

⁶C. Gundersen and J. P. Ziliak. *Health Affairs* (2015). DOI: 10.1377/hlthaff.2015.0645.

⁷H. K. Seligman and D. Schillinger. *New England Journal of Medicine* (2010). DOI:10.1056/NEJMp1000072. ▶

Research Question: *Is county-level food insecurity associated with COVID-19 mortality during the first 1.5 years of the COVID-19 pandemic?*

Hypothesis: We hypothesize that county-level food insecurity, given its association with other health outcomes, will adversely predict county-level COVID-19 deaths.

Analysis Plan

■ Variables

- ▶ *Dependent variable:* **County-level COVID-19 count**
 - ▶ *Source #1:* John Hopkins University Coronavirus Resource Center (age-standardized via *indirect standardization*)
 - ▶ *Source #2:* Provisional CDC restricted access individual-level data (age-standardized via *direct standardization*)
 - ▶ *Time window:* 03/25/2020-12/25/2021
- ▶ *Independent variable:* **County-level food insecurity prevalence (2020)** (*source:* Feeding America's Map the Meal Gap)

Covariates

Table 1. Covariates and their data sources.

Covariate ^a	Source
<ul style="list-style-type: none"> Population Density Females (%) Black (%) Native-American (%) Hispanic (%) Asian-American (%) Non-Hispanic white (%) Unemployment Rate (%) Poverty Rate (%) No Access to Vehicle (%) Disability (%) No Health Insurance (%) Gini Index Median Age 	<i>American Community Survey, United States Census Bureau, 2020 (10,11)</i>
<ul style="list-style-type: none"> Average Household Size, 2015-2019 (Persons) Persons with a 4-year college degree or more, adults 25 and over, 2015-2019 (%) Persons with no high school diploma or GED, adults 25 and over, 2015-2019 (%) Civilian labor force 16 and over employed in wholesale and retail trade, 2015-19 (%) Civilian labor force 16 and over employed in transportation, warehousing and utilities, 2015-2019 (%) 	<i>Atlas of Rural and Small Town America, Economic Resource Service, United States Department of Agriculture (USDA) (12)</i>
<ul style="list-style-type: none"> Obesity Prevalence^b, 2017 (%) Diabetes Prevalence^b, 2013 (%) 	<i>USDA Food Environment Atlas (13)</i>
<ul style="list-style-type: none"> Ratio of Total County Non-Federal Emergency Physicians (MD & DO) to County Population, 2019 	<i>American Medical Association Physician Masterfile (14)</i>
<ul style="list-style-type: none"> Cardiovascular Disease Mortality Rate^b, 2014 Cancer Mortality Rate^b, 2014 Respiratory Disease Mortality Rate^b, 2014 Smoking Prevalence^b, 2019 (%) 	<i>The University of Washington Institute for Health Metrics and Evaluation (15)</i>
<ul style="list-style-type: none"> COVID-19 Case Incidence Count, March 17, 2020-December 17, 2021 (Expressed as a standardized incidence ratio (SIR) using the national or region-specific mean incidence rate to compute the expected case count)^c 	<i>The Johns Hopkins Centers for Civic Impact for the Coronavirus Resource Center (3-5,17), Centers for Disease Control and Prevention (CDC)</i>
<ul style="list-style-type: none"> COVID-19 Vaccination Percentage, as of December 25, 2021^d (%) 	<i>CDC^e (18)</i>
<ul style="list-style-type: none"> 2020 General Election Vote Differential^d (%) 	<i>The Guardian, townhall.com, Fox News, Politico, and the New York Times (19)</i>
<ul style="list-style-type: none"> Urban-Rural Classification Scheme, 2013 (Metropolitan—large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan—and Non-Metropolitan—micropolitan and noncore) 	<i>The National Center for Health Statistics (20)</i>

^a All variables were measured at the county level unless otherwise noted (see footnote below).

^b A state-level aggregated version of this variable was also computed and included in the analysis.

^c Variable used in a principal components analysis to generate a health index risk score (see the footnotes in Table 2 for further details) (8).

^d Vaccination data from the state of Hawaii were not available, resulting in omission of its counties from the analysis.

^e Included as a surrogate measure of county-level social-distancing policies and vaccine hesitancy, which were demonstrably correlated with party affiliation across political jurisdictions (21-23).