Identifying Geographic Disparities in Suicide Determinants Across United States Counties with Spatial Modeling

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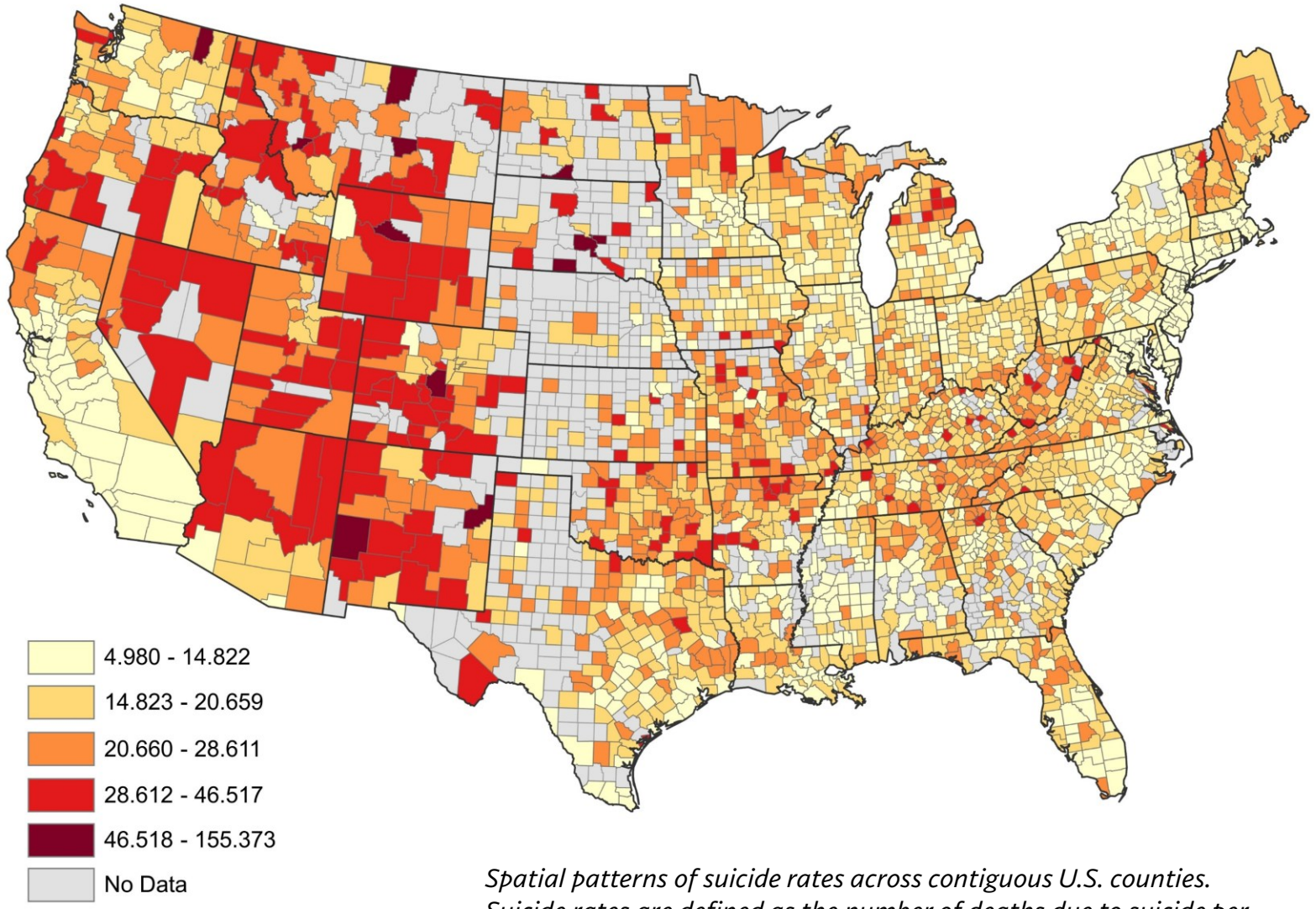
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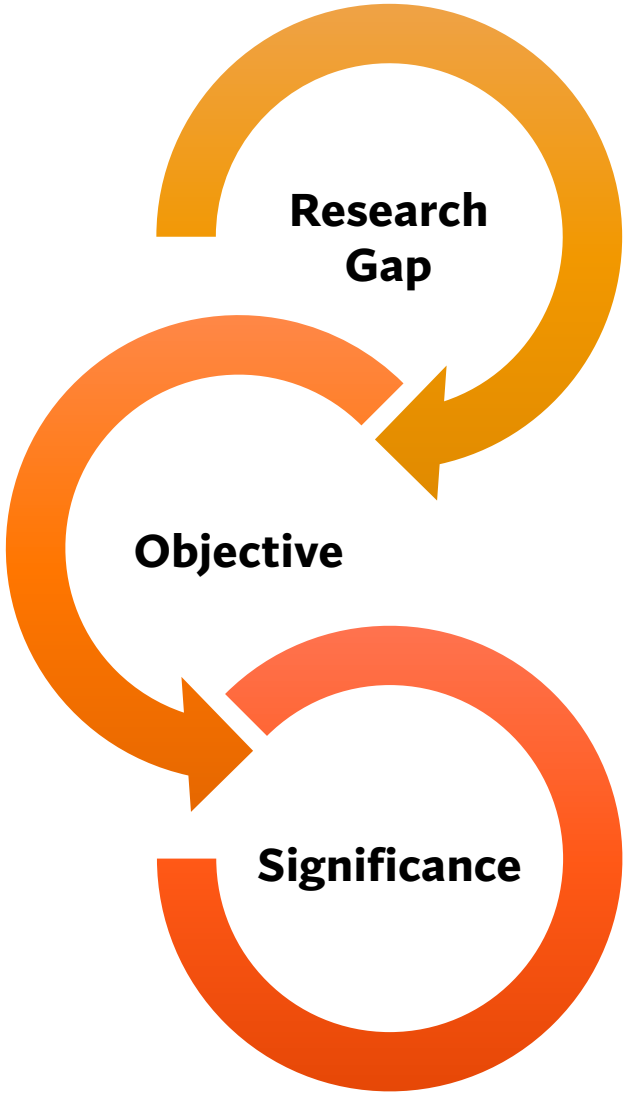
Introduction and Background

- Growing mental health crisis in the United States
    - Suicide ranks among the leading causes of deaths in the country (CDC, 2025).
- **Spatial non-stationarity**: the statistical variation in relationships between certain variables over geographic space (Fotheringham et al., 1996).
- Geographically Weighted Regression (GWR) (Brunsdon et al., 1998) has been used to assess spatially varying associations between risk factors and suicides (e.g., Trgovac et al., 2015).



Spatial patterns of suicide rates across contiguous U.S. counties. Suicide rates are defined as the number of deaths due to suicide per 100,000 population (age-adjusted) from 2016-2020.

Research Objectives



- To our knowledge, **Multiscale GWR (MGWR)** has not yet been applied to examine how the relationships between suicides and its determinants vary across ***space and scale***

- This study uses MGWR alongside traditional regression to analyze the spatial non-stationarity between suicide rates (2016–2020) and social determinants across contiguous U.S. counties

- Spatially assessing these relationships aims to identify geographic disparities where targeted interventions and resources can have the greatest impact

Methods: Data

Dependent Variable:

- County-level suicide rate (age-adjusted) from *County Health Rankings & Roadmaps*
- Measured as suicide-related deaths per 100,000 population
- Aggregated over 2016–2020
- 2,410 U.S. Counties

*County-aggregated **independent variables**, grouped by social determinants of health (SDoH) categories, analyzed in this study. Data is from County Health Rankings & Roadmaps (CHR) and U.S. Census Bureau's American Community Survey (ACS).*

Independent Variables		
SDoH Category	**Variable**	**Description**
Community and Social Context	Living Alone	Percent of population living alone
	Smart Phone Access	Percent of households without access to a smart phone
	Veteran	Percent of veteran civilian population aged 18+
Economic Stability	Unemployed	Percent of population unemployed
Education	Bachelor's Degree	Percent of population aged 25+ who completed at least a bachelor's degree
Food	Food Insecurity	Percent of population who did not have access to a reliable source of food
Healthcare System	Mental Care Providers	Number of mental health providers per 100,000 population
	No Health Insurance	Percent of population with no health insurance
	Poor Mental Health Days	Average number of mentally unhealthy days reported in past 30 days (age-adjusted)
	Primary Care Physicians	Number of primary care physicians per 100,000 population
Physical Environment	Rural	Percent of land considered rural area
Socioeconomic	American Indian/ Alaskan Native	Percent of American Indian and Alaskan Native alone population
	Black	Percent of Black population alone
	Dependent	Percent of population within dependent age groups: under 18 or over 65
	Divorced	Percent of divorced population
	Female	Percent of Female population
	White	Percent of White population alone

Methods: Spatial Analyses

- **Cluster and Outlier Analysis**
  - Used Local Moran's I (Anselin, 1995) to identify spatial patterns and heterogeneity in county-level suicide rates

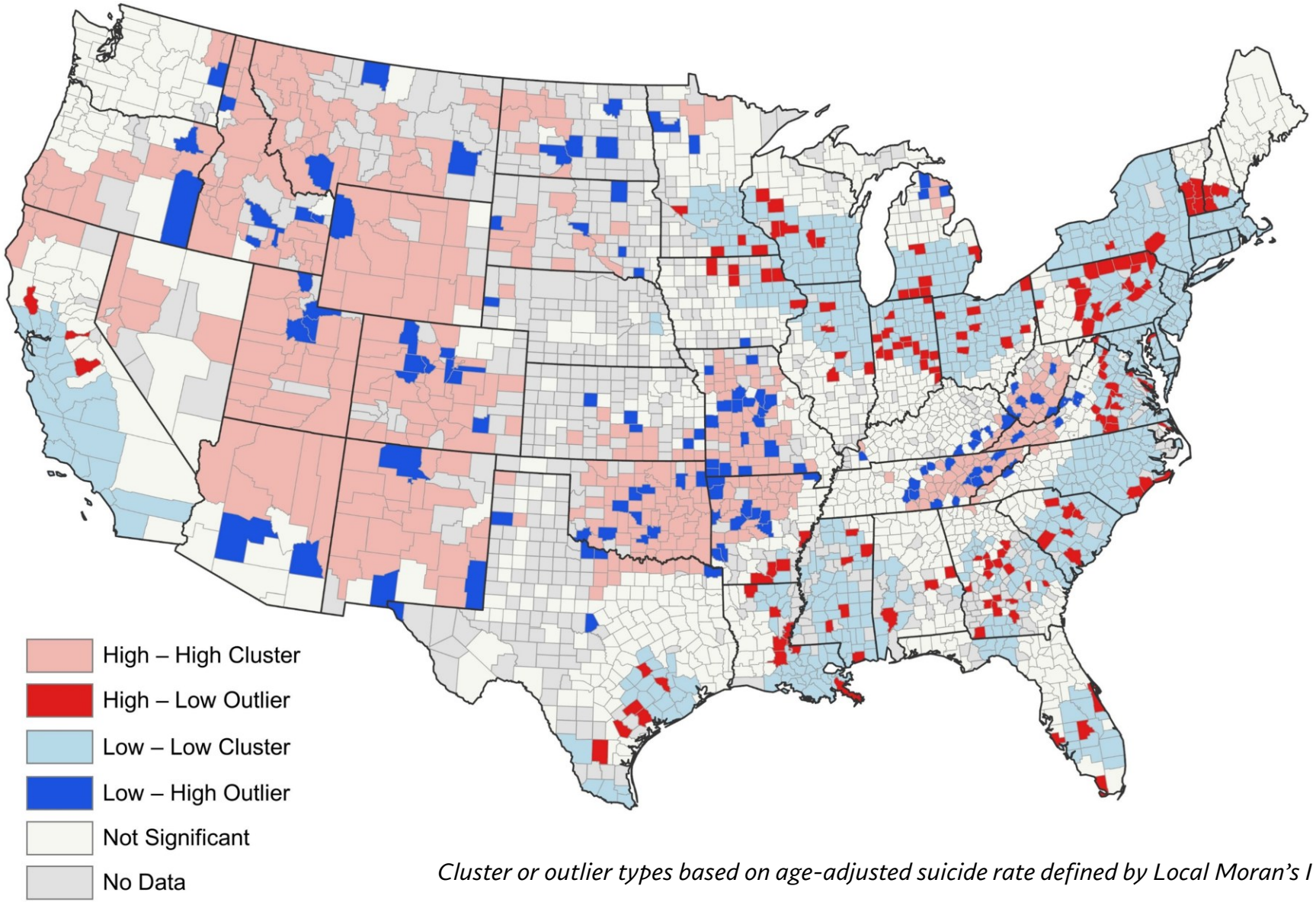
- **Ordinary Least Squares (OLS) Regression**
  - Modeled the global relationship between 17 independent variables and suicide rates
  - Assessed direction, strength, and significance of associations
  - Produced a single set of global coefficients across 2,410 U.S. counties

- **Multiscale Geographically Weighted Regression (MGWR)** (Fotheringham et al., 2017)
  - Explored *spatial non-stationarity*:
    How the associations between independent variables
    and suicide rates vary over space and scale

$$y_i = \sum_{j=1}^{M} \beta_{bw_j} X_{ij} + \varepsilon_i$$

Equation for MGWR.

Results: Cluster and Outlier Analysis



Cluster or outlier types based on age-adjusted suicide rate defined by Local Moran's I statistic.

An interactive map of the results can be accessed at: https://arcg.is/0i018f1

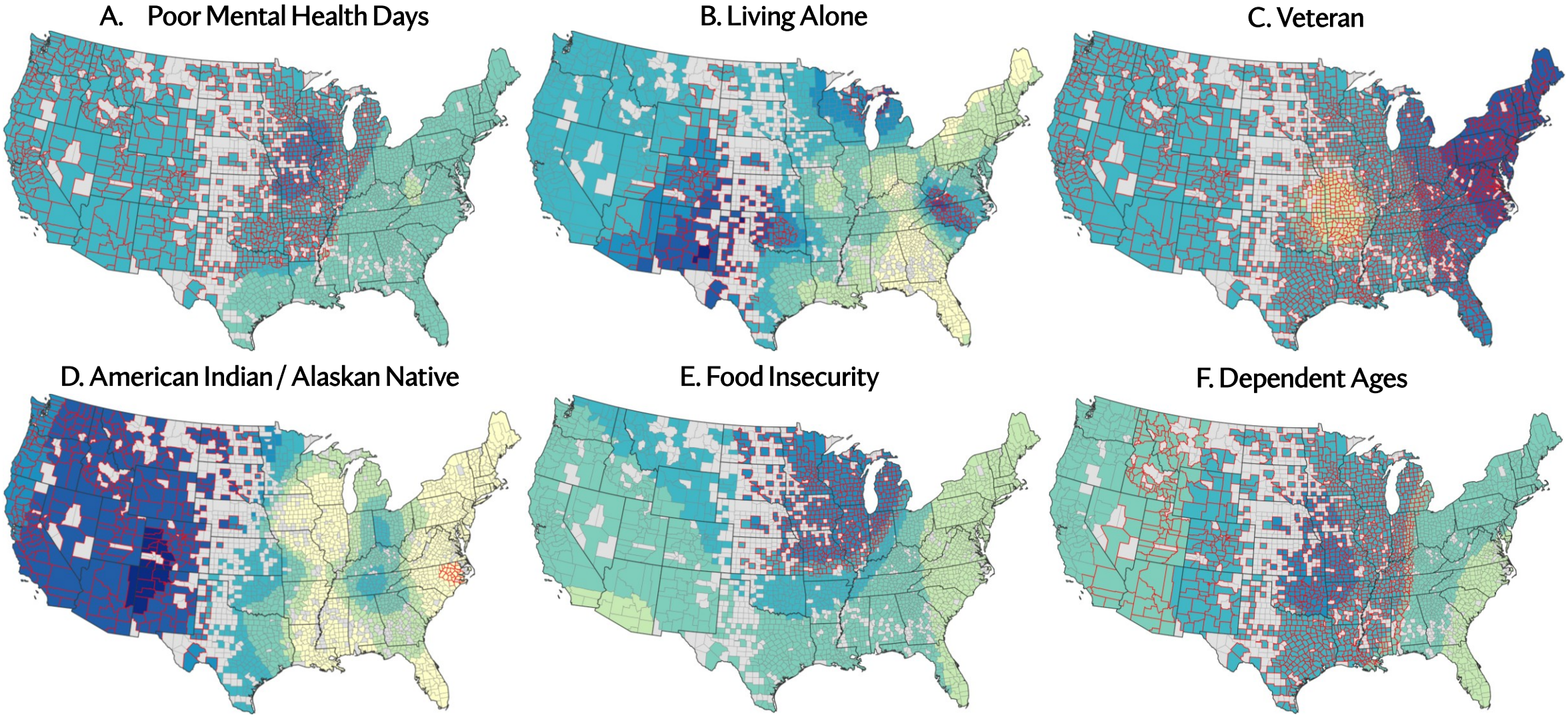
Results: OLS Regression and MGWR Coefficients

Comparison of OLS and MGWR model results for each standardized independent variable. Column 3 displays results from the OLS model. Columns 4–10 present MGWR model results.

		OLS Model (R^2 = 0.46)	MGWR Model (R^2 = 0.67)						
SDoH Category	**Variable**	**Coefficient**	**Mean**	**Std. Dev.**	**Minimum**	**Median**	**Maximum**	**Neighbors (% Counties)**	**Significance (% Counties)**
Community & Social Context	Living Alone	0.129*	0.083	0.0664	-0.0503	0.0792	0.2517	377 (15.64%)	328 (13.61%)
	Smart Phone Access	-0.092*	-0.0508	0.0563	-0.1666	-0.0478	0.0329	1072 (44.48%)	317 (13.15%)
	Veteran	0.213*	0.1475	0.0427	0.0839	0.1316	0.2325	1583 (65.68%)	2410 (100.00%)
Economic Stability	Unemployed	-0.007	0.0106	0.0638	-0.2464	0.0127	0.1493	346 (14.36%)	0 (0.00%)
Education	Bachelor's Degree	-0.052	-0.1248	0.0439	-0.1820	-0.1334	-0.0292	1072 (44.48%)	1110 (46.06%)
Food	Food Insecurity	0.054	0.0929	0.0547	0.0101	0.0866	0.2036	1021 (42.37%)	566 (23.49%)
Healthcare System	Mental Care Providers	0.016	0.0005	0.0018	-0.0048	0.0006	0.0049	2410 (100.00%)	0 (0.00%)
	No Health Insurance	0.153*	0.0095	0.0568	-0.107	0.0067	0.105	806 (33.44%)	18 (0.75%)
	Poor Mental Health Days	0.090*	0.0992	0.0352	0.0492	0.096	0.1601	1021 (42.37%)	1118 (46.39%)
	Primary Care Physicians	0.008	-0.0064	0.0035	-0.0112	-0.0075	0.0023	2410 (100.00%)	0 (0.00%)
Physical Environment	Rural	0.160*	0.1027	0.0876	-0.0996	0.1179	0.3183	327 (13.57%)	235 (9.75%)
Socioeconomic	American Indian/Alaskan Native	0.107*	0.0482	0.1001	-0.1658	0.0379	0.2533	327 (13.57%)	412 (17.10%)
	Black	-0.305*	-0.0681	0.0356	-0.1512	-0.0664	-0.0054	1154 (47.88%)	191 (7.93%)
	Dependent	0.094*	0.0974	0.0383	0.0353	0.0935	0.1630	1501 (62.28%)	1335 (55.39%)
	Divorced	0.106*	0.0282	0.0935	-0.1682	0.0330	0.2872	346 (14.36%)	238 (9.88%)
	Female	-0.070*	-0.0301	0.0414	-0.1389	-0.0164	0.0400	939 (38.96%)	210 (8.71%)
	White	0.021	0.2168	0.2515	-0.5175	0.2079	0.8281	69 (2.86%)	384 (15.93%)

An asterisk (*) denotes statistically significant associations at a 95% confidence level

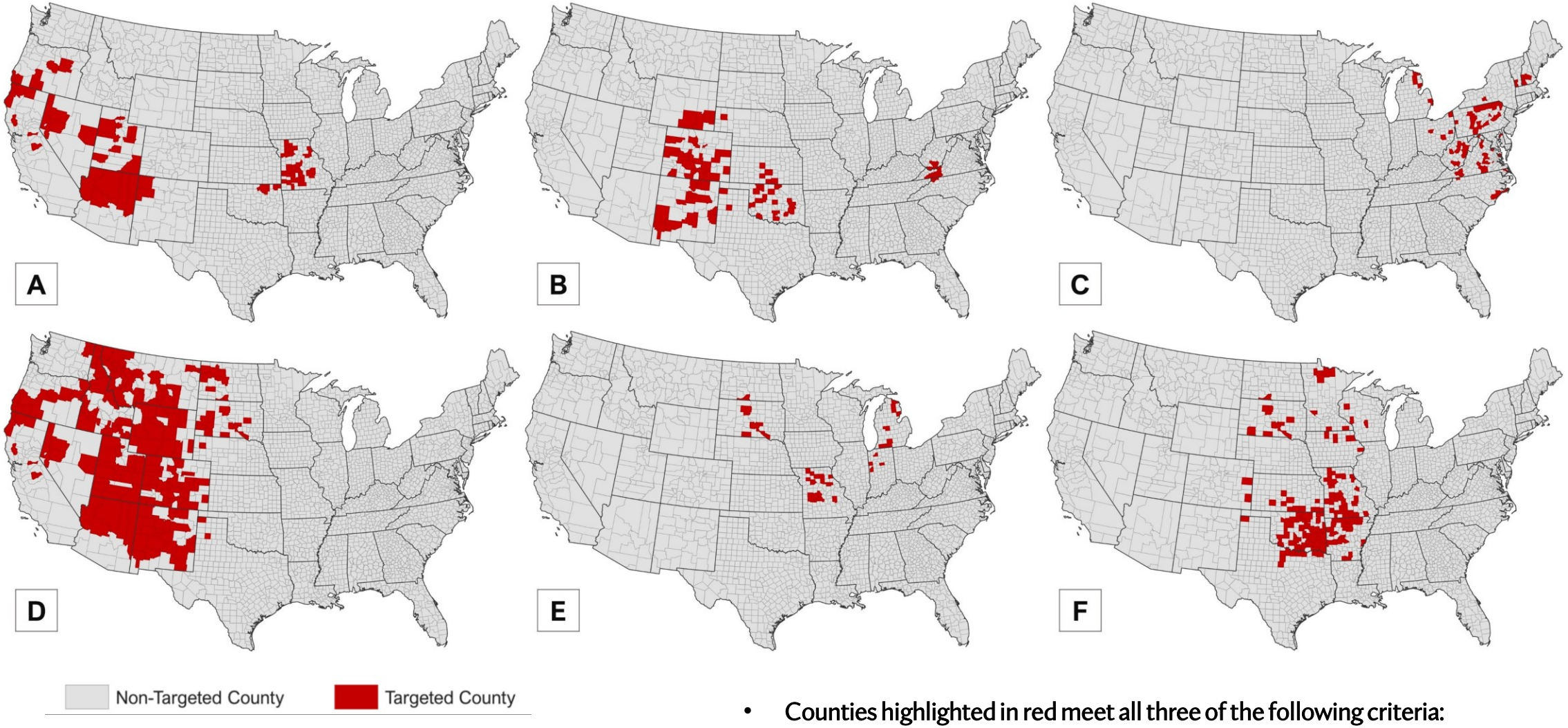
Results: MGWR Maps



MGWR results showing the spatial variability of coefficients for selected independent variables and their statistical significance in explaining suicide rates across U.S. counties.

An interactive map of the results can be accessed at: https://arcg.is/0i018f1

Discussion: Synthesizing Results to Identify Geographic Disparities



Counties identified for targeted suicide prevention interventions based on: (A) *poor mental health days,* (B) *living alone,* (C) *veteran population,* (D) *American Indian or Alaskan Native population,* (E) *food insecurity,* (F) *dependent population.*

- **Counties highlighted in red meet all three of the following criteria:**
  - High values (> average) for the given independent variable
  - Located in high clusters or outliers of suicide rates (Local Moran's I)
  - Have high (> mean +1 std.), statistically significant MGWR coefficients

An interactive map of the results can be accessed at: https://arcg.is/0i018f1

Conclusions

Key Findings

- Suicide rates are strongly associated with factors like demographics, social isolation, and mental health distress
- MGWR reveals how these relationships vary across counties and scales
- Highlights geospatial disparities, where locally tailored, data-driven prevention strategies should be prioritized

Implications & Future Directions

- Spatial modeling framework can support region-specific or finer-scale studies (e.g., census tracts)
- Adaptable to other public health issues (e.g., substance abuse, chronic diseases)
- Offers a tool that supports strategic, place-based public health planning and interventions

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Thank you!

Questions?

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An interactive map of the results can be accessed through ArcGIS Online at: https://arcg.is/0i018f1.