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** is defined as: *a lack of consistent access to enough food for every person in a household to live an active, healthy life.*

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FI in the United States

- 13.8 million FI households across the U.S. (10.5%) in 2020[1]
  - Low-income[2] households: 31.2% prevalence in 2021[3]
- Racism and housing inequality
  - Housing/redlining and supermarket redlining[4]
- Government welfare programs mitigate FI[5]
  - The Supplemental Nutrition Assistance Program (SNAP)
  - Women, Infants, and Children (WIC)
  - The National School Lunch Program

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

[2] Household income below 130% of the poverty line

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

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

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

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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

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

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

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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.

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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)

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Covariates

Table 1. Covariates and their data sources.

Covariate[a]	Source
▪ 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	*American Community Survey, United States Census Bureau, 2020* (10,11)
▪ 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 (%)	*Atlas of Rural and Small Town America, Economic Resource Service, United States Department of Agriculture (USDA)* (12)
▪ Obesity Prevalence[b], 2017 (%) ▪ Diabetes Prevalence[b], 2013 (%)	*USDA Food Environment Atlas* (13)
▪ Ratio of Total County Non-Federal Emergency Physicians (MD & DO) to County Population, 2019	*American Medical Association Physician Masterfile* (14)
▪ Cardiovascular Disease Mortality Rate[b], 2014 ▪ Cancer Mortality Rate[b], 2014 ▪ Respiratory Disease Mortality Rate[b], 2014	*The University of Washington Institute for Health Metrics and Evaluation* (15)
▪ Smoking Prevalence[b], 2019 (%)	*Behavioral Risk Factor Surveillance System* (16)
▪ 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) [†]	*The Johns Hopkins Centers for Civic Impact for the Coronavirus Resource Center* (3–5,17), *Centers for Disease Control and Prevention (CDC)*
▪ COVID-19 Vaccination Percentage, as of December 25, 2021 [†] (%)	*CDC* [c] (18)
▪ 2020 General Election Vote Differential[d] [†] (%)	*The Guardian, townhall.com, Fox News, Politico, and the New York Times (19)*
▪ Urban-Rural Classification Scheme, 2013 (Metropolitan—*large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan*— and Non-Metropolitan—*micropolitan and noncore*)	*The National Center for Health Statistics* (20)

[a] All variables were measured at the county level unless otherwise noted (see footnote below).
[†] A state-level aggregated version of this variable was also computed and included in the analysis.
[b] Variable used in a principal components analysis to generate a health index risk score (see the footnotes in Table 2 for further details) (8).
[c] Vaccination data from the state of Hawaii were not available, resulting in omission of its counties from the analysis.
[d] 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).

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